



WHITE PAPER

Harnessing Innovation and Emerging Technologies to Address the Impact of COVID-19 in Africa

African Union High Level Panel on Emerging Technologies

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About the AU and AUDA-NEPAD

The African Union (AU)

The African Union (AU) is a continental body consisting of all 55 countries on the African continent. It was established on 26th May 2001 in Addis Ababa, Ethiopia, and launched on 9th July 2002 in South Africa, to replace the Organisation of African Unity (OAU). The AU was established following the 9th September 1999 Sirte Declaration of the Heads of State and Governments of the Organisation of the African Unity (OAU). The most important decisions of the AU are made by the Assembly of the African Union, a semi-annual meeting of the Heads of State and Government of its member states. The AU's secretariat, the African Union Commission, is based in Addis Ababa, Ethiopia.

The AU is based on a common vision of a united and strong Africa and on the need to build a partnership between governments and all segments of civil society, in particular women, youth and the private sector, in order to strengthen solidarity and cohesion amongst the peoples of Africa. As a continental organization, it focuses on the promotion of peace, security and stability. The development work of the AU is guided by the AU Agenda 2063, which is a 50-year plan to harness Africa's comparative advantage to deliver on the vision of "The Africa We Want".

The African Union Development Agency (AUDA-NEPAD)

The African Union Development Agency (AUDA-NEPAD) is a strategic framework for pan-African socio-economic development. AUDA-NEPAD is spearheaded by African leaders to address critical challenges facing the continent including poverty, development and Africa's international marginalization. AUDA-NEPAD provides unique opportunities for African countries to take full control of their development agendas, to work more closely together and to cooperate more effectively with international partners.

AUDA-NEPAD was preceded by the NEPAD Planning and Coordinating Agency (AUDA-NEPAD) which was established in February 2010 as an outcome of the integration of NEPAD into the AU's structures and processes. AUDA-NEPAD manages a number of programmes and projects in four main investment portfolios, namely Natural Resources Governance; Youth and Skills Development; Regional Integration; Infrastructure and Trade; and Industrialization, Science, Technology and Innovation.

The African Union High Level Panel on Emerging Technologies (APET)

The first Specialized Technical Committee on Education, Science and Technology (STC-ESTI) requested the AU Commission and AUDA-NEPAD to advise Member States and RECs on matters of technology prospecting, including regulatory and ethical requirements that need to be put in place in order for the continent to benefit from emerging technologies. The Ministers further directed the then NEPAD Agency to establish a system for obtaining expert contribution on the matters of technology development, acquisition, and deployment for socio-economic development.

In order to achieve the above objective, in December 2016, the Chairperson of the African Union Commission (AUC), H.E. Dr. Nkosazana Dlamini Zuma, appointed ten (10) eminent experts from various fields to serve on the African Union High Level African Panel on Emerging Technologies (APET). The High Level Panel has been constituted in recognition of the need to harness both existing and emerging innovations and technologies for the economic development of Africa. The appointed eminent experts are drawn from diverse professional backgrounds and are critical in terms of providing evidence-based analyses and recommendations that should inform policy direction at the continental, regional and national levels on the utilization of existing and emerging innovations and technologies.

With the passing of Prof. Calestous Juma, the High Level Panel currently consists of nine (9) leading experts representing both gender and geographical demographics, and is chaired by Prof. Yaye Kène-Gassama Dia, Professor in Plant Biotechnology at the University Cheikh Anta Diop de Dakar and Vice-Chair of the board of the National Academy of Science and Technology of Senegal and Chair of the basic, applied sciences and innovation section. She is a former minister of Science and Technology of Senegal, and acting on behalf of the Senegal Government, as chair of AMCOST II (African Ministerial Council on Science and Technology). Other members of the panel include: Prof. Roseanne Diab, Director, Gender INSITE, former Executive Officer of the Academy of Science of South Africa (ASSAf) and Emeritus Professor in the School of Environmental Sciences, University of KwaZulu-Natal; Professor Berhanu Abegaz, former Executive Director of the African Academy of Sciences; Professor Francine Ntoumi, Director of the Foundation Congolaise pour la Recherche Médicale and Senior Lecturer at University M. Ngouabi, Congo-Brazzaville; and Professor Abdallah Daar, Emeritus Professor of Clinical Public Health and Global Health at the Dalla Lana School of Public Health, University of Toronto with a cross-appointment in the Department of Surgery.

The other members are Professor O. Ibidapo-Obe, a distinguished Professor of Systems Engineering and former Vice-Chancellor (2000-2007) at the University of Lagos and the pioneering Vice-Chancellor at the Federal University Ndufu Alike Ikwo (FUNAI) Ebonyi State, Nigeria (2011-2016); Dr. Rachel Chikwamba, CSIR Group Executive: Strategic Alliances and Communication and manager of the CSIR's high-level partnerships and stakeholder interactions and associated communication; Prof. Dr. Shireen Assem, Vice-President for Research at the Agricultural Research Center (ARC) in Egypt of Egypt; and Prof. Karim Maredia, Professor and Director of the World Technology Access (WorldTAP) Program in the College of Agriculture and Natural Resources at Michigan State University, East Lansing, Michigan, USA.

Apart from offering advice to the AU and its Member States on harnessing innovations and emerging technologies for economic development, the High Level also makes recommendations on the nature of regional institutional arrangements that are required to promote and sustain common regulatory approaches to the application of, and proposes strategies and policies on innovations and emerging technologies in Africa.

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Preface

The African Union High Level Panel on Emerging Technologies is a distinctive forum composed of eminent professionals from the six regions of Africa, including the Diaspora. APET works with AU member states in addressing challenges to the harnessing of innovation and emerging technologies for the socio-economic development of the continent. The Panel also contributes to efforts to understand and assist African governments respond to new developments and concerns, such as the coronavirus or COVID-19 pandemic. The Panel provides a setting where governments are provided with technical support through identifying relevant issues, seeking answers to common challenges and constraints, sharing lessons and good practices and policy experiences and providing policy recommendations on innovation and emerging technologies.

The stimulation of innovation and the effective harnessing of emerging technologies is central to empowering Africans to find African solutions to African problems. These technologies potentially go towards effectively addressing the needs and aspirations outlined in the Agenda 2063, STISA 2024 and national and regional development plans. Effective solutions place Africa in a better position to address global demands in sustainable development, economic growth and “The Africa we want.”

The COVID-19 pandemic brings sharply to the fore the realization that Africa, as a continent, is affected by global imperatives, whether good or bad. This requires that we be abreast with global tools and systems to predict, manage and monitor emerging challenges, as we are exposed to pressures and challenges that require innovation, rapid or flexible responses and adaptable strategies. Particularly on knowledge creation and utilisation of innovations that address health equity, Africa cannot play a background role as these interventions address her health system challenges adequately. Maximising knowledge empowers African citizens in an increasingly competitive world.

African governments have a pivotal role to play in creating environments in which innovation and emerging technologies are effectively harnessed and thrive. A culture of innovation is pivoted on strategic interactions among its constituent elements, and promoting such systems in AU Member States at the highest level maximises the possibilities of all these systems interacting. The current coronavirus pandemic has categorically shown that cooperation between governments, innovators (both local and external), industry, research, funding bodies and other relevant stakeholders are prerequisites for the growth and development of innovative tools that adequately address national and regional priorities and further meet the seven aspirations of Agenda 2063. Governments’ role in policy choices also ensures adequate investments in infrastructure, capacity building and strengthening research and development. These should ideally be located within frameworks that ensure appropriate balances to ensure that while viable global innovations are embraced, local initiatives are not side-lined.

Approaches to the effective harnessing of innovation and emerging technologies should be multidisciplinary and should sustain the active involvement of local partnership ecosystems. These approaches should also encourage the training of a new generation of scientists and innovators that are oriented towards problem-solving approaches by being abreast with country needs and frameworks, a merge of science and policy. When policy issues are addressed in product development, they are more easily adopted by governments and their stakeholders. This APET White Paper seeks to empower AU member states through provision of recommendations and evidence-based policy choices in harnessing innovation and emerging technologies to address the impact of COVID-19 in Africa.

Prof. Yaye Kene Gassama
APET Chair

Foreword

The COVID-19 pandemic has caused staggering human suffering and economic costs. The pandemic is far more than a health crisis. It is affecting global and more specifically, African societies and economies at their core. While the impact of the pandemic varies from one African country to another, it will most likely increase poverty and inequalities at a global scale, with special impact on African countries where there are large informal sectors, thereby making the achievement of AU Agenda 2063 and SDGs even more urgent.

Addressing the pandemic therefore, calls for African countries to adopt a multi-sectoral approach by harnessing innovation and emerging technologies both locally and globally. Assessing and addressing the impact of the COVID-19 crisis on African societies, economies and especially vulnerable groups is fundamental to inform and tailor the responses of African governments and partners to enable them to recover from the crisis and ensure that no one is left behind in this effort.

The African Union and AUDA-NEPAD have assumed immediate responses in supporting African governments to undertake a range of measures to protect their populations from the immediate and long-term socio-economic and humanitarian impact of the pandemic. The COVID-19 pandemic highlights the need for concerted multi-sectoral efforts between public, private, national and regional leaders and specialized platforms such as the AU High Level Panel on Emerging Technologies in addressing this unprecedented global public health challenge. APET is contributing to efforts that create a better understanding of the impact of COVID-19 and harnessing of innovation and emerging technologies in addressing this impact on the economies of African countries.

Through this White Paper, APET is working further in supporting AU member states to develop multi-sectoral preparedness and response plans for mitigating not only COVID-19 but also any other future crisis. Over the next 12 - 18 months, APET's support will be delivered through the dissemination of the White Paper and provision of technical support for the immediate and long-term socio-economic response to the corona virus pandemic. Additionally, APET acts as a connector is facilitating knowledge exchanges through sharing lessons learned and best practices between experts and institutions.

The ongoing response to the COVID-19 pandemic provides daily examples of how harnessing frontier technologies can make the difference between life and death. However, despite the well-documented advantages that emerging technologies offer in solving a vast range of problems associated with the pandemic, for many people on the African continent, their benefits remain a distant prospect. Scaling technologies so that everyone, including the most vulnerable in Africa can benefit from affordable and unrestricted access requires a coordinated approach to initiating global cooperation for scientific advancement and resource mobilization.

The White Paper on APET response to the coronavirus pandemic adds to the value of providing a shared understanding of global best practices in the area of preparedness strategy for pandemics, and we encourage AU member states to adopt the recommendations and strategies contained therein. It is our hope that the recommendations proposed in the White Paper will be effectively utilised by Member States in building the post-COVID Africa we want.

Dr. Ibrahim Assane Mayaki
AUDA-NEPAD, CEO

Prof. Sarah Agbor
AUC HSRT, Commissioner

Executive Summary

African Heads of State and decision-makers, through Agenda 2063 have highlighted science, technology and innovation as key enablers in promoting the ability of African countries to achieve their economic transformation and socio-economic development goals. This decision of the AU Heads of State and Government follows the adoption of the Science, Technology and Innovation Strategy for Africa (STISA, 2024) in June 2014. The AU Agenda 2063 recognizes Science, Technology and Innovation (STI) as drivers for achieving Africa's sustained growth, competitiveness and economic transformation.

The COVID-19 pandemic and its consequential impacts have created a "new normal" culture with increased reliance on innovation and emerging technologies. These technologies are imperative in addressing new problems posed by the pandemic as well as existing problems that have not been adequately addressed by existing solutions. The continent in foresight, has within STISA 2024, six priority areas that prioritize the needs of the continent that can be addressed through innovation and emerging technologies. This White Paper serves both as a compendium on innovations and emerging technologies being currently utilised in addressing the pandemic as well as serve as guidance on the short-term, medium-term and long-term strategies essential to mitigating impacts of the COVID-19 pandemic on African countries.

In the short-term, it is envisioned that the continent needs to immediately address the health challenges posed by the pandemic. As primarily a health problem, the pandemic has posed considerable strains on health systems and exposed lapses both in African economies. It calls for proactiveness in utilizing best practices in health used in addressing previous pandemics and the automation of processes where required. Across the African continent, the panel analysed responses tackling health diagnostics, epidemiology, research and vaccine development, health equipment and leveraging on indigenous African health knowledge systems. These innovations are promising and a louder call to African governments to invest in health equity across the continent.

Additionally, government strategies in controlling the pandemic heavily rely on effective communication,

as miscommunication has the potential to erase gains made. Particularly in volatile situations, it is important to manage any public mistrust for government services and interventions. The White Paper reflects on innovations being developed on the continent to support effective communication both by governments and the private sector. Public sensitisation has been primarily driven by mobile applications who serve the dual function of contact tracing and sensitisation. Governments have also leveraged social media as knowledge dissemination avenues, particularly for the youth.

Immediate responses to the pandemic require a gendered narrative to support equity. It goes without saying that pandemics and state of emergencies further increase inequalities in societies and challenges that arise are felt exponentially by the least empowered. The White Paper thus explored the gender considerations of the pandemic, highlighting the importance of integrating a gender analysis into public health emergency preparedness and response since women play a predominant role as informal carers in the home and frontline health workers.

The proposed medium-term responses on supporting Africa's recovery from the pandemic focuses on supporting the continent's MSMEs and achieving food security. To minimise shocks on these enterprises, MSMEs on the continent have to leverage on the automation that technology utilisation offers to work processes. Innovations and emerging technologies support cheaper access to automated work processes using improved designs and local materials. Globally, the second industrial revolution was characterised by less manual way of work in Europe which supported their manufacturing and industrialisation agenda and consequently strengthened their economies. Africa is opportune in this era to leapfrog and utilise innovations and emerging technologies in the fourth industrial revolution – towards addressing continental challenges. As a continent with the highest number of MSMEs and a youthful workforce, complementing innovative ideas with emerging technologies would support the recovery of the continent in the medium-term.

The pandemic highlights social inequalities resulting

from increased food insecurity due to strained economies and loss of livelihoods and businesses. The panel explored technologies that address the food value chain, towards improving “farm-to-fork” processes. In an era of restricted movements, the use of food delivery services powered by mobile technologies is a prime component of the “new normal.” This supports social distancing measures recommended by the WHO in curtailing the virus as well as sustains food security. Other innovators are utilising technologies to reduce food waste, increase soil productivity and support market linkages for small-scale farms, thereby addressing the food value chain. These are explored and highlighted in the White Paper.

In the long-term, Africa needs to look up to a post-COVID-19 world that is further strengthened by the pandemic to tackle essential developmental areas. There is the need to strengthen legal and regulatory systems on emerging technologies in Africa at the continental, regional and national level. Hence, AU Member States and RECs must be engaged to promote a culture that allows responsible regulation of emerging technologies without imposing an undue burden on adoption. An ideal avenue is through capacity building and strengthening across the board.

AU High Level Panel posits that Africa’s human resources are her greatest assets and they need to be adequately prepared with “skills for the future” for “jobs of the future.” A “new normal” paradigm has emerged in this era, encouraging remote working, flexi-hours and the use of virtual platforms for engagements and work. This implies that the requisite skills for Africa’s labour force need to be built where required or strengthened. The continent’s educational systems have also been compelled to integrate new approaches to learning using virtual platforms. Online learning, radio and television have been tools currently utilised in many African countries as schools are compelled to temporarily shut down. The disruption in academic systems has necessitated the use of other modes of teaching, for which some educational systems were unprepared. The panel further documents initiatives being carried out in African countries as proposed models or best practices to be leveraged.

