

EMERGING DIGITAL TECHNOLOGIES FOR KENYA

EXPLORATION & ANALYSIS







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ACRONYMS

AFTA	Africa Free Trade Area
AI	Artificial Intelligence
CBK	Central Bank of Kenya
CBDC	Central Bank Digital Currency
CMA	Capital Markets Authority
DLT	Distributed Ledger Technology
DMV	Department of Motor Vehicles
GSMA	Global System for Mobile communications Association
ICO	Initial Coin Offering
ICT	Information and Communications Technologies
IoT	Internet of Things
KRA	Kenya Revenue Authority
LOC	Letter of Credit
MDA	Ministry, Departments and Agencies
NHIF	National Hospital Insurance Fund
NIIMS	National Integrated Identity Management System
PwC	PricewaterhouseCoopers
SME	Small and Medium Enterprises
WFP	World Food Program



THE DISTRIBUTED LEDGERS TECHNOLOGY AND ARTIFICIAL INTELLIGENCE TASKFORCE



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We would also like to thank the Global System for Mobile Communication Association (GSMA) and Cisco Systems, Inc. for accommodating the task force for the period during which this report was developed. Further, we extend special appreciation to the Communication Authority, IBM officials: Ben Mann, Jonathan Lenchner, Reha Yurdakul, and Robin Miller of Dalberg, for their special contribution to this report.

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We also wish to thank all other individuals and organizations that participated in the development of this report. The contributors were too numerous to mention, thank you to everyone who submitted, engaged with the committee and shared their ideas.





Cabinet Secretary



FOREWORD FROM THE CABINET SECRETARY, MINISTRY OF INFORMATION, COMMUNICATIONS & TECHNOLOGY



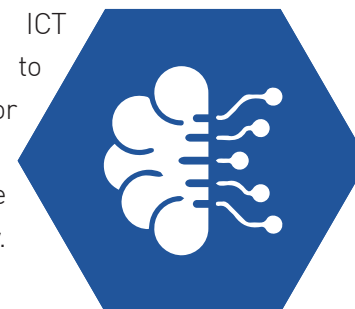
Corruption is perhaps the biggest obstacle to our nation building endeavours, and technologies such as blockchain and Artificial Intelligence (AI) are emerging as effective tools to deal with the scourge. There is every reason to believe that through the application of emerging technologies including blockchain, corruption will be defeated. Blockchain is a distributed-ledger technology that will certify records and transactions without the use of a central database and in a way that cannot be erased, altered or tampered with. As noted by the World Economic Forum, Blockchain and AI provide an unprecedented level of integrity, security and reliability to the information it manages, reducing the risks associated with having a single point of failure. It eliminates the need for intermediaries, cuts red tape and reduces the risk of arbitrary discretion. It also makes it possible to track and trace transactions. The immutable trail of transactions can be used by law enforcement and government auditors.

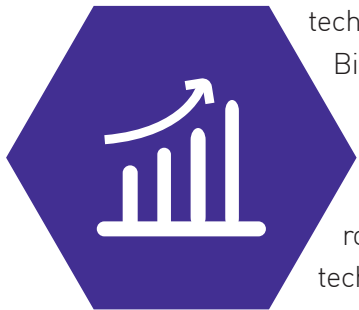
It is for this reason that in accordance with the mandate of my Ministry, I created the Distributed Ledger and Artificial Intelligence Taskforce via Kenya Gazette Notice Number 2095 of 2018, to develop a roadmap for emerging technologies that will define the evolving Fourth Industrial Revolution. These technologies are expected to be disruptive and will change the way business is conducted. They further promise to enhance public service delivery, while promoting efficiency in the private sector by streamlining supply chains. Virtually every industry will be affected by Blockchain and AI technologies.

Most importantly, all sectors featured in the Big Four Agenda will be positively impacted by these technologies.

However, taking full advantage of these technologies will not be possible without digitization and supporting technologies, such as Big Data, the Internet of Things (IoT) and advances in broadband. Recent developments in big data have allowed us to organise large amounts of information into structured components that can be rapidly processed by computers. These technologies will transform the manner in which we manage our assets and help organisations to optimally utilise resources, proactively provide services to their customers, plan in an appropriate manner and even develop tailored marketing.