Interspersed in the documents are case studies that look at best practices on the continent that further support the proposed short-, medium- and long-term strategies recommended by the panel. The first case study is on a health innovation by the Centre for Scientific and Industrial Research

(CSIR). The CSIR Lung Inspiratory Flow Enabler is an innovation very much needed to address the pandemic due to the pulmonary nature of the coronavirus disease outbreak. The second case study is on a new partnership between AUDA-NEPAD and the Ecobank Group – collaborating to establish a Continental framework to support African Micro-Small-Medium Enterprises. As the essence of sustained MSMEs has been highlighted in this document, the partnership is designed to create a one-stop platform which will address the issues, challenges and needs of MSMEs during and post COVID-19, and be an all-encompassing, flexible and comprehensive one-size-fits-all tool for MSMEs in the formal and informal sectors across the continent. Lastly, the white paper discusses the African Education, Science, Technology and Innovation Fund (AESTIF). This is an Africa-initiated, continental level financing instrument designed to facilitate Technical Vocational Education and Training (TVET); Science, Technology, Engineering and Math (STEM); Higher Education (HE); Research, and Development and Innovation (R&D&I) in Africa. Its aim is to bridge the gap in the financing of key education and skills, and STI sub-sectors through pooling of about US\$ 300 million via innovative financing mechanisms, with an initial grant component of US\$ 120 million for the Grant Trust Fund. The target is to impact 5 million Africans by 2030 indirectly through job opportunities for women and youth.

Lastly, in the White Paper the panel outlays recommendations for African governments and relevant stakeholders to inform strategies on effectively harnessing innovation and emerging technologies to address the COVID-19 pandemic and post-COVID reconstruction. The recommendations are categorised by stakeholders or sectors in nine priority areas: (i) The African Union; (ii) Health; (iii) Food Security and Nutrition; (iv) Education and E-Learning; (v) Science, Technology and Innovation; (vi) Adaptation of Policies and National Planning Systems; (vii) Communication, Advocacy and Community Engagement; (viii) Global partnerships; and (ix) Investment.

APET posits that any post-COVID-19 recovery strategy will need to re-establish the conditions for a quick return to a path of economic growth, improved social contract, and overall human development that can foster more inclusive societies in the future. This APET White Paper seeks to contribute to the growing knowledge on the continent on how to effectively mitigate the impact of the coronavirus pandemic and achieve a post-COVID-19 *Africa we want*.

Introduction

The COVID-19 Pandemic

The COVID-19 pandemic has been deemed as the greatest global threat the world has faced since the Second World War. It is not the deadliest or most infectious disease recorded, but the level of globalization and interconnectedness of the world renders it particularly destructive to societies globally.¹ The depth of the global economic crisis is exceptional; not only is it considered by experts as worse than the 2008 global recession, but it is exacerbated by its occurrence at a point where there is weakened global collaboration and political posturing over COVID-19 at an international level and in many individual countries². The African continent and the world at large are in the throes of a “new normal” revolution which will change forever the way we live, work, play, organise our societies and ultimately define ourselves.

The COVID-19 pandemic has globally impacted 213 countries and territories with more than 14.8 million confirmed cases and over 613,000 mortalities. As of the 20th of July 2020, reports on COVID-19 cases in Africa indicates 721,292 confirmed cases, 15, 169 deaths and 383, 195 recoveries in all 55 African Union (AU) Member States.³ Estimated case fatality rates in Member States vary widely due to significant differences in testing, reporting and attribution across countries. As more data are collected, African countries can better ascertain the severity of population vulnerabilities, like tuberculosis or malnutrition, on COVID-19 mortality. Each country has had unique levels of impact of the pandemic on their sectors and this requires unique strategies building up on global best practices to support the recovery of economies and an improved post-COVID-19 Africa.

According to the United Nations COVID-19 response that analyses the social impact of the pandemic, early evidence indicates that the health and economic impacts of the virus are being borne disproportionately by poor people. Homeless and displaced populations particularly are most vulnerable to lockdown restrictions, as they have little accommodation options and living in packed shelters further increases risks of disease transmission. People without access to running water, refugees, migrants, or displaced persons also stand to suffer disproportionately from strict restrictions due to limited movement, fewer employment opportunities, and increased xenophobia, among others. These social impacts, if not addressed lead to increasing inequality, exclusion, discrimination, and global unemployment in the medium and long-term. Several responses have been recorded from governments, donor agencies and development partners in mitigating the impact of COVID-19. At the African Union level, the African Union Commission through its Centre for Disease Control developed a continent-wide strategy with two overarching goals of preventing severe illness and death from COVID-19 infection in Member States and minimising social disruption and economic consequences of COVID-19 outbreaks. In addition, the AU has acted swiftly to establish a Coronavirus Fund with commitments already totalling USD20 million. At the national level, most African countries have implemented lockdowns, testing (of suspected cases) and contact tracing. AUDA-NEPAD, as the Union’s development agency, has developed medium- to long-term responses anchored in five key priorities that are aimed at strengthening (1) Health Systems, (2) Food Systems (3) Skills Development and Employment, (4) Education and (5) National Planning and Data Systems. The agency will deliver in those critical areas leveraging the support of its technical networks and it’s South-South and triangular cooperation⁴.

It is important that the pandemic is tackled recognizing that this is not only a health crisis but rather a multi-sectoral challenge, resulting in a disruption in the daily lives of people from education to livelihoods and from agricultural production to supply-chain and trade bottlenecks. Tackling the pandemic, therefore, calls

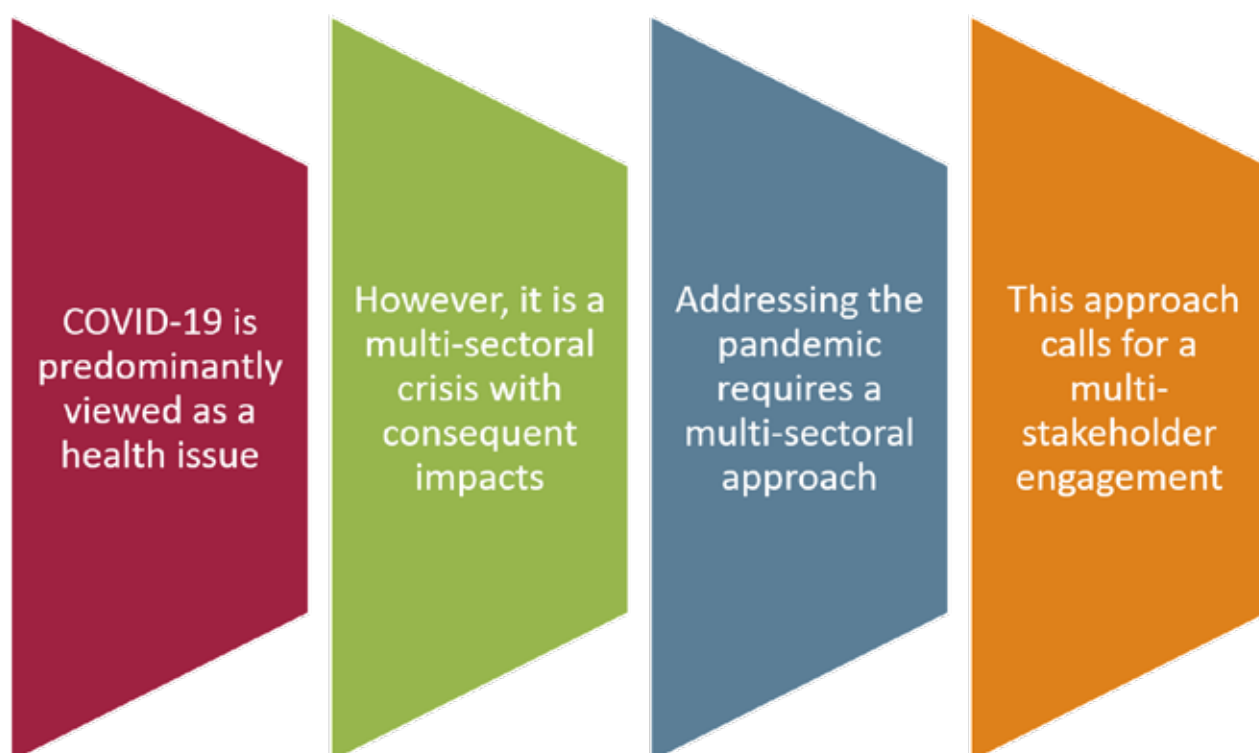
¹ WHO. Coronavirus disease 2019 (COVID-19) Situation Report – 57. 2020. https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200317-sitrep-57-covid-19.pdf?sfvrsn=a26922f2_4 (accessed 2020 July 2)

² Remuzzi A, Remuzzi G. COVID-19 and Italy: what next? *Lancet* 2020; 0. DOI:10.1016/S0140-6736(20)30627-9.

³ Coronavirus Disease 2019 (COVID-19) <https://africacdc.org/covid-19/>

⁴ AUDA-NEPAD Response to COVID-19 & other Epidemics <https://www.nepad.org/publication/auda-nepad-response-covid-19-other-epidemics>

for a multi-sectoral approach to ensure all sectors and areas impacted are adequately addressed. Further, the pandemic demands the expertise of multi-stakeholders to adequately tackle the impact and support the recovery of the African continent. The AU High Level Panel on Emerging Technologies proposes taking a three-pronged approach to the COVID-19 crisis that focuses on responding in the short-term; planning for long-term recovery; building resilience for sustainability. Recognizing that the COVID-19 pandemic is not just a health crisis but is disrupting every aspect of life, APET is working synergistically with AU member states to take a multi-sectoral approach across areas that include employment and livelihoods, finance and investment, enterprise development, gender, youth, and evaluation and education and skills. Additionally, APET recommends the response, recovery, and resilience-building efforts of AU member states to be socially inclusive, gendered and targeted to the needs of the marginalized who have been hit hardest by this pandemic.



Science, Technology and Innovation Strategy for Africa (STISA-2024)

The Constitutive Act establishing the African Union recognises the ever-growing urgency to collectively address the global social, economic and environmental challenges across our national boundaries. Governments cannot single-handedly tackle global challenges such as food and nutrition insecurity, neglected and poverty-related diseases, climate change and energy, among others, which are exponentially increasing in scope and complexity.

APET members are deeply convinced that science, technology and innovation can play an essential role in meeting these challenges through large-scale transnational collaborative

approaches which pool together technical competencies and available resources. In this regard, the high level panel has been assigned to provide technical support to AU member states in implementing appropriate policies for harnessing science, innovation and emerging technologies across the continent.

To deepen and enrich the Union's education, science and technology innovation policy debate, the AU Assembly created a Specialized Technical Committee in charge of education, science and technology. This committee is designed as a platform for African Ministers in charge of these sectors to periodically deliberate and take collective decisions.

The status of education, science and technology

is rapidly improving across the continent. The African Union recently (in 2013) adopted a people-centred, long-term Agenda 2063, which strives to enable us to remain focused and committed to the ideals envisaged in the context of a rapidly changing world. This Agenda articulates that Africa's sustained growth, competitiveness and economic transformation will require sustained investment in new technologies and continuous innovation in all development sectors.

To effectively and efficiently contribute to the implementation of the AU Agenda 2063, the AU Assembly adopted three distinct strategies for advancing education and science, technology and innovation:

- i. Continental Strategy for Education (CESA-16-25);
- ii. Continental Strategy for Technical and Vocational Education and Training (TVET); and
- iii. Science, Technology and Innovation Strategy for Africa (STISA-2024).

These strategies will also contribute immensely to achieving AU Agenda 2063 and the global Sustainable Development Goals (SDGs) and the creation of long-term economic benefits for the continent and beyond.

The mission of STISA-2024 is to “Accelerate the transition of African countries to innovation-led, and knowledge-based economies”. This will be achieved by improving science, technology and innovation readiness in Africa and implementing specific policies and programmes in these areas which address societal needs in a holistic and sustainable way. STISA-2024 is the first of the ten-year incremental phasing strategies within the broader Agenda 2063. Through STISA-2024, the AU Commission is rapidly deploying science, technology and innovation across various socio-economic sectors with a view to fostering social transformation and economic competitiveness. In the first ten years of its implementation, STISA-2024 will focus on addressing six distinct socio-economic priorities namely:

- i. Eradicating hunger and ensuring food and nutrition security
- ii. Prevention and control of diseases
- iii. Protection of our space
- iv. Communication (physical and intellectual mobility)

- v. Promoting living together and building society; and
- vi. Wealth creation

STISA-2024 is innovative. The strategy urges and mobilises all key stakeholders such as academics, researchers, innovators, funding bodies, entrepreneurs, private sector, civil society and the public to collectively and inclusively deploy science, technology and innovation in all sectors the socio-economic development of AU member states. For example, Africa should attain sustainable agriculture underpinned by strong R&D interventions if countries are to effectively address food insecurity and be able to feed its growing population, which is projected to reach 1.6 billion in 2030.

There are four mutually reinforcing pillars which are prerequisite conditions to harness science, technology and innovation in Africa. These pillars are:

- i. Building and/or upgrading research infrastructures
- ii. Enhancing professional and technical competencies
- iii. Promoting entrepreneurship and innovation; and
- iv. Providing an enabling environment for STI development in the African continent

STISA-2024 defines a new era for research and development in Africa. It calls for a stronger, dynamic and more sustainable research enterprise in all development sectors, capable of translating scientific discoveries into products, services and processes that are required to sustain Science, Technology and Innovation on the continent. The African Union High Level Panel on Emerging Technologies is the panel formed to support African Union member states to rapidly adopt emerging technologies within the context of appropriate policy and strategic frameworks in order to develop and implement such a plan.

Through the panel, the African Union looks at the preparedness of African countries for emerging technologies and innovations, regulations that are in place and those needed, as well as any ethical concerns. Due to the cross-cutting nature of STI, STISA-2024 was designed to meet the knowledge, technology and innovation demands in various AU economic and social sector development frameworks and has a leading role to play in increasing efficiency,

while eliminating duplication of effort in the design and implementation of national, regional and African Union policies on the STI.

Science, Technology and Innovation (STI) and knowledge systems play a key role in enhancing development and resilience of countries to shocks or crisis in many ways. The response to COVID-19 in Africa has shown how countries are working in some areas, but also where they could be improved. APET posits that there is a need to embrace people-driven knowledge, multi-sectoral and interdisciplinary knowledge partnerships and application of research to promote innovations. These are essential, not just in pursuing development, but also as a safety net for the continent's gains and contributions to the AU Agenda.

From the COVID-19 pandemic experience, it is important to note that investments in research and knowledge systems in Africa are important not only for onward future development efforts, but also in safeguarding the progress on development that has been made so far by AU member states. To make these investments work for Africa, there is the need to work towards more adaptive and multifaceted knowledge systems that can better cope with unexpected circumstances, like pandemics, which require rapid social and technical innovation.

Harnessing Innovation and Emerging Technologies in Addressing the COVID-19 Pandemic in Africa

In Africa, the coronavirus pandemic has arrived at a time when the continent's Member States are making efforts to build systems that promote science, technology & innovation (STI) in line with three agendas: the Science, Technology and Innovation Strategy for Africa (STISA-2024), the AU Agenda 2063 and the Sustainable Development Goals (SDGs). Knowledge systems, innovation and emerging technologies are critical for the response to the COVID-19 pandemic in Africa. Firstly, the behaviour change expected to combat the coronavirus pandemic and develop resilience systems in countries mainly relies on both formal and informal medical, social, and economic knowledge. And secondly, the pandemic is quickly reshaping how people think about our knowledge systems, as well as how African countries can repurpose scientific knowledge, innovation and emerging technologies to be more adaptive towards unprecedented pandemics and other disasters.

As the various measures taken in Europe and the US start to see a flattening of the curve, the next frontier and the most vulnerable are developing in African countries, because of their low levels of economic resilience, innovation advancement and knowledge, health care systems, resource bases and social fabric. A global threat like COVID-19 leaves no population or geographic area untouched. Not all countries have high levels of capability and support for developing economies has to be part of international cooperation. Currently, there is a broad perception in Africa, that countries are inadequately prepared for harnessing innovation and emerging technologies to address challenges and crises such as the COVID-19 pandemic. Approaches of countries to harnessing innovations are fragmented with uneven utilisations by the various AU member states.

APET recognizes the unprecedented nature of this crisis, its dire human consequences and the risks of catastrophic impacts on African countries. In the absence of a fast, adequate and context-specific response, efforts to achieve sustainable development on the continent are at risk. The number of poor and food-insecure people may increase significantly. Additionally, it is important to address the disproportionate impact on vulnerable and marginalised population groups, notably women and children, people with disabilities or health conditions and victims of domestic violence. Emerging technologies and innovative solutions have been proposed and utilised in addressing the COVID-19 pandemic and its effect on the continent. Particularly in health systems, there are increased innovative ideas in improved diagnostics, cost-effective ventilators and efficient ways of handwashing, personal protective equipment (PPEs) and social distancing measures have been developed by African countries like Ghana, Senegal, Uganda, Kenya and South Africa. Some of these ideas have been utilised in other AU member states' coronavirus pandemic responses, while others have simply remained as ideas.

Smart technological breakthroughs, tracing, and tracking systems are critical, as are technologies that improve analytical and decision-making processes. However, research and development and scientific advances require international collaboration between the private sector, scientific community and research universities and governments. Advanced and emerging economies can play a leading role; philanthropic health care organizations can prove indispensable. Scientific breakthroughs should be focused on the identification, prevention and protection, and cure of such pandemics. These

endeavours should also address climate change, a great contributor to widespread health threats. Often, wealthier countries are more likely to invest in and utilise innovation and emerging technologies. In less conservative settings, more often in the western world, the early adopters of emerging technologies and innovations are mostly the youth who are abreast with scientific advancements and readily use them even before regulatory issues are addressed. In African settings, these populations are relatively few, perhaps due to technology illiteracy, and innovators are often reliant on private sector interests particularly in ideas with business potentials.

The slow adoption of innovation and emerging technologies in Africa has been attributed to limiting regulation on the continent. However, the state of emergencies that pandemics bring ultimately require faster processes for regulatory oversight of emerging technologies that mitigate these emergencies. In a rapidly evolving world where technologies are being developed daily, it is important that African regulations keep up the pace without compromising on standards. For instance, rapid diagnostic tests developed in some member states to support the massive screening exercises of COVID-19 still required approval from regulators as it pertained to human lives. However, this had to be done at a faster rate than normal. Effective utilisation of best practices could expedite review processes or technologies developed to address issues such as this pandemic, where some regulatory processes can be skipped based on previous knowledge. An added advantage is the use of technologies like Artificial Intelligence to support data modelling, where the effects of the technology utilisation can be measured while mimicking real-life conditions.

Another issue of concern is intellectual property namely patents, trademarks, copyrights and trade secrets. It is imperative to ensure that seeking the good of a country by offering innovative tools required in times of urgency would ultimately not lead to the loss of intellectual properties. These rights of innovators need to be protected while the official processes for obtaining patents or copyrights are pursued. Technologies like Blockchain can be utilised in protecting intellectual properties and securing copyrights of technologies and innovations being utilised. Digital contents will be noted as a digital transaction in a decentralised ledger, which will ensure that each content creator will obtain their royalty distribution and protect their works. These outlined challenges are not for a lack of policies, as the continent does not lack adequate frameworks

or policies to address these challenges in harnessing emerging technologies. Limiting factors have often been in the implementation of these frameworks effectively and their adoption by AU member states.



The Purpose of this White Paper

APET members are gravely concerned by the consequences of the unfolding COVID-19 pandemic and the global economic crisis on the sustainable development prospects of African countries. In this respect, the panel convened and discussed the main impacts of the crisis on AU member states and how their specific contexts and pre-existing vulnerabilities may reduce room for manoeuvre, and further aggravate the crisis' outcomes on the continent. APET members deliberated more specifically on policy measures implemented in several African countries, the role of international co-operation in supporting the immediate, short, medium and long-term responses, and on the contributions that APET can make to inform AU member states' efforts to devise policies and partnerships to respond, reset and rebuild better, thereby contributing to the realisation of STISA 2024, AU Agenda 2063 and the 2030 Agenda for Sustainable Development.

In this White Paper, APET aims to elaborate on the innovation and emerging technologies that African countries can use in intervening in various sectors of the economy as a response to the impact of COVID-19 pandemic in the short-term (response), medium-term (recovery) and long-term (reform). The paper further defines the levels of urgency, discusses current African innovations and emerging technologies that have been developed, and offers recommendations on effectively utilising them, and lastly explores how emerging technologies will influence the future of education, work, workforce, workspace and livelihood in Africa post-COVID-19. The pandemic presents an opportunity to leapfrog innovation and emerging technologies now than ever. The world is entering a new distance economy and it is unlikely that Africa will follow the same world of work path that developed countries have followed. There is a need to ensure that African governments are prepared to deal with the impact of the COVID-19. The White Paper serves as the basis for more investment in adaptive research and knowledge research such as production, investment and dissemination that responds to emerging challenges and opportunities, which could prepare African countries to better handle issues like post-COVID-19 reconstruction, risk preparedness and further development. This calls for long-term pro-poor and disaster-proof development programmes to cushion the poor, but also skills, and innovation and emerging technologies to safeguard existing socio-economic development gains especially those related to poverty alleviation.



Response: What must African Countries do Immediately?

The outbreak of the novel coronavirus pandemic puts a spotlight on the resilience of health systems and African countries' emergency preparedness and response. The pandemic has drawn attention to the already overburdened public health systems in many African countries and to the challenges faced in recruiting, deploying, retaining and protecting sufficient well-trained, supported and motivated health workers. It highlights the strong need for sustainable investment in health systems, including the health workforce, and decent working conditions, training and equipment, especially in relation to personal protective equipment and occupational safety. Social dialogue is essential to building resilient health systems and therefore, has a critical role both in crisis response and in building a future that is prepared for health emergencies.

Health Innovations in Addressing the Pandemic

Since the World Health Organization (WHO) declared COVID-19 a world pandemic in March 2020, the virus has spread in different parts of the world as governments continue to put in place measures to contain it. The virus has created a vicious circle, impacting all spheres of life including health, security, political, economic, social or technological. The health sector which is the epicentre of dealing with the virus has been the worst affected. The health systems, in many African countries are overstretched as cases continue to rise. With relatively weak health systems characterised by inadequate health personnel, inadequate equipment, inadequate budgets and a high burden of infectious diseases, it was expected that the continued spread of the virus would overburden the health systems in African countries. In the worst-case scenario, it was predicted that most of the health systems would be overwhelmed and collapse due to the unprecedented spread of the virus.

Despite these challenges and the predictions, anecdotal evidence based on country-specific interventions indicates that African countries have appeared quite resilient or somewhat immune to infections and studies on the effect in Africa are ongoing. The region has however, put in place stringent measures that include mandatory quarantine, curfews, closure of social and entertainment venues, closure of schools, and

encouragement of basic hygiene measures among other interventions.

Africa has a favourable demographic profile (60% of the population below 25 years), in projections of the continents' most at risk to COVID-19.⁵ This is viewed as favourable because older persons are particularly susceptible to the risk of infection from the pandemic, especially those with chronic health conditions such as hypertension, cardiovascular disease, and diabetes⁶. The high prevalence of HIV/AIDS in southern regions, chronic respiratory and kidney diseases in certain countries, and tuberculosis and malnutrition, makes a considerable percentage of the population still vulnerable to the virus.

African scientists and researchers have responded to the health crises by supporting the development of improved diagnostic tools, vaccines, epidemiology tools and the manufacturing of equipment. The African Research Universities Alliance (ARUA) continuously catalogues the achievements of its member universities in the development of technologies and innovation in addressing the pandemic on the continent⁷. While African governments have made efforts to strengthen the various aspects of the health system in order to cope with the pandemic, it is expected that the continued spread will significantly impact the health systems of countries in various ways. It can be argued that African countries that have strong health systems in the region are most likely to endure the impact of the virus as compared to countries that have relatively weak health system especially if the numbers increase rapidly. This reality calls for collective efforts both at national and regional levels to support countries with weak health infrastructure. This will ensure that this group of countries cope effectively with the effects of the virus and emerge stronger during post-COVID era.

Some countries have introduced the use of mobile phone location data to track COVID-19 spread at the national level. Scaling-up digital technologies to inform, train and guide the population, especially in poor and remote locations, can improve transparency,

⁵ UNICEF (2020) Impact of COVID-19 on vaccine supplies. Available at <https://www.unicef.org/supply/stories/impact-covid-19-vaccine-supplies>

⁶ Everyone Included: Social Impact of COVID-19 <https://www.un.org/development/desa/dspd/everyone-included-covid-19.html>

⁷ Research universities' multiple responses to COVID-19 <https://www.universityworldnews.com/post.php?story=20200420091917110>



service delivery and management during the pandemic. African governments must increase the harnessing of innovation and emerging technologies both during and post-COVID period. Technological advances, such as online and mobile health applications, 3D-printing and artificial intelligence can enhance health service delivery and ways of working during and beyond the pandemic.

Research and Vaccine Development

Research and development is a very important component in addressing the impact of COVID-19. Efficacious vaccines and therapeutics are urgently required to alleviate this pandemic, as was done during the Spanish flu, Ebola and related viral pandemics. In South Africa, Stellenbosch University and a South African biotechnology company (AzarGen Biotechnologies (Pty) Ltd) have partnered towards the development of human therapeutic proteins which they hope will assist in the treatment of patients with severe effects related to COVID-19⁸. Similarly, the University of Pretoria in South Africa, by its participation in the World Health Organisation's multi-centre clinical trial for Africa, is working towards the project objective of accurately estimating the effects of antiviral treatments on in-hospital mortality⁹.

A team from the University of Cape Town, led by Professors Anna-Lise Williamson and Ed Ricki, is working on HIV-1 vaccines for South Africa, using technologies such as soluble trimeric spike protein production for HIV Env in animal cells and plants, and use of DNA and poxvirus-based vaccine vectors for HIV protein delivery¹⁰. They complement this with the activities of scientists at the Biopharming Research Unit at the University of Cape Town using the DNA and poxvirus and cell culture and plant production approaches to develop candidate vaccines for SARS-CoV-2 S protein and its related genes. There are other efforts to develop antibodies for COVID-19, for instance, by mining monoclonal antibody genes from survivors and the establishment of immunoassays and enzyme immunoassays for antibody detection for sero-surveillance. A team from the CSIR led by Dr Rachel Chikwamba, supported by the Department of Science and innovation and the South African Medical Research Council is localising technologies for local manufacture of candidate vaccines and repurposed antibody therapeutics for COVID-19 prevention and treatment in plants.

Scientists at the University of Ghana have successfully sequenced the genome of the coronavirus in Ghana. The feat, which was achieved through collaboration between scientists from the Noguchi Memorial Institute for Medical Research and the West African Centre for Cell Biology of Infectious Pathogens, represents an important milestone in understanding the variations of the virus. The Noguchi Memorial Institute, which is one of two facilities initially designated for testing COVID-19, remains Ghana's primary testing facility for all suspected COVID-19 cases, accounting for over 80% of tests nationally.

At Addis Ababa University in Ethiopia, a COVID-19 research working group comprising faculty from different colleges and research institutes has been allocated an amount of ETB10 million (US\$307,000) by the state. Their focus areas include psycho-social and economic impacts, epidemiological and clinical, molecular epidemiology, vaccines and diagnostics development. Also,

⁸ SU and local biotech company tackle COVID-19 together <http://www.sun.ac.za/english/Lists/news/DispForm.aspx?ID=7234>

⁹ University of Pretoria Health Sciences Faculty contributes to COVID-19 fight https://www.up.ac.za/news/post_2888045-university-of-pretoria-health-sciences-faculty-contributes-to-covid-19-fight

¹⁰ FHS COVID-19 Research Summary <http://www.health.uct.ac.za/fhs-covid-19-research-table>

two faculty members from the Association of African Universities formed part of the COVID-19 Clinical Research Coalition, which aims to accelerate research on the prevention and treatment of COVID-19 in low- and middle-income countries. The University of Nairobi has been selected to play a leading role following the selection of Kenya by the World Health Organization (WHO) as a testing site for vaccine trials. A team of virus specialists from the university form part of a national task force.

Manufacturing of Health Equipment

The medical equipment and device manufacturing industry in Africa (often referred to as the MedTech industry or medical devices industry) designs and manufactures a wide range of medical products that diagnose, monitor, and treat diseases and conditions that affect humans, and this industry has become increasingly relevant during the COVID-19 pandemic. In Tunisia, The National School of Engineers of Sousse and the Faculty of Medicine of Sousse launched a challenge to manufacture respirators or resuscitators on a national scale and within a few weeks students from the National School of Engineering of Sousse (Eniso) made 3D printed protective masks for medical staff at Farhat Hached Hospital in Sousse where patients with coronavirus are hospitalized¹¹. The University of Pretoria's MakerSpace centre is producing 3D-printed visor frames to be used as facial shields by health workers¹². The 3D printing laboratory of the division of orthopaedic surgery at Stellenbosch University has been repurposed to print and assemble much-needed visors for frontline workers.

Additionally, Robots Can Think, a South African company that specialises in creating artificial intelligence capable of controlling robots (factory robots, household robots, cars) is collaborating with other companies to provide cheap and accessible medical masks for hospitals¹³. With the support of members of the Robots Can Think platform and Women in AI community, their founder Natalie Raphil is using about five 3D printers to design and produce 100 masks a day for distribution to some major hospitals in Johannesburg. Still, in South Africa, Engineers and students at the faculty of engineering and the built environment at the University of Witwatersrand have been involved in producing face shields and breathing assistance devices for use at local hospitals¹⁴. Their colleagues at the Addis Ababa University are also producing PPE including face shields and bubble helmets being used by health workers and patients¹⁵.

CASE STUDY 1: THE CSIR LUNG INSPIRATORY FLOW ENABLER

In response to the need to assist severely affected COVID-19 patients to breathe, the CSIR, South Africa, has developed a range of non-invasive positive airway pressure ventilator devices, the CSIR Lung Inspiratory Flow Enabler or CSIR L.I.F.E. products (CPAP – continuous positive airway pressure and Bi-PAP – Bi-level Positive Airway Pressure).