Adoption of these emerging technologies will transform the Kenyan economy by creating opportunities to solve current problems, including unemployment, corruption, (in)security and poverty. In addition, these technologies will create new opportunities for Kenyan workers through the Ajira platform, propelling the country forward and positioning Kenya as a regional and international leader in the ICT domain. I am committed to working with the private sector on the potential presented by these technologies for the benefit of our national economy.





I am happy that the taskforce reviewed these digital technologies in a critical and contextual manner. The taskforce considered the role of digital technologies in delivering the Government's Big Four Agenda of affordable housing, universal healthcare, manufacturing, food security and all the related value chains. The team has provided a roadmap for the manner in which these technologies can promote and enhance government services, including overall public service delivery, job creation through the Ajira Digital Programme, cyber security, trusted single digital identity (Huduma Namba), financial inclusion, reduction of transactional fraud, land titling, promotion of democracy, the election process, and the precepts of a sharing economy.

I have noted the recommendations presented in this report. Some of the recommendations will require new legal frameworks; however, I believe we can begin with the low hanging fruits, especially in regard to improving public service delivery.

Through my Ministry, I intend to collaborate with my colleagues to ensure that a majority of the recommendations are implemented as early as possible. The Government has already begun the process of establishing a trusted identity that will be a key pillar in realising the aspirations that are contained in this report.

Our government will take full advantage of these cutting-edge technologies and new opportunities for

improving public service delivery. I thank the taskforce members and other experts who contributed to this report and commend them for playing an integral part in helping Kenya achieve its development goals.

Hon. Joe Mucheru,EGH

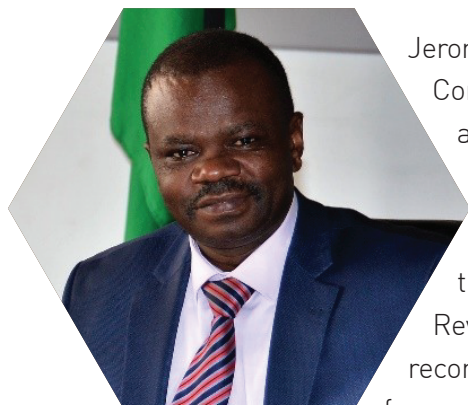
CABINET SECRETARY

I am committed to ensure complete implementation of this report and will provide the necessary impetus for all stakeholders to propel the ICT sector into the global digital ecosystem that will play a vital role in the economic transformation of Kenya.

¹<https://www.weforum.org/agenda/2018/03/will-blockchain-curb-corruption/>



MESSAGE FROM PRINCIPAL SECRETARY



Jerome Okoth Ochieng, Principal Secretary in the Ministry of Information, Communications and Technology in charge of State Department of ICT and Innovation.

This report clearly outlines the road map for the implementation of blockchain and artificial intelligence technologies in Kenya. These are the technologies that will drive the emerging Fourth Industrial Revolution. It will require a concerted policy environment to realize all the recommendations that the report makes. I am aware that the existing legal framework may not be adequate to address innovations that come with the new technologies. To this end, we are providing a supportive regulatory regime that enables innovation to thrive while ensuring consumer protection.

One of the areas that these technologies have been deployed is in postal services that depend on addresses and are the source of verified addresses in many countries. We now have the opportunity to leverage these technologies for national addressing systems and enabling e-commerce services, thereby creating employment. Blockchain and AI will therefore help our country leapfrog to a new age.



The report explores the impact of these emerging technologies and why policymakers and the legislature, must fast track an enabling legal environment that does not just seek to regulate but tolerate mistakes, while creating a conducive environment for innovation. Some of the recommendations will have far reaching benefits to the world. I am optimistic that issuance of initial coin offers through the proposed digital asset framework will revolutionize funding of the Micro, Small and Medium Enterprises that are the backbone of many developing countries. With regard to artificial intelligence, I am confident that it will positively impact the Big Four Agenda.

Jerome Okoth Ochieng,

Principal Secretary.