The devices are simple and robust for use mainly in clinical environments but under right conditions can be used effectively in many other medical environments. Multiple configurations of operation for the CSIR L.I.F.E. products are possible: (i) A single pressure mode, where the device functions as a typical CPAP ventilation device. This is applicable for the less serious patients, where a clinician might decide that a CPAP Treatment is most relevant. In this configuration, the device only requires a pressurised oxygen supply; (ii) in a second configuration, the device can operate in multiple modes for example as simple CPAP device, as a BiPAP fixed mode or as a BiPAP sensed mode.

In the BiPAP fixed mode, the breathing rate is set, and the inhalation and exhalation pressures are delivered as per this set rate. The fixed mode is generally used for patients with more severe symptoms that require more assistance with breathing. In the BiPAP sensed mode, the device allows the medical operator to adjust the inspired oxygen proportion (FiO₂ level) of the gas supplied to the patient as well as the inhalation and exhalation pressures required. In this mode the CSIR L.I.F.E. senses the patient's breathing rate and assists where applicable, thus making it easier for patients to breathe whilst maintaining a positive air pressure on the lungs. The device conforms to the licence requirements set out by the South African Health Products Regulatory Authority and conforms to WHO guidelines for these types of products.

¹¹ Tunisia-Sousse – Coronavirus: Engineers manufacture 3D printed medical masks <https://news-tunisia.tunisienumerique.com/tunisia-sousse-coronavirus-engineers-manufacture-3d-printed-medical-masks/>

¹² University of Pretoria's MakerSpace Centre producing 3D visor frames for facial shields for healthcare workers https://www.up.ac.za/coronavirus-updates/news/post_2884703-university-of-pretorias-makerspace-centre-producing-3d-visor-frames-for-facial-shields-for-healthcare-workers

¹³ 6 amazing African innovations against COVID-19: A cure from physics? <https://techpoint.africa/2020/04/23/african-innovations-covid-19/>

¹⁴ Wits engineers make face shields to protect healthcare workers <https://www.wits.ac.za/news/latest-news/general-news/2020/2020-04/wits-engineers-make-face-shields-to-protect-healthcare-workers.html>

¹⁵ Institute to Use Respiratory Protective Device <https://addisfortune.news/institute-to-use-respiratory-protective-device/>

Coenie Koegelenberg, a Professor of Pulmonology at Stellenbosch University's Faculty of Medicine and Health Sciences, South Africa has designed a double robotic robot that allows medical staff to perform ward rounds virtually, especially among intensive care patients, thereby protecting medical staff from the risk of infection¹⁶. In Uganda, the school of public health at Makerere University is collaborating with the local Kiira Motors Corporation and the Ministry of Science, Technology and Innovation under the Resilient Africa Network project to develop open design low-cost ventilators to meet local demand¹⁷. Companies in Senegal are producing hand sanitisers while companies in Ghana are producing face masks.

Improved Health Diagnostics

Universities, research institutions and governments in Africa have and continue to collaborate in manufacturing health kits intended for addressing the challenges of the coronavirus pandemic. In working towards improved diagnostics, a local Ghanaian diagnostics company (Incas Diagnostics) has partnered with the Kwame Nkrumah University of Science and Technology to develop a simple-to-use COVID-19 testing kit that gives results in 15 to 20 minutes¹⁸. Similarly, in Senegal, Manufacturers are prototyping a COVID-19 testing kit that will reportedly cost less than \$1, in a collaborative programme involving British and French researchers with distribution expected in June 2020¹⁹. The Makerere University of Uganda has also supported cost-effective kit development and have subsequently a swab tube dipstick test for the coronavirus pandemic that can reportedly give results within minutes at the cost of just \$1. Innovators in Kenya²⁰, South Africa²¹ and Tunisia, have reported similar research.

Beyond swabs, some Tunisian engineers²² have built an accessible web-based platform that scans lung X-rays and evaluates whether patients are likely to be suffering from the novel coronavirus. Backed by German development agency GIZ, the Italian Society of Medical Radiology and tech giants IBM,

some teachers and students of the National Institute of Applied Sciences and Technology (INSAT) have been developing the platform — COVID-19 Exam CT/XR images by AI — since March. With thousands of lung X-rays for both healthy and coronavirus pandemic patients being fed into the platform, the AI can recognise the signs of the virus on human lungs. The University of Dar es Salaam has engaged in multidisciplinary research on the efficacy of traditional medicine for COVID-19 treatment²³.

The South African Medical Research Council (SAMRC) and the Technology Innovation Agency have launched a call to escalate the production of locally manufactured PCR reagents and test kits to be used on open PCR testing platforms²⁴. The SAMRC is funding a network of genomic research groups who are conducting genomic analysis on COVID-19 strains across South Africa. Groups from 5 research institutions are sharing data in real-time to track the epidemiology of the disease.

Disease Epidemiology Tools

The coronavirus pandemic is heavily reliant on effective trace-back strategies and useful disease epidemiology principles. Given the urgency of the present global situation, many African governments are boosting manufacturing capacity quickly by empowering companies to manufacture epidemiology tools by relying on existing and approved manufacturing procedures, quality assurance programmes and certificates of conformity held by existing PPE manufacturers. In Nigeria, a company called Wellvis created the COVID-19 Triage Tool²⁵, a free online tool to help users self-assess their coronavirus risk category based on their symptoms and their exposure history. Depending on their answers, users will be offered remote medical advice or redirecting to a nearby healthcare facility. The tool has helped to reduce the number of unnecessary and curious callers to disease control hotlines and has been used by more than 380,000 people globally since 19th March, 2020.

In Ghana, Darlington Ahiale Akogo, Founder and Director of Artificial Intelligence at GUDRAG, has built a comprehensive real-time tracker of COVID-19 cases across Africa²⁶. This provides policy and

¹⁶ 'Robot' helps Tygerberg specialists on ward rounds during pandemic <http://www.sun.ac.za/english/Lists/news/DispForm.aspx?ID=7277>

¹⁷ Bulamu Ventilator <http://www.kiiramotors.com/bulamu-ventilator/>

¹⁸ Diagnostic start-up, KNUST Develop Rapid COVID-19 Test <https://mastercardfdn.org/diagnostic-start-up-knust-develop-rapid-covid-19-test/>

¹⁹ Senegal: 10-minute coronavirus test may be on its way - for \$1 <https://www.aljazeera.com/news/2020/03/senegal-10-minute-coronavirus-test-1-200327053901231.html>

²⁰ Covid-19 results in 15 minutes: KEMRI starts manufacturing rapid test kits <https://www.standardmedia.co.ke/health/article/2001367222/covid-19-results-in-15-minutes-kemri-starts-manufacturing-rapid-test-kits>

²¹ CapeBio creates breakthrough fast result coronavirus tests <https://www.capetownetc.com/news/capebio-creates-breakthrough-fast-result-coronavirus-tests/>

²² The ground-breaking way to search lungs for signs of Covid-19 <https://www.bbc.com/news/business-52483082>

²³ UDSM develops automatic hand washing machine <https://arua.org.za/university-of-dar-es-salaam/>

²⁴ SAMRC to finalise process of reviewing covid-19 testing innovations <https://ewn.co.za/2020/06/03/samrc-to-soon-finalise-process-of-reviewing-covid-19-testing-innovations>

²⁵ Here's how Africans are using tech to combat the coronavirus pandemic <https://www.weforum.org/agenda/2020/04/africa-technology-coronavirus-covid19-innovation-mobile-tech-pandemic>

²⁶ Preparing Africa for an Artificial Intelligence Future <https://runmilainstitute.com/>



decision makers and relevant parties with real-time information to track the spread of the virus and help them plan efficient interventions like drug and medical supply distribution, as well as social distancing measures.

At the University of the Witwatersrand (Wits) in South Africa, an interdisciplinary team of researchers led by Professor Bruce Mellado from the school of physics has developed an intuitive and interactive dashboard to track and model the spread of the virus based on information from local sources, the National Institute for Communicable Diseases and the WHO²⁷. The dashboard provides a day-by-day account of the tests and recorded infections and nuances in the data by province. The University of Pretoria has a repository at the department of data science that provides real-time data on COVID-19 infections globally. Additionally, the University has a transdisciplinary team from its faculty of health sciences and the department of mathematics and applied mathematics that is engaged in modelling of the pandemic in South Africa²⁸. The University of Lagos, Nigeria²⁹ and the department of mathematics and applied mathematics at the University of Cape Town³⁰ are all working on epidemiological modelling tools to address the pandemic.

The CSIR-South Africa has utilised a locally-developed command-and-control platform, Cmore, to support screening and contact tracing activities during the pandemic. Cmore is a central situational awareness platform, which will provide a single view of reality. Underpinning this platform is a set of competencies that include epidemiological modelling, data analytics, high-performance computing and data visualisation. The platform, which is housed in a secure facility at the Council for Scientific and Industrial Research (CSIR), in Pretoria, provides close to real-time analytics and dashboards on the Coronavirus outbreak per province, district, local municipality and ward. Visualisation dashboards are then made available to government officials at various levels to support decision-making³¹.

A team, led by Prof Co-Pierre Georg, from the University of Cape Town, has developed Covi-ID³² an open-source platform to ensure contact tracing happens within as short a period as possible after someone has tested positive. The solution has been developed with Africa in mind (for example, many similar solutions depend on ubiquitous access to smartphones and data, which is not always the case in Africa). By combining QR codes and check-ins for public spaces, Covi-ID provides unparalleled precision and coverage, crucial because any missing link in a contact chain can put lives at risk.

An individual generates a QR code that is linked to a unique Covi-ID wallet by using a computer or smartphone. Creating these QR codes can be done as a service by businesses, by colleagues or friends or at Internet Cafés. The QR codes can be printed and carried by the individual. When visiting a public space

²⁷ Wits researchers launch most comprehensive COVID-19 dashboard in South Africa <https://www.wits.ac.za/news/latest-news/general-news/2020/2020-03/wits-researchers-launch-most-comprehensive-covid-19-dashboard-in-south-africa.html>

²⁸ UP models COVID-19 Pandemic in South Africa <https://arua.org.za/university-of-pretoria/>

²⁹ Nigeria responds to COVID-19; first case detected in sub-Saharan Africa <https://www.nature.com/articles/d41591-020-00004-2>

³⁰ Projects underway at universities in support of struggle against covid-19 pandemic http://pmq-assets.s3-website-eu-west-1.amazonaws.com/200421Annexure_C_Research_Report.pdf <http://www.math.uct.ac.za/>

³¹ CSIR's Cmore tapped for COVID-19 situational awareness <https://www.defenceweb.co.za/joint/science-a-defence-technology/csirs-cmore-tapped-for-covid-19-situational-awareness-2/>

³² COVID-19 risk management designed to protect privacy <https://www.coviid.me/>

(e.g. a shopping centre, using public transport, or returning to employment), this QR code is scanned by someone with the Covi-ID verifier app (this can be a security guard, receptionist, public transport driver, etc.). The date, time, and geolocation are then “stamped” in the individual’s Covi-ID wallet. If the individual tests positive, anyone that has been at the same place at the same time is alerted to be tested. Contact tracers are also alerted. The geolocation history is kept in the Covi-ID wallet for 2 weeks retrospectively.

Efforts towards improved health diagnostics and disease epidemiology tools call for more concerted efforts to ensure all areas are adequately covered in disease surveillance on the continent. These efforts must be consolidated to support peer learning and mentoring and to enable African experts to tackle the pandemic whilst utilising best practices. The AU High Level Panel emphasises the need for investment in, and access to innovation and technologies to strengthen productive and educational capacities in African countries, which could help provide a more effective response to the current and future crises. Key investment areas include quality infrastructure and sustainable energy. It will be necessary to reflect on post-COVID-19 industrial systems and the implications for African countries, including access to technology, associated with the possible reorganisation of global value chains, in order to harness the digital economy and build more diversified and resilient economies.

Protective equipment, ventilators and treatment support

All over the world, there is an acute shortage of personal protective equipment (PPE) for health personnel. Countries that used to be net exporters of the equipment have either run out of stock or are keeping it to deal with the COVID-19 pandemic in their own nations, leaving almost all African states, which essentially import equipment, with a huge deficit. Many African leaders have been calling on local firms to switch to the production of the lifesaving equipment as part of efforts to help protect the lives of frontline health professionals. A good number of universities and companies have responded to the calls using what is available to them.

Engineers and students at the faculty of engineering and the built environment at Wits have been involved in producing face shields and breathing assistance devices for use at local hospitals, while the University of Pretoria’s MakerSpace centre is producing 3D-printed visor frames to be used as facial shields by health workers. The 3D printing

laboratory of the division of orthopaedic surgery at Stellenbosch University has been repurposed to print and assemble much-needed visors for frontline workers. Addis Ababa University is also now producing PPE including face shields and bubble helmets to be used by health workers and patients. Africa has the lowest number of ventilators in the world. As in other parts of the world, there is great interest in ventilators. A faculty member at Rhodes University in South Africa, Professor Justin Jonas, joined a national task team as technical advisor to produce ventilators for South Africa.

Leveraging Indigenous African Knowledge

The use of medicinal plants as a fundamental component of the African traditional healthcare system is perhaps the oldest and the most assorted of all therapeutic systems. According to the WHO, 80% of the emerging world’s population relies on traditional medicine for therapy; with over 90% use in some African countries. In many parts of rural Africa, medicinal plants are the most easily accessible and affordable health care resource available to the local communities and at times the only therapy that subsists. The ratio of traditional healers to the population in Africa is 1:500 whereas the ratio of medical doctors to population is 1:40,000 (WHO). In African countries where the number of practitioners of modern medicine may not be enough to meet the health care needs of the country, traditional medicine and its practitioners are considered an important resource for population health.

WHO recognizes that traditional, complementary and alternative medicine has many benefits and Africa has a long history of traditional medicine and practitioners that play an important role in providing care to populations. Medicinal plants such as *Artemisia annua* are being considered as possible treatments for COVID-19 and should be tested for efficacy and adverse side effects. Africans deserve to use medicines tested to the same standards as people in the rest of the world. Even if therapies are derived from traditional practice and natural, establishing their efficacy and safety through rigorous clinical trials is critical. These species are mostly rampant in Africa, with the Republic of Madagascar topping the list by 82%.

Africa contributes nearly 25% of the world trade in biodiversity. Nonetheless, the paradox is that despite this huge potential and diversity, the African continent has only a few drugs commercialized globally. The potential of the promising medicinal plants from the African biodiversity which have short- as well as long-term potential to be

developed as future phytopharmaceuticals to treat and/or manage panoply of infectious and chronic conditions remains untapped. That said, the use of products to treat COVID-19, which have not been robustly investigated can put people in danger, giving a false sense of security and distracting them from hand washing and physical distancing, cardinal in COVID-19 prevention, and may also increase self-medication and the risk to patient safety. Additionally, development in national and regional regulations for assessment of the quality, safety and efficacy of medicinal plants to fast track commercialization of the African indigenous knowledge in medicine is limited, meaning Africa has to rely on western standards for approval to use its rich biodiversity for its citizens.

African governments through their Ministers of Health adopted a resolution urging Member States to produce evidence on the safety, efficacy and quality of traditional medicine at the 50th Session of the WHO Regional Committee for Africa in 2000. It is imperative for African governments to undertake relevant research and require national medicines regulatory agencies to approve medicines in line with international standards, which include the product following a strict research protocol and undergoing tests and clinical trials.

Effectively Communicating a Pandemic

Researchers and practitioners have developed a variety of aggregated metrics using mobile phone data that can help fill gaps in information needed to respond to COVID-19 and address uncertainties regarding mobility and behaviours. Adequate access to information through effective communication, especially in an era of a pandemic directly influences the mitigation of the pandemic. Misinformation, on the other hand, retrogresses successes of interventions, as unreached populations may carry on with life without following proposed security measures. As experienced in the harnessing of some emerging technologies, populations become averse to the change when communication fails.

Using innovation and emerging communication technologies, AU Member States can ensure the representation of all populations in decision-making, thereby enabling its citizens to monitor policy, learn, collaborate and react to proposed legislation. It also eases communications processes of governments as more people are reached faster in more cost-effective ways. This builds a society which understands and values science, engineering and technology and their critical role in ensuring health equity for her citizens.

Technologies offer opportunities for disadvantaged populations, particularly in rural areas, to leapfrog into the benefits of the 4th Industrial Revolution through the utilisation of emerging technologies for communication and capacity building. At present, disadvantaged populations in some African settings have little access to these technologies, and thus much-needed information. For example, eLearning platforms are used in more developed or urban settings, with adequate internet access, which provides substantive e-discussions and capacity-strengthening of knowledge networks and allows practitioners to engage in an in-depth discussion, and exchange on emerging issues and common challenges facing



the network. These platforms develop thematic communication workspaces that contribute to a dynamic collection of knowledge resources.

Africa's interventions in promoting communication should be to ensure that innovation and emerging technologies are accessible at all levels of society to achieve knowledge balance in communities and among individuals and "leave no one behind." This includes access to affordable telecommunication channels to ensure universal access to communication tools, as it guarantees equitable access to information nationally, regionally and continentally. For instance, although the continent is flooded with mobile phones, a smaller percentage of those phones have internet access and a further small percentage of its owners can afford internet services.

Seminal work on human mobility has shown that aggregate and (pseudo-) anonymized mobile phone data can assist the modelling of the geographical spread of epidemics. Thus, researchers and governments have started to collaborate with private companies, most notably mobile network operators and location intelligence companies, to estimate the effectiveness of control measures in a number of countries. There is, however, little coordination or information exchange between these national or even regional initiatives.

The potentials of mobile phones if connected to affordable internet cannot be overemphasised. This takes into account the undoubted potential of communities at various levels to cooperate, bridge differences, and work for mutual upliftment and the meeting of basic needs, and to redress the social imbalances of underdevelopment if the platform is provided. Although ad hoc mechanisms leveraging mobile phone data can be effectively (but not easily) developed at the local or national level, regional or even global collaborations seem to be much more difficult given the number of actors, the range of interests and priorities, the variety of legislations concerned, and the need to protect civil liberties. The global scale and spread of the COVID-19 pandemic highlight the need for a more harmonized or coordinated approach.

Public Education, Sensitisation and Advocacy Initiatives on the Continent

Public education has become key to supporting efforts at stopping the spread of the pandemic. For most African economies, functional literacy remains low, and superstition tends to be rife in addressing public health concerns. In South Africa, the Centre for

Deaf Studies at Wits University launched initiatives to disseminate information on the pandemic, self-protective measures and government programmes aimed at curbing the spread of the disease to hearing-impaired communities³³. Some students at the university have also been engaged in the production and translation of educational posters and comics on the coronavirus. Additionally, the South African government is using WhatsApp to run an interactive chatbot which can answer common queries about COVID-19 myths, symptoms, and treatment.

According to the World Economic Forum³⁴, the platform has reached over 3.5 million users in five different languages since it was launched in March and is being rolled out globally. The chatbot was developed by a local non-profit organisation, according to Praekelt.org, a Johannesburg-based non-profit organisation that helped the Department of Health build the bot. In Tunisia³⁵, a group of experts has developed a chatbot under the name of Corona Bot in order to provide free answers and advice, available 24/7 and messages every day to fight against fake news.

Makerere University has developed an online Coronavirus Resource Centre to provide comprehensive and fact-based information on the virus to the public and policy-makers. The university's school of public health, in collaboration with the Ugandan Ministry of Health, designed and organised a training and sensitisation event for organisations on preparing the workplace for COVID-19. Kenya's University of Nairobi has initiated a public blog and webinar series on COVID-19 which highlight preventive measures and offer options to deal with various COVID-19 related social challenges.

Gender Considerations of COVID-19

In most African countries the division of labour in the home places a heavy reliance on women for the provision of home care. Women are facing particular challenges during this pandemic. Globally, they make up more than 70 per cent of the health workforce³⁶. Women also carry the burden of unpaid care work,

³³ Centre for Deaf studies breaks the silence on COVID-19 <https://www.wits.ac.za/news/latest-news/general-news/2020/2020-04/centre-for-deaf-studies-breaks-the-silence-on-covid-19.html>

³⁴ Here's how Africans are using tech to combat the coronavirus pandemic <https://www.weforum.org/agenda/2020/04/africa-technology-coronavirus-covid19-innovation-mobile-tech-pandemic>

³⁵ TAPP Project Launches an Online Chatbot to Educate about COVID-19 <https://tn.usembassy.gov/tapp-project-launches-an-online-chatbot-to-educate-about-covid-19/>

³⁶ ILO: ILO Monitor, 2nd edition: COVID and the world of work. Geneva: ILO, 7 April 2020



such as taking care of children or elderly family members. It is estimated that while women's contribution to health care accounts for nearly 5 per cent of global GDP, almost half of their contribution is, in fact, unpaid and unrecognized. Women in the health and social work sectors in Africa tend to be engaged in lower-skilled jobs, with less pay and at the lower end of professional hierarchies, contributing to a gender pay gap of on average 26 per cent in high-income and 29 per cent in upper-middle-income countries.³⁷

During this pandemic, women, in particular, are being confronted with the challenges of balancing an increased workload, the anxiety of spreading the virus to loved ones and the management of their care responsibilities and home-schooling of children at home. Governments should ensure that measures are taken to support health workers, in particular those with additional care responsibilities at home.

Previous outbreaks have shown the importance of integrating a gender analysis into public health emergency preparedness and response since women play a predominant role as informal carers in the home and frontline health workers. The pressing demand on women as informal care providers highlights the strong need for flexible working time arrangements that are predictable and gender-responsive, and that allow and encourage men and women to better balance their work and family responsibilities.

Travel restrictions and anxiety about infection pose additional obstacles to providing home care for the elderly and sick people. Home care is predominantly provided by women as personal care workers in African families. The current COVID-19 outbreak is significantly highlighting the need for support for women during this pandemic, and African governments, policy and decision-makers, families and communities alike are encouraged to be cognizant of the gendered impact of the coronavirus pandemic during the development of policies and programmes.

³⁷ ILO: *A quantum leap for gender equality: for a better future of work for all*, Geneva, 2019

Recovery: How do African Countries Rebuild what has been lost?

MSMEs as Drivers of Africa's Recovery post-COVID-19

In Africa Micro, Small & Medium Enterprises (MSMEs) make a significant contribution to local employment and to overall gross domestic product (GDP). The economic downturn African countries are experiencing due to the coronavirus pandemic to which MSMEs are especially vulnerable, has hit these developing economies at the heart. With generally small reserves and limited working capital, many MSMEs rely upon a steady flow of continuous demand for their products and services. Many would struggle to survive a prolonged period of reduced economic activity. Despite this situation, MSMEs have been touted as solutions for taking Africa out of the economic distresses that this pandemic has created. The key to limiting the economic impact of coronavirus in African countries is acting early to cushion the effect of an economic downturn on MSMEs. It is easier and more cost-effective to sustain existing businesses and livelihoods during the pandemic than to rebuild new businesses once the crisis has passed. Some MSMEs have benefited from the government's relief effort to businesses to enable them to stay afloat amidst the lockdown measures. In addition to government support, entrepreneurs should take measures early to ensure their businesses have the resilience levels necessary to withstand an economic downturn or temporary closure.

Africa's support structure for creating and sustaining micro-enterprises and small businesses during and post-COVID-19 will require a strong technology component. Technology offers more automation, which ultimately leads to more comparative yields. In the face of lockdown measures and restrictions, this also means less staff required at a point in time in a work process, thereby supporting social distancing measures.

Technological support for Africa's MSMEs in the face of growing globalization needs to be encouraged, particularly in line with job assessments in the green economy and recognising their roles as driving forces behind the economy. These businesses require leadership, research, incentives and support towards a shared vision of African innovation, backed by governments and relevant stakeholders. It is imperative that public investments in research

and development be designed to address both government and private sector initiatives and to encourage private sector investments in R&D. This ensures a sustainable model where both sectors maximise resources to support the use of innovation and emerging technologies in sustaining Africa's MSMEs.

The transformation of new ideas into commercial successes, which are so important to the nation's ability to achieve economic development, employment creation and competitiveness, requires that attention be devoted not only to R&D and the technical factors of innovation but likewise the social, institutional and market factors such as adoption, dissemination and transport. Translating ideas into innovation and a product for mainstream markets requires financial support. Particularly for SME's, limited resources are deciding factors for their sustenance, however innovative their venture. To integrate the new demands of innovation and emerging technologies, firms and government must undertake an organisational effort to embrace novel methods of production, management and dispersion. Funding for such measures requires the active participation of both public and private sectors and through internal cash flows, industry levies, equity financing, among others. In post-COVID-19, governments are encouraged to set up innovation funds to support MSMEs in innovation and the harnessing of emerging technologies as was undertaken for mitigating impacts of the pandemic. Funding can also be provided in-kind through tax incentives and through direct funding of MSMEs.

CASE STUDY 2: COVID-19 RECOVERY THROUGH EMPOWERED MSMEs

A sustainable post-COVID-19 Africa relies on sustainable businesses to drive inclusive economic growth. MSMEs have been identified as catalysts to socio-economic recovery on the continent post-COVID-19. To enhance their impact, AUDA-NEPAD and Ecobank Group are collaborating to establish a Continental framework to support African Micro-Small-Medium Enterprises. The objectives of the initiative are to:

1. Create a one-stop platform which will address the issues, challenges and needs of MSMEs during and post COVID-19, and be an all-encompassing, flexible and comprehensive one-size-fits-all tool for MSMEs in the formal and informal sectors across the continent;
2. Identify opportunities and innovative ways to support and protect MSMEs and job opportunities, especially in food and agribusinesses, technology start-ups, health specialized entities and those operating along with supply chain operations, noting that MSMEs account for an estimated 90% of businesses in most African economies; and
3. Coordinate and harmonize initiatives and ongoing efforts that support MSMEs to gain access to information, finance, and fiscal stimulus during the outbreak. The platform also aims to ensure that MSMEs have continuous access to national, regional and continental markets while recommending to policymakers, solutions regarding domestic debts as they are projected to face challenges due to the economic difficulties that the Member States will face.

Food Security, Nutrition and the Pandemic

The State of Food Insecurity 2001 report³⁸ defines food security as “a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”. Food security involves the availability, accessibility and affordability of food to all and is of major concern to most economies. The primary risks to food security in Africa are at the country level. As the coronavirus crisis unfolds, disruptions in domestic food supply chains, other shocks affecting food production, and loss of incomes and remittances are creating strong tensions and food security risks in many countries. The FAO reports that the COVID-19 pandemic is threatening the food security and nutrition of millions of people on the African continent. Hundreds of millions of people were already suffering from hunger and malnutrition before the virus hit and, unless immediate action is taken by African governments and private sector, we could see a global food emergency. In the longer term, the combined effects of the coronavirus pandemic as well as corresponding mitigation measures and the emerging global recession could without large-scale coordinated action, disrupt the functioning of food systems.

On the 16th of April 2020, FAO committed jointly with the African Union and Ministers of Agriculture in Africa to “support access to food and nutrition for Africa’s most vulnerable; providing Africans with social safety nets; minimising disruptions to the safe

movement and transport of essential people, and the transport and marketing of goods and services; and keeping the borders open on the continent for the food and agriculture trade”. To accomplish this, there’s a need for a far greater focus on the full value chain, from concept to commercialisation, and such an approach requires the coordination of a range of stakeholders, including academics, indigenous knowledge holders, industry, science organisations and governments in Africa to ensure progress.

Currently, intra-regional trade makes up 27% of total Agri-food exports and 17% of total Agri-food imports³⁹. This implies that the continent still relies on global imports and is thus exposed to shocks of global markets. Common markets to support and sustain the food value chain in Africa have been promoted under the Continental Free Trade Agreement recently ratified in 2019. This would expedite intra-regional trade and ensure that Agri-food supply chains and trade channels remain open. Effective CFTA implementation is dependent on innovation and emerging technologies like Blockchain that support the exchange of goods and services with little movements of physical cash. Block chain-backed service delivery is not dependent on centralised structures and solutions as decentralised solutions (infrastructure and systems) can provide complete traceability of all transactions for a certain commodity, e.g. energy, raw materials, etc. which enables the establishment of small enterprises to augment centralised services and enable intra-Africa trade.

³⁸ The state of Food Security in the World 2001 <http://www.fao.org/3/y1500e/y1500e00.htm>

³⁹ Intra-African trade, the African Continental Free Trade Area (AfCFTA) and the COVID-19 pandemic <https://www.tralac.org/documents/resources/covid-19/3342-intra-african-trade-the-african-continental-free-trade-area-and-the-covid-19-pandemic-fao-au-april-2020/file.html>



Current Innovation and Emerging Technologies Considerations for Food Security

The continent has utilised emerging technologies and innovation in supporting food security in the face of lockdown measures. In Uganda, women market sellers are using an app to help people observe social distancing measures. This app allows vendors to safely sell and deliver farm produce to customers. Launched in 2018, this app supports market women earn an income even within lockdown measures while offering food to the general populace. The Market Garden app was developed by the Institute for Social Transformation, a charitable organization in Uganda. It lets the vendors safely sell and deliver fruits and vegetables to customers as restrictions to promote social distancing comes into play. This reduces activity in marketplaces while supporting local farmers and vendors. Payments are received electronically, to further reduce physical interactions, while further building capacity of these vendors in the use of software applications.⁴⁰

In Kenya, 15 AgTech start-ups are looking at leveraging digital technologies through ongoing partnerships with the World Bank to transform the delivery of inputs, soil testing, crop insurance, credit, extension advice and market linkages, to enable farmers to overcome temporary COVID-related constraints and ensure better targeting and more effective service delivery especially in remote areas in the long run⁴¹. This reduces food waste as excess food can be converted to materials useful in tackling the pandemic.

⁴⁰ Here's how Africans are using tech to combat the coronavirus pandemic <https://www.weforum.org/agenda/2020/04/africa-technology-coronavirus-covid19-innovation-mobile-tech-pandemic>

⁴¹ Covid-19: Stellies researchers turning bread into hand sanitizer <http://www.sun.ac.za/english/Lists/news/DispForm.aspx?ID=7239>

Post COVID-19 Reform: How can African Countries Ensure Resilience and better Preparedness for a future crisis?

Utilising Africa's Human Resources in Reforming a Post-COVID-19 Africa

Globally, the United Nations reports that up to 195 million jobs could be lost due to the coronavirus pandemic. The UN Labour Agency indicates that “the rapidly intensifying economic effects of COVID-19 on the world of work are proving to be far worse than the 2008-9 financial crisis, with cutbacks equivalent to nearly 200 million full-time workers occurring in April-June, 2020”⁴².