FOREWORD FROM THE CHAIRMAN



In the course of human progress, an era characterised by disruption ensues. War, pestilence, climate change or advances in technology are amongst the factors that could cause the disruption. Most of the disruptive moments are never anticipated or recorded for posterity. I am sure the report on the discovery of the wheel would have made interesting reading if the early humans had the technology of writing, education and analytical capacity that we currently possess.

I consider it a singular honour to have been appointed to chair the Distributed Ledgers Technology and Artificial Intelligence Task Force, a dedicated team of professionals appointed by the Cabinet Secretary for ICT, Joseph Mucheru, via Kenya Gazette Notice Number 2095 of 2018, to put together this report on fast-evolving, emergent and transformative technologies.

The report will also help academics and researchers understand the tremendous digital transformational opportunities. The abundant burgeoning opportunities will help Kenya leapfrog several stages of development and hasten our journey toward becoming a leading developed economy by leveraging and taking ownership of the Fourth Industrial Revolution.



Prof. Bitange Ndemo

Chairman

I am confident that this report will guide policy makers in their efforts to stimulate an efficient and resilient economy with respect to the digital transformational technologies, especially with the realization of the Big Four Agenda.



EXECUTIVE SUMMARY



The Fourth Industrial Revolution is upon us. The advent of this revolution presents governments with an opportunity to lead innovation and at the same time create an environment that enables innovation to thrive. The Fourth Industrial Revolution will result in massive transformations in the labour force, economy and productivity of our society. It will fuse the physical, digital and biological worlds, thereby affecting all sectors, geographies and economies. As Klaus Schwab, chairperson of the World Economic Forum, has stated, “We stand on the brink of a technological revolution that will fundamentally alter the way we live, work and relate to one another.” In Africa, emerging technologies have already allowed governments to leapfrog legacy infrastructure systems, generate economic growth and promote social inclusion for citizens.

This report assesses how the emerging technological revolution could be leveraged to enhance Kenya’s impressive track record of ICT adoption and development. In Africa, the government of Kenya possesses a strong history with respect to the involvement in and prioritization of digital agendas. Kenya’s willingness to embrace innovation in partnership with the private sector has earned her the moniker of ‘Africa’s Silicon Savannah’.

This innovative, forward-leaning approach to national development is reflected in Kenya’s Big Four Agenda, which will be supported and enhanced by leveraging emerging technologies. The Big Four Agenda focuses on food and nutrition security, affordable housing, enhancing manufacturing and universal health

coverage. This report describes how these emerging technologies can support all these agenda items, ranging from improving health coverage by employing the Internet of Things (IOT) and Artificial Intelligence (AI) to improving the food sustainability using Blockchain technology to eradicate counterfeit seeds. The report argues that of all the emerging technologies, none exhibits the potential to be as disruptive and transformative as distributed ledgers with a focus on Blockchain and AI technologies.

The use of Blockchain and AI technologies could be transformative across several key sectors in Kenya, including healthcare, agriculture, education and government services. The improved efficiency, transparency and accountability of Blockchain can considerably benefit government services in which several emerging markets struggle with inefficient legacy infrastructures and an inability to provide citizens with fast, accountable and transparent service delivery.

“We stand on the brink of a technological revolution that will fundamentally alter the way we live, work and relate to one another.”

² WEF: The fourth industrial revolution, 2016 [Online] <https://www.weforum.org/about/the-fourth-industrial-revolution-by-klaus-schwab>

³ Schwab, Klaus: The fourth industrial revolution, 2016. WEF

⁴ Big Four Agenda is President Uhuru Kenyatta’s legacy initiative to enhance economic growth during his last term by focusing policy and investment in the four key agenda items.

⁵ Official website of the President: The big four, 2018 [Online] <http://www.president.go.ke/>

Another important role for government is protection of its citizens from the impact of technologies disruptions.

For example, creating a Blockchain-based land registry would considerably improve the citizens' ability to prove land ownership (and provide access to credit). It would also reduce the corruption that is prevalent in the existing system.

In the education sector, AI exhibits the potential to improve learning outcomes by supporting the delivery of personalised virtual lessons. A good example here is M-Shule, an SMS-based learning platform in Kenya, which uses AI to track and analyse student performance and to deliver lessons that satisfy their needs and increase their competency. The platform reduces the fear of failure that is inherent in several learning