According to the chief of the International Labour Organisation, Mr Guy Ryder, global rates prior to the pandemic were at 190 million and up to 2.7 billion workers globally have been impacted by partial or complete lockdown measures in four out of five sectors: food and accommodation (currently have 144 million workers), retail and wholesale (currently have 482 million workers); business services and administration (currently have 157 million workers); and manufacturing (currently 463 million workers). Additionally, 94% of the world's workers are living in countries with some sort of workplace closure measures in place per the ILO Monitor 4th Edition in May 2020⁴³. These workers represent 37.5% of the global workforce and the rippling effects of these impacts are reflecting on global economies. In Africa, reports are rife on increasing job losses and its consequent effect on the well-being of Africa's citizens. Africa's current data paucity on the job loss impacts, especially in the informal sectors, implies these cannot be fully measured. However, data on global impacts give an idea of the extent of impact.

According to the ECA's report on COVID-19 exit strategies⁴⁴, a month-long lockdown across Africa would cost the continent about 2.5% of its annual GDP (\$65 billion). This is in addition to the wider external shock of lower commodity prices and investment flows. These assessments assume a continuation of essential services and fairly normal government expenditure, but a sharp drop to private consumption, investment, and labour supply. Additionally, the OECD estimates a 2% decline in GDP per month in OECD countries, should stringent lockdown measures be implemented. Top challenges reported by these strict regulations include: (i) Drop in demand for products/services; (ii) Lack of operational cash flow; (iii) Reduction of opportunities to meet new customers; (iv) Businesses going out of operation; (v) Issues with changing business strategies and offering alternative products/services; (vi) Decline in workers' production/productivity from working at home (vii) Workers cannot return to work (viii) Challenges in logistics and shipping of products; and, (ix) Difficulties in obtaining supplies of raw materials essential for production. On average, businesses in Africa were reported to be operating at only 43% between the 14 and 20 April 2020, with the manufacturing, health/entertainment/utilities, and transport/trade sub-sectors most impacted. This is a ban on our economy and job security and requires adequate mitigation.

These consequences of the pandemic call for strategic reforms that would sustain Africa's recovery from the pandemic and also prepare the continent for any future crisis. To effectively utilise her resources in the “new normal,” the continent requires capacity building and strengthening in both institutional and individual spheres. Institutional capacity building in Africa will require substantial investments in infrastructure development that would focus on key resources required to support the R&D environment and translation such as education, infrastructure, open access pilot facilities, science parks, museums and libraries. Additionally, investments are required in “soft” infrastructure such as the facilitation of data flow, intellectual property matters, and other important factors in the utilisation of R&D products.

The development of modern and flexible management systems and evolving strategic plans for the development of staff skills and competencies are just as important. Africa's greatest assets are her people,

⁴² COVID-19: impact could cause equivalent of 195 million job losses, says ILO chief <https://news.un.org/en/story/2020/04/1061322>

⁴³ ILO Monitor Fourth Edition of May 2020 https://www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/documents/briefingnote/wcms_745963.pdf

⁴⁴ COVID-19: Lockdown exit strategies for Africa <https://www.tralac.org/documents/resources/covid-19/regional/3545-covid-19-lockdown-exit-strategies-for-africa-report-unece-may-2020/file.html>

and support towards recovery should be designed to ensure they are fully empowered to fully deliver. Rather than evaluate innovation and emerging technologies only in the light of increasing automation and consequent job losses, technology creates avenues for new solutions that implicitly creates new jobs. This expands the job sectors defined by the ILO and creates newer ways of working, backed by innovation and emerging technologies that Africa's youthful population can maximise. The World Economic Forum's "Jobs of Tomorrow" report⁴⁵ indicates that "96 jobs across seven professional clusters are fast emerging in tandem, reflecting "digital" and "human" factors driving growth in the professions of tomorrow". They further report that these jobs are projected to grow by 51%, which represents 6.1 million job opportunities globally. There is a greater demand for Green Economy jobs, roles at the forefront of the Data and AI economy as well as new roles in Engineering, Cloud Computing, and Product Development. In Africa, the African Union, African Development Bank, AUDA-NEPAD and other relevant stakeholders are establishing a Fund to provide support to member states.

Innovative Education as a Capacity Building Mechanism

The coronavirus pandemic has exposed the unpreparedness of many education institutions in Africa to migrate online. The leadership and managers of higher education institutions across the continent, in particular, have become fully aware that empowering students to prepare for a future where pandemics such as COVID-19 and other disruptions might become a part of our daily lives also means embracing change in learning and teaching. It is clear that technological innovations such as content management systems (CMS), learning management systems (LMS), and internet use have become a part of the DNA of higher education in Africa. Ministries of Education in African countries and higher education institutions have to rethink what the future of education would look like and take practical steps towards adopting a blended learning approach in education to improve access and equity.

Post COVID-19, African countries will require innovative education, skills and capacity-building mechanism reforms that work towards developing sustainability competencies. Second, there is a need for a solution-oriented approach to education at the local, national and transnational levels. This includes sustainability initiatives that have universities in

various African countries as a core, and stakeholders to accelerate the steps of transformation through capacity building. Educational reforms will be necessary to embrace three central competencies, "critical thinking," "normative dialogue" and "transformative leadership." Critical thinking is indispensable as a tool to synthesize problems and their solutions reiteratively. Normative dialogue is important as the ability to understand and work with diverse opinions and ideas about values. Transformative leadership is the capacity to implement solutions in diverse stakeholder contexts. Education in the "new normal" will entail greater use of innovation and emerging technologies. As a result, African education systems must be recalibrated to accommodate the new demand.



⁴⁵ Jobs of Tomorrow: Mapping Opportunity in the New Economy <https://www.weforum.org/reports/jobs-of-tomorrow-mapping-opportunity-in-the-new-economy>

CASE STUDY 3: THE AFRICAN EDUCATION, SCIENCE, TECHNOLOGY AND INNOVATION FUND

The African Education, Science, Technology and Innovation Fund (AESTIF) is a unique, Africa-initiated, continental level financing instrument designed to facilitate Technical Vocational Education and Training (TVET), Science, Technology, Engineering and Math (STEM), Higher Education (HE), Research, Development and Innovation (R&D&I) in Africa.

The AESTIF was developed in response to the gap in the financing of key education and skills, and STI sub-sectors that have a high potential for employment and wealth creation leading to industrialization and economic transformation as a way to achieve the SDGs and aspiration of Agenda 2063 “A prosperous Africa based on inclusive growth and sustainable development”.

Initiated, owned and managed by Africa, the Fund is designed to be a blended finance mechanism (Grants, Technical Assistance, Guarantees and Concessional Loans for private sector MSMEs in Education, Tech and Innovation) that is aimed at pooling US\$ 300 million via innovative financing mechanisms with an initial grant component of US\$ 120 million for the Grant Trust Fund; US\$ 60 million for the Guarantees facility and US\$120 million for the concessional loan facility.

These funds will be mobilized from within Africa led by RMCs and complemented by multi-lateral and bilateral contributions, the private sector and philanthropic foundations. The 10-year funding cycle is expected to generate up to US\$1 billion in investments in education, science, technology and innovation in Africa.

Ultimately, AESTIF is expected to reach 2 million Africans by 2030, impacting 5 million indirectly through job opportunities for women and youth. AESTIF will ensure that all project beneficiaries are at least 30% of women. The Fund will also facilitate critical technology development and innovation for the industrial and economic transformation of Africa.

Education and training in innovation and emerging technologies will build the capacities of AU Member States in creating innovative economies. This is a necessary response to gaps in knowledge innovation in business models as this can be transformative and is critical to businesses of the future. These are often underpinned by emerging technologies in IT, big data and the internet of things, and are necessary for the realisation of the potential presented by emerging technologies. Existing businesses that cannot rethink and reinvent themselves will tend to lose their competitiveness and fade away. The COVID-19 pandemic and the need to social distance has indeed demonstrated how businesses can continue through the leverage of our current connectedness to deliver platforms that allow for live interactive engagements driving business, and our world of work will not be the same post this pandemic. Hence African enterprises both old and new must rethink how they will create and deliver value for their new and existing customers.

Innovation utilisation and the effective harnessing of emerging technologies are important in addressing concerns of job losses linked to lack of skills. Currently, there is limited readiness in leveraging these technologies. Hence a critical factor is the need for capacity building and strengthening for relevant stakeholders across AU member states. Nuanced patterns are observed in educational systems in Africa, between countries and between regions on the continent in addressing innovation and emerging technologies using relevant curricula.

The educational systems in African countries also require new approaches within the context of global fast-paced settings where skills constantly need overhauls in order to catch up with technologies.

Africa's youthful populations are the greatest determinants of adequate capacity for the effective harnessing of innovation and emerging technologies. The ILO⁴⁶ reports that particularly for young people, changing skill requirements might exacerbate youth unemployment if the youth have not developed the skills needed for the future of work. For Africa's informal sector, targeted approaches in the strengthening of curricula of Technical, Entrepreneurial and Vocational Education (TVET) with areas of skills that are relevant to the emerging needs in STI would have rippling effects on work in the informal sectors.

To respond to changing labour market conditions, capacity development should also inculcate problem-solving abilities and critical thinking, contextualized to addressing Africa's identified challenges. That way, skills development is not done in a vacuum with theoretical approaches but rather coached to be innovative and needful.

A vital angle to capacity building is education on emerging technologies, to reduce aversions to innovations built on ignorance, rather than an informed stance. Africa relatively has more

⁴⁶ *Skills for Youth Employment* https://www.ilo.org/skills/areas/skills-for-youth-employment/WCMS_672181/lang-en/index.htm

conservative populations and increasing objections to innovation and emerging technologies have been linked to knowledge gaps that are subsequently filled with misinformation. Capacity building ensures an understanding of social processes and problems and the need for technologies and policies to address these problems. Effectively harnessing innovation and emerging technologies is a wheel that relies on the continuous generation of knowledge and its translation into applicable ideas. Thus, the promotion of applied and basic research in both natural and social sciences are crucial.

Laudable initiatives like those compiled by UNESCO⁴⁷ on 36 African countries that are using mainstream media to reach students in rural populations have been reported. Almost all countries on the continent have responded to education challenges using eLearning portals, radio and television.

Online Learning

As a result of COVID-19, education has changed dramatically, with the distinctive rise of e-learning, whereby teaching is undertaken remotely and on digital platforms. With this sudden shift away from the classroom in many parts of Africa, some are wondering whether the adoption of online learning will continue to persist post-pandemic, and how such a shift would impact African education institutions and the continent's education market. The AU Member States have explored eLearning online platforms for education on the continent; some as complementary to radio and TV platforms. In Chad, the official eLearning platform of Chad (EduTchad) containing online courses and material for secondary school students, launched mid-April to facilitate learning from home. The platform includes classes both in Arabic and in French. Additionally, GoClass, an eLearning platform for primary and secondary school students in Chad, was also created in April to assist the continuity of learning during the COVID crisis.

Ecole Numerique in Cote d'Ivoire is a platform of pedagogical resources created by the Ministry of Education intended for preschool, elementary, middle and high school students while Voda Educ is an eLearning platform launched by the Ivorian Ministry of Primary, Secondary and Vocational Education to facilitate distance learning during the health crisis. Djibouti also has an eLearning platform Menfop which is an official eLearning platform introduced by the Ministry of Education. This is in addition to the country's Cours Télévisés initiative,

where TV and radio classes are transmitted by the Radio Télévision Djibouti since the 1st of April, 2020. In Uganda, the National Information Technology Authority partnered with UNICEF to introduce Kolibri countrywide, a free eLearning platform to assist children during the school shutdown caused by the COVID-19 pandemic. The platform is available online and offline, with education content approved by the National Curriculum Development Centre (NCDC). Ethiopia, Gabon, Guinea, Kenya, Liberia, Malawi, Namibia, Nigeria, Rwanda, Senegal, South Africa, Zambia, Egypt and Zimbabwe have all invested into eLearning platforms for their students⁴⁸.

In response to significant demand, many online learning platforms are offering free access to their services. Some tertiary institutions in Africa are subsidizing the data for students, while some governments have entered into Public-Private Partnerships with telephone companies to reduce data for students. There are, however, challenges to overcome. Some students without reliable internet access and/or technology struggle to participate in digital learning; this gap is seen across the continent and between income brackets within countries. There is a huge urban-rural divide in Africa, resulting in a significant gap between those from privileged and disadvantaged backgrounds.

TV Channels

Considering the technological divide in Africa, most countries are also using television and/or radio-based programmes to implement distance online education. Africa seems to be the most active in the efforts to leverage either TV or radio (70%), some combining both (34% of countries), while Europe and North America seem to be using less radio than other regions, yet very active in deploying TV-based distance education programmes. The value of educational broadcasts through television and radio also goes beyond the needs of students alone. In some countries, these programmes are conceived to provide intergenerational learning, including in local languages. They also include issues such as health and psychosocial well-being, both of which are important in supporting populations affected by the threat of COVID-19.

To reduce internet costs and support students with limited or no access, many African countries have resorted to the use of television channels for educating their students during this pandemic. In Angola, the Tele aulas (TV) has been involved in the transmission of teleclasses with didactic content

⁴⁷ National learning platforms and tools <https://en.unesco.org/covid19/educationresponse/nationalresponses#AFRICA>

⁴⁸ National learning platforms and tools <https://en.unesco.org/covid19/educationresponse/nationalresponses>



broadcasted by the Tele Aulas channel, in partnership with the Ministry of Education and the Public Television of Angola⁴⁹. Similarly, in Botswana, the Botswana Educational Television⁵⁰ of the Ministry of Education and Skills Development confirmed the launch of an educational television mid-April, broadcasting classes, through TV to assist distance learning. The channel Burkina Info⁵¹ in Burkina Faso is focused on broadcasting educational programs during school closures, with special emphasis on Math, Physics, Chemistry, French and Philosophy. In neighbouring Ghana, the Ministry of Education broadcasts educational programs through GLTV, a free-to-air National Television Channel, while Equatorial Guinea, Gambia, Mali, Mauritius, Madagascar and São Tomé and Príncipe have all been involved in transmitting daily lessons to pupils approved by the Ministry of National Education⁵².

Radio

Another avenue of distance education is the use of Radios. In Cabo Verde⁵³, Radio Educativa has educational programs such as 'Educa com TIC' and 'Aprender e Estudar em casa' broadcasted on Radio Educativa channel for teachers, parents and students. Radio Ndeke Luka in partnership with the Central African Ministry of Education, Fondation Hirondelle and UNICEF launched radio-based education programmes. Every day, at 5:05 p.m. Bangui time, numeracy and reading lessons in French and Sango, the national language, are broadcasted to support the Ministry of Education's action for the affected children. Sierra Leone's Ministry of Basic and Senior School Education (MBSSE) and the Teaching Service Commission have launched a radio teaching programme for children and adolescents. The programme covers the core curriculum subjects for primary to senior secondary level education⁵⁴. Malawi, Mozambique, Niger and Tanzania are all involved in utilising radios to ensure students continue learning during school closures⁵⁵.

⁴⁹ Aulas na TV e no Youtube. O que esperar da nova telescola? <https://www.dn.pt/pais/aulas-na-tv-e-no-youtube-o-que-esperar-da-nova-telescola-12071692.html>

⁵⁰ Botswana educational TV channel launched <https://www.mmegi.bw/index.php?sid=1&aid=1593&dir=2011/June/Tuesday14/>

⁵¹ Burkina Info TV, the Burkina Faso media organisation promoting democracy <https://www.cfi.fr/en/news/burkina-info-tv-burkina-faso-media-organisation-promoting-democracy>

⁵² National learning platforms and tools <https://en.unesco.org/covid19/educationresponse/nationalresponses>

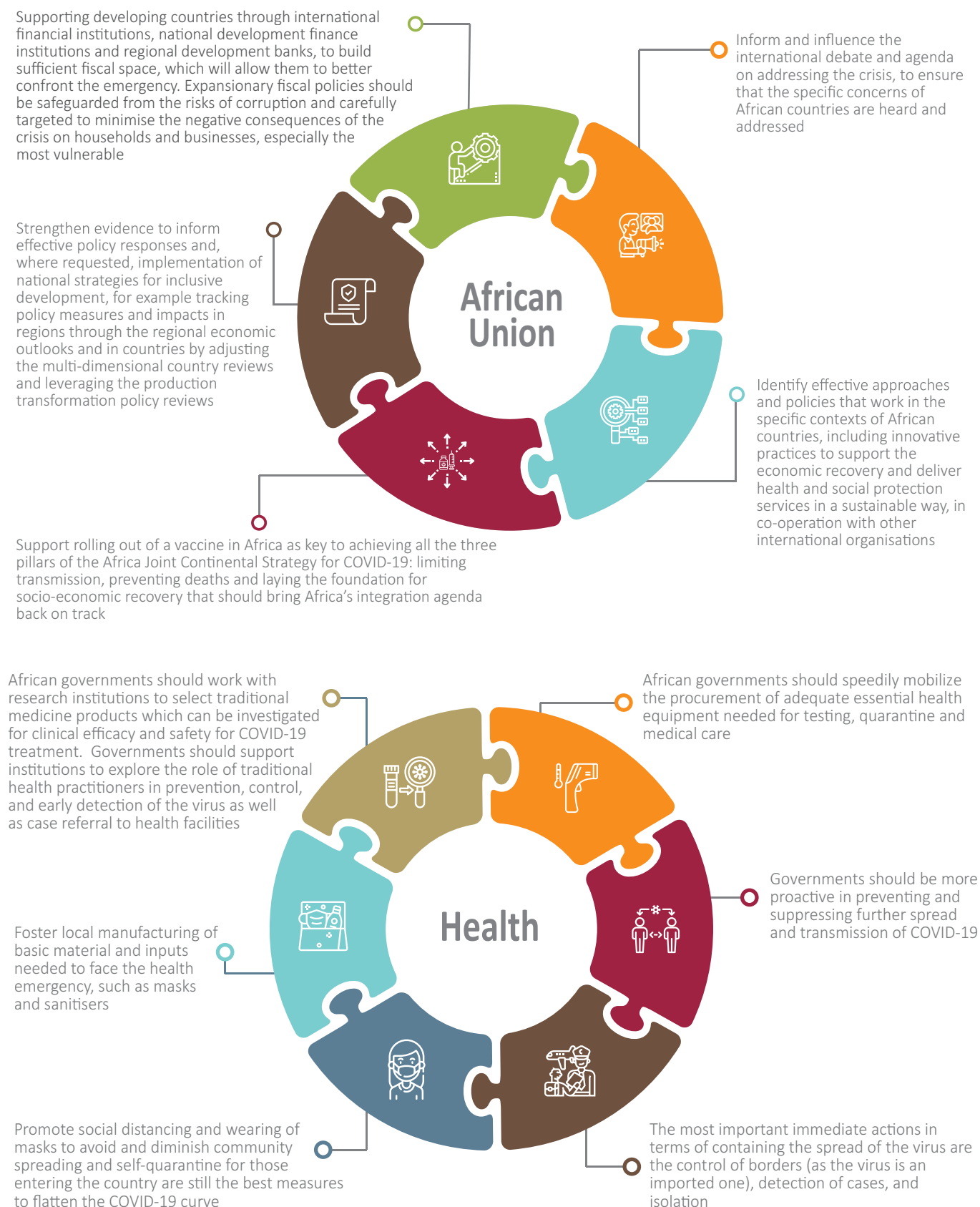
⁵³ Aulas à distância arrancam mas nem todos puderam assistir <https://expressodasilhas.cv/pais/2020/04/27/aulas-a-distancia-arrancam-em-cabo-verde-mas-nem-todos-puderam-assistir/69156>

⁵⁴ UNFPA Sierra Leone provides technical support to radio teaching programme <https://sierraleone.unfpa.org/en/news/unfpa-sierra-leone-provides-technical-support-radio-teaching-programme>

⁵⁵ National learning platforms and tools <https://en.unesco.org/covid19/educationresponse/nationalresponses>

Recommendations

Policymakers across the African continent need to make rapid decisions on their COVID-19 pandemic response with limited available data or guidance. The AU High Level Panel on Emerging Technologies is working to support these decision-making processes by providing relevant policy guidance. Based on the context analysis the AU High Level Panel on Emerging Technologies recommends the following key policy options:



Target and implement disaster relief initiatives for the most vulnerable groups that are already at risk, such as unemployed and informal workers, especially women, people living in highly concentrated areas or lacking access to basic social services and drought and flood-affected communities

Policy measures need to clearly address the livelihoods of informal workers, who are strongly hit by the shutdown and economic crisis, with the majority of the population in most African countries having informal employment

Support the investment in small and medium-scale processing and manufacturing projects for crops to increase the income of small scale farmers, narrow down the production-consumption gap and increase the added value from the crops

Reduce taxes (VAT) on essential commodities including medicine and food, temporary wage advances and salary top-ups, enhanced social security payments could be considered if the situation warrants such action

Provide incentives to private firms for business continuity, local businesses and agricultural farming which are essential for keeping the economy running



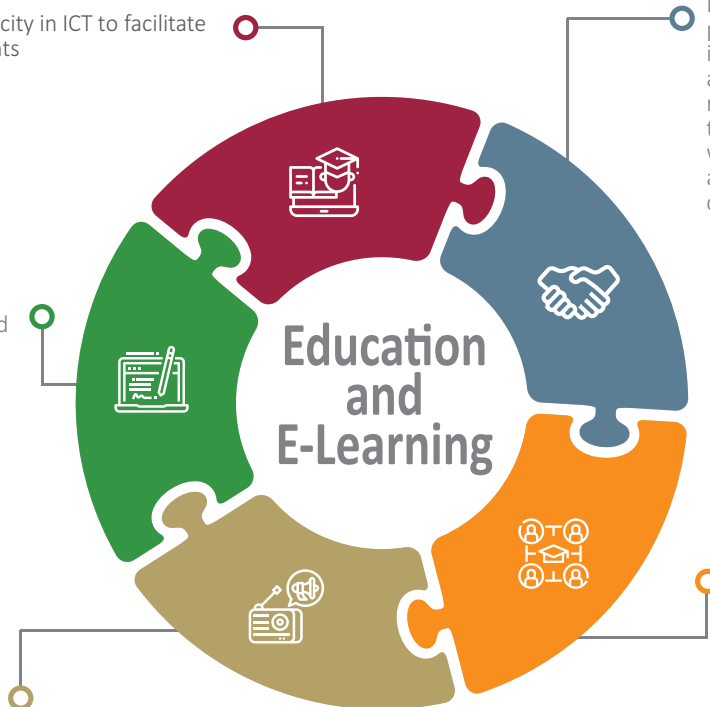
Strengthen teacher capacity in ICT to facilitate eLearning among students

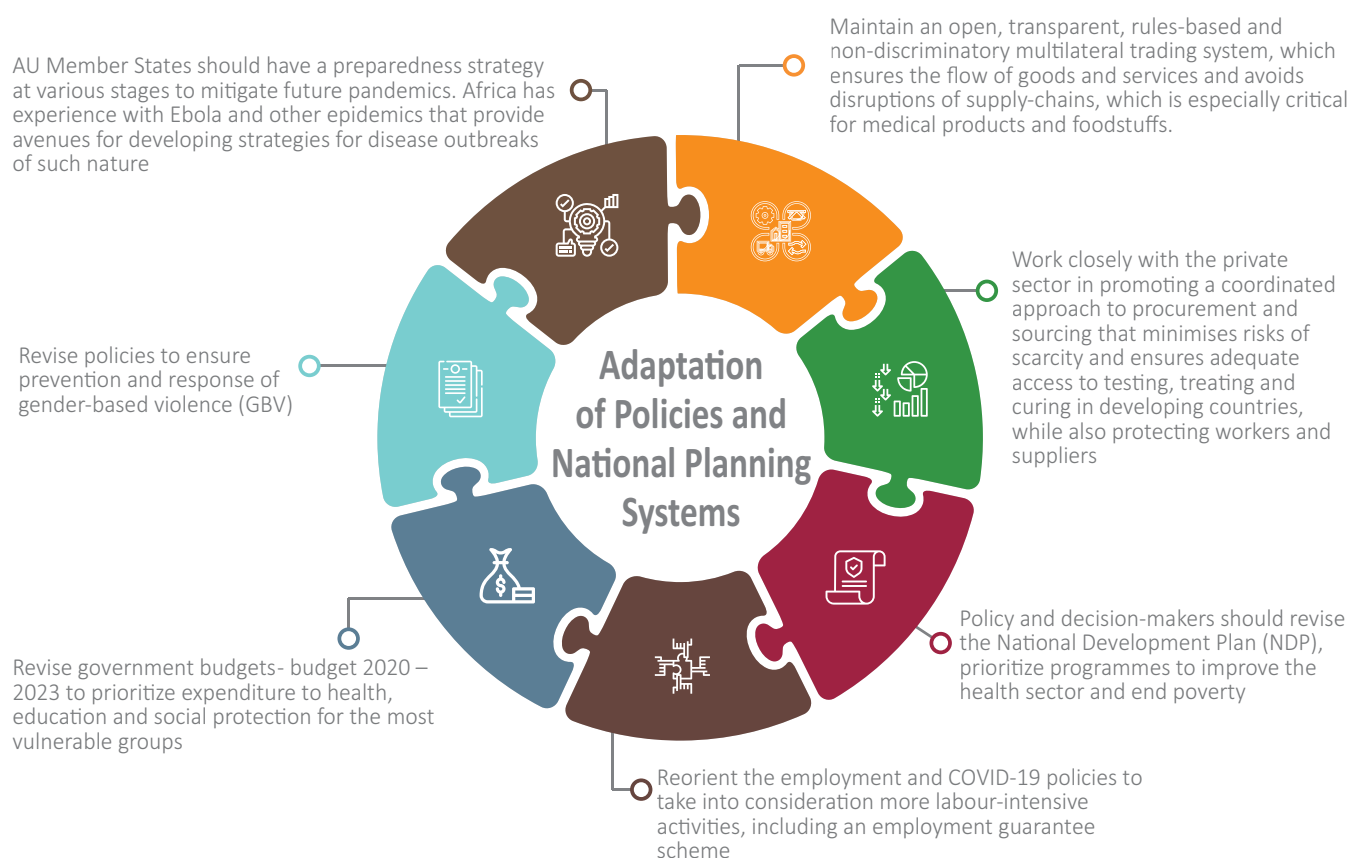
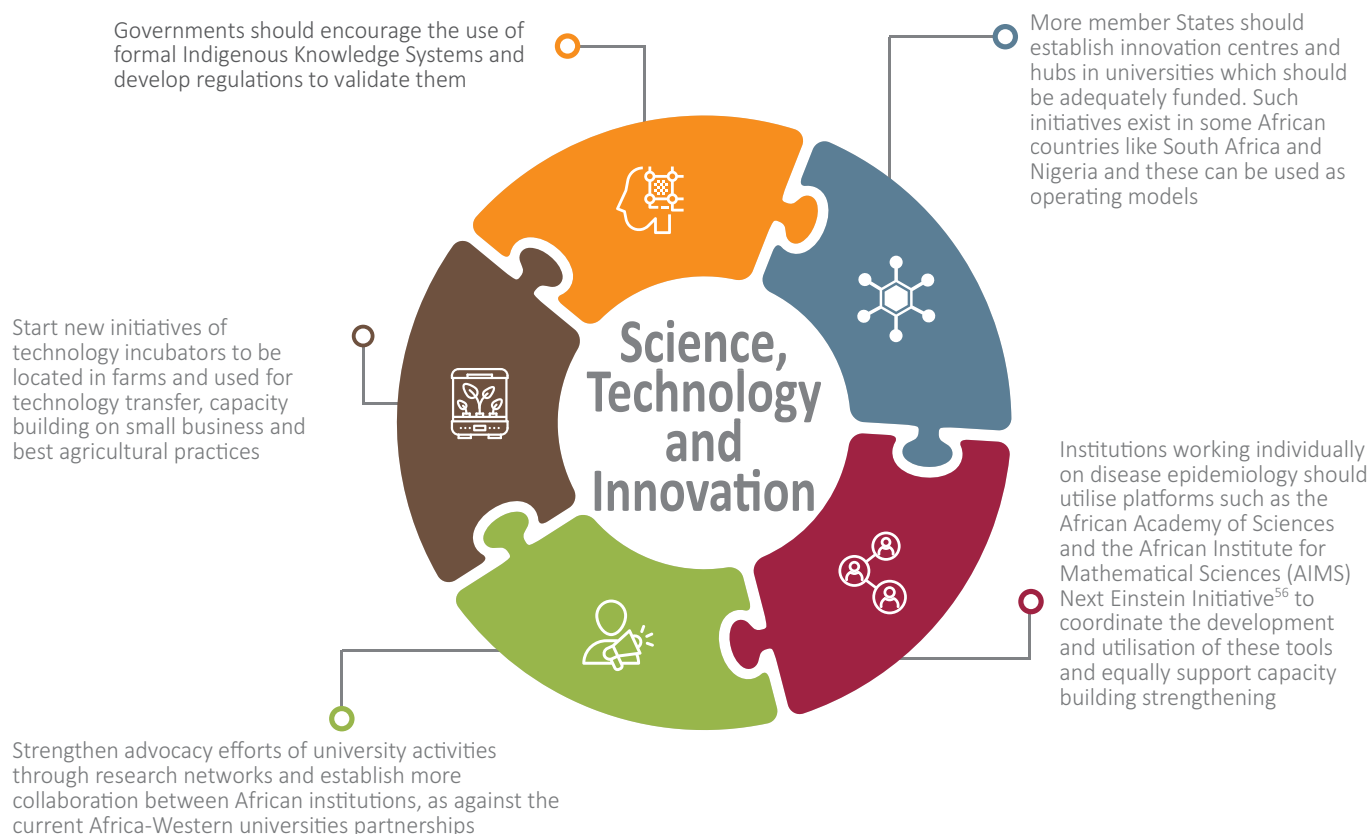
Ministry of education, Science and Technology to coordinate the supply of adequate tools and equipment to encourage home learning and reduce the rural-urban divide in accessing e-learning

Distribute radio and megaphones for improving community communication and ensure local and regular awareness-raising while being confined; this will include the dissemination of preparedness, response and solidarity messages

Leverage Public-Private partnerships for enhancing internet infrastructure to address internet access inequality, particularly in resource-deprived communities, the provision of such infrastructure would ensure all students have access to e-resources at little or no cost

Governments to collaborate with universities, vocational institutes and basic and high school systems to design and roll-out policies that both target and complement critical skills of the future workforce





⁵⁶ The Next Einstein Forum (NEF) <https://www.nexteinstein.org/next-einstein-forum/>

Organize awareness creation, especially focusing on elders and vulnerable groups to other diseases with similar symptoms to reduce the number of suspected cases and improve local immunity

Establish proactive communications measures required to take messages to the rural communities whose response may not be as effective as one would expect in this critical time

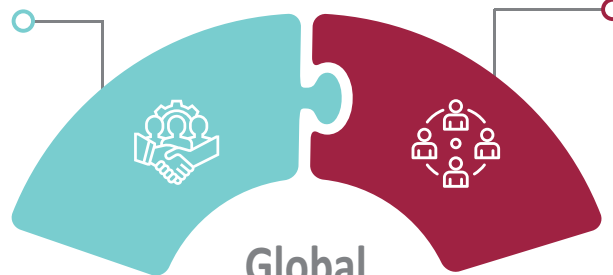
Emphasise communication in vernacular where needed, to reach uneducated populations



Assign clear responsibilities at the community level and establish communication channels/mechanisms with local authorities; this should include the appointment of responsible community members to identify the most vulnerable, promote local solidarity, supervise the implementation of control measures, and ensure two-way communication with communities

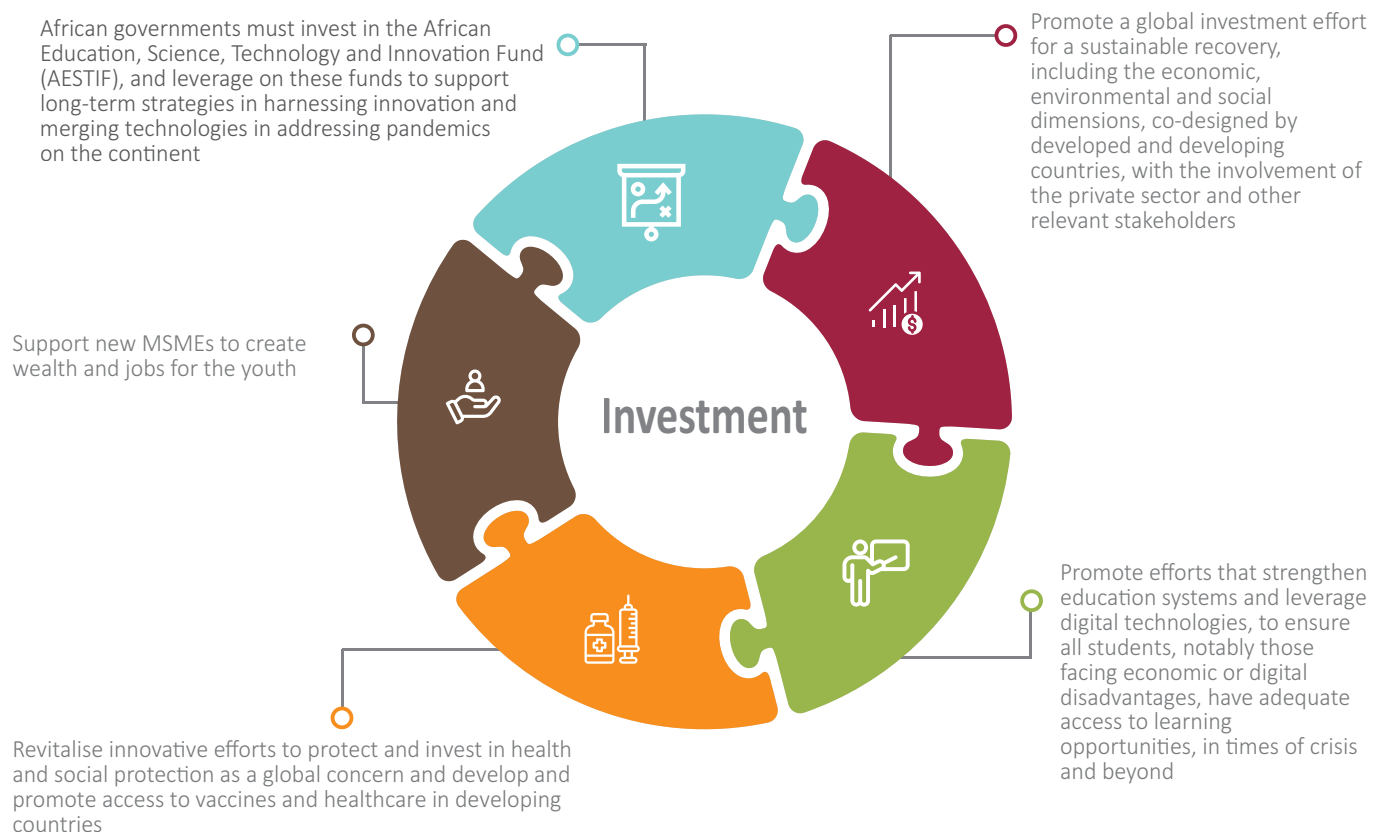
Distribute radios and megaphones for improving community communication to ensure local and regular awareness-raising while being confined; this will include the dissemination of preparedness, response and solidarity messages

Enhance Africa's global partnerships at all levels (local, national, regional, continental and global). These partnerships would be useful to the scaling up of local innovations to the market, in light of the prospects AfCFTA offers in intra-regional trade



African countries should adopt a tri-strategic approach, where governments act as enablers, public-private partnerships act as technical and funding support, and youth act as drivers of innovation and harnessing emerging technologies on the continent

Global Partnership



Innovation in Pictures

Drones in Action⁵⁷



Drones equipped with loudspeakers were used to broadcast messages, encouraging citizens to respect confinement measures, social distancing, wearing a mask and follow good respiratory hygiene. It's also a way to keep an eye on the streets and control crowds

Drones were used to spray disinfectants on hard-to-reach areas. The drone carries around 15 litres of disinfectant and could cover a 1.5 km section in 15 minutes. This technique is very similar to what is done in the field of Agriculture to fight against crop and plant diseases

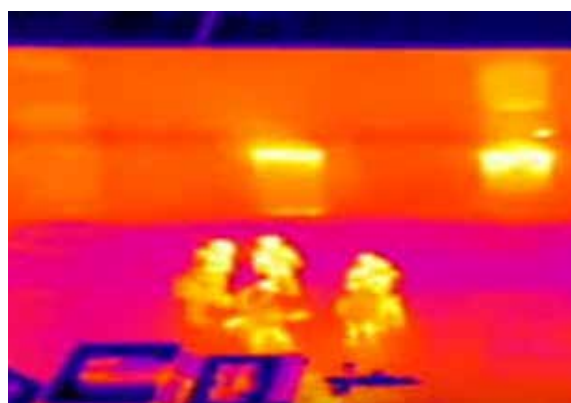
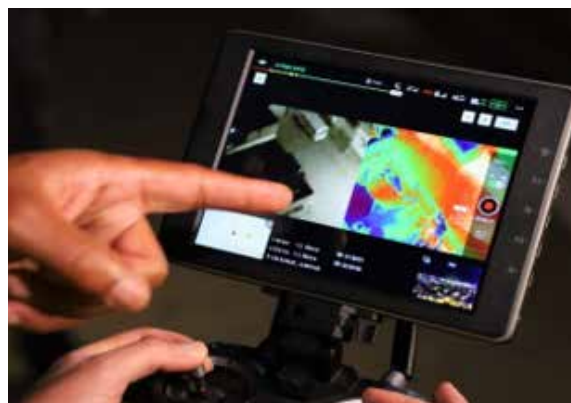


⁵⁷ Adapted from slides of Prof Mokhtar Sellami, 3rd Cailestous Juma Executive Dialogue. "The role of Innovation and Emerging Technologies in the socio-economic development of post-COVID Africa"



Drones are the safest and fastest means of delivering medical supplies (personal protective equipment, COVID-19 test kits, test results), but also samples from hospitals to laboratories with minimal personal contact to prevent viral transmission. Samples of COVID-19 flown 45 miles away for analysis in hospital.

Drones have been used to monitor and identify people who do not comply with the rules of the state of health emergency, especially the curfew. Violators have been followed to their homes to enter their geographic coordinates which are then transferred to national security via the location applications. From an ethical point of view, this operation caused a lot of controversies.





Kenyatta University unveils ventilators made by students. Kenya is looking to boost ICU capacity as COVID-19 cases increase⁵⁹

A 21-year-old Somali mechanical engineer developed a home-made respirator capable of automated ventilation. Mohammed Adawe's solution is bound to change the course of the COVID19 epidemic in the country⁶⁰



The Defence Industries Corporation of Nigeria (DICON) has gone into the production of essential and life-saving equipment as part of the contribution of the Armed Forces to the national effort against the COVID-19 pandemic in the country⁶¹



⁵⁹ K.U Makes Ventilators <http://www.ku.ac.ke/component/k2/item/1655-k-u-makes-ventilators>

⁶⁰ Somali engineer creates home-made respirator to ease country's COVID-19 crisis <https://www.euronews.com/2020/05/02/somali-engineer-creates-home-made-respirator-to-ease-country-s-covid-19-crisis>

⁶¹ COVID-19: DICON manufactures ventilators, PPEs, hand sanitisers <https://www.lipstickalley.com/threads/african-ingenuity-during-the-covid-19-pandemic-3445460/>

Man puts on a self-sanitising mask developed at Makerere university⁶²



The Central University of Free State's innovative projects to combat COVID-19 pandemic⁶³



Employees work on a Moroccan ventilator at a factory following an outbreak of the coronavirus disease (COVID-19), in Casablanca, Morocco April 10 (Reuters)⁶⁴

⁶² COVID-19 CRISIS: Makerere-based tech hub develops self-sanitising face mask <https://www.pmldaily.com/news/2020/04/covid-19-crisis-makerere-based-tech-hub-develops-self-sanitising-face-mask.html>

⁶³ CUT's innovative project to combat COVID-19 pandemic <https://www.cut.ac.za/news/cuts-innovative-project-to-combat-covid-19-pa>

⁶⁴ Morocco medical equipment to meet coronavirus needs <https://theArabweekly.com/morocco-medical-equipment-meet-coronavirus-needs>

Food Security Innovations



Market Garden app for food delivery⁶⁵

Fresh in a box innovation for delivery food using a mobile application⁶⁶



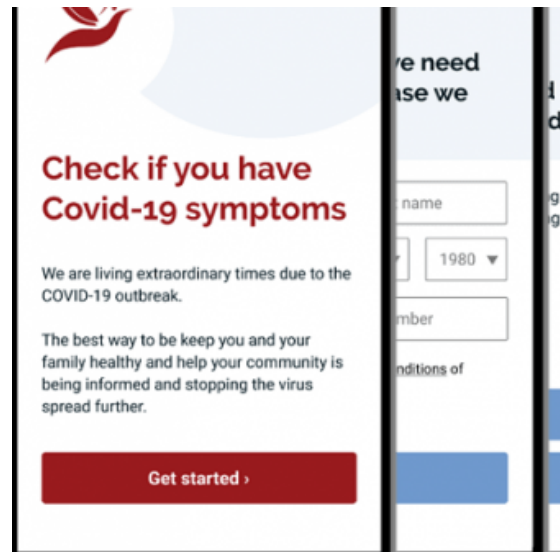
In an effort to quell the panic and provide South Africans with reliable and accurate information about the coronavirus (COVID-19), two University of Cape Town (UCT) alumni have built Coronapp, a centralised online platform for information about the disease. Tamir Shklaz and Wisani Shilumani are the brains behind Coronapp⁶⁷

⁶⁵ Market Garden <https://play.google.com/store/apps/details?id=com.lst.elinemarket>

⁶⁶ Fresh in a box <https://freshinabox.co.zw/shop>

⁶⁷ UCT alumni build 'Coronapp' platform <https://www.news.uct.ac.za/article/-2020-03-20-uct-alumni-build-coronapp-platform>

Ghanaian e-health start-up Redbird has launched the COVID-19 Daily Check-in App and Symptom Tracker in its bid to counter the spread of the novel coronavirus on the African continent⁶⁸



Robots against COVID-19 in Africa



A police robot has been deployed to patrol areas of Tunisia's capital, Tunis, to ensure that people are observing a coronavirus lockdown⁶⁹

⁶⁸ Ghanaian e-health start-up Redbird launches COVID-19 daily check-in app, symptom tracker <https://disrupt-africa.com/2020/03/ghanaian-e-health-startup-rebird-launches-covid-19-daily-check-in-app-symptom-tracker/>

⁶⁹ Coronavirus: Tunisia deploys police robot on lockdown patrol <https://www.bbc.com/news/world-africa-52148639>



New robots have been donated to Rwanda's Ministry of Health to help fight the spread of coronavirus in the country⁷⁰

⁷⁰ Rwanda has enlisted anti-epidemic robots in its fight against coronavirus <https://edition.cnn.com/2020/05/25/africa/rwanda-coronavirus-robots/index.html>

Conclusion

The COVID-19 pandemic has not spared the African continent. Each country's experience is unique, but some common challenges arise, as detailed in this White Paper. To date, lessons from other regions where the virus is more advanced have been successfully applied. Considerable additional support and solidarity will be needed to remain on this trajectory. There is a need to draw lessons from other global contexts and rapidly design homegrown African responses. In this regard, the central question is not just how to reduce the spread of the disease, but also how to implement these mitigation and suppression measures in a manner that is culturally and economically palatable within the African context. Incentives for solidarity and not stigmatization are recommended while enhancing trust, social accountability, and promoting peer to peer support after the crisis are urgently needed. However, the window of opportunity is closing due to the rapid escalation of confirmed cases.

African governments urgently need to intensify efforts to reach out to citizens, to inspire and mobilize them as the countries face a collective threat. Policy options are dictated by several parameters including an existing weak health care system, a large section of the population with pre-existing conditions and governance deficits that have strained public trust. The question in the minds of African and global leaders in the midst of the evolving pandemic is how affected communities will bounce back and in a sustainable manner recover from the crisis. The economic distress associated with the pandemic, health implications to those affected especially most vulnerable in the community, the strain on service delivery infrastructure and the societal cost in terms of well-being could be enormous.

APET posits that any post-COVID-19 recovery strategy will need to re-establish the conditions for a quick return to a path of economic growth, improved social contract, and overall human development that can foster more inclusive societies in the future. The survivors and others directly affected by the disease must be assisted to regain their dignity and the affected communities supported to recover their livelihoods. This will require investment in innovative approaches for restoration of health systems; co-creation of culturally sensitive protection and community, peace and cohesion building measures that integrate recovery of lost learning opportunities and livelihoods. A conflict-sensitive approach in such a case will be critical in the identification of risk and opportunities to ensure strategies do not worsen existing but latent fragility, but rather help strengthen social cohesion if possible.

The High Level Panel has emphasised the need for investment in, and access to technology and knowledge to strengthen productive and educational capacities in developing countries, which could help provide a more effective response to the current and future crises. Key investment areas include quality infrastructure and sustainable energy. It will be necessary to reflect on post-COVID-19 industrial systems and the implications for African countries, including access to technology, associated with the possible reorganisation of value chains across the continent, in order to harness the digital economy and build more diversified and resilient economies. A strong, co-ordinated and reformed multilateral system is crucial to support African governments to foster innovative and coherent responses and to increase co-ordination across different policy communities in contexts of multiple crises in order to build a resilient post-COVID-19 Africa.

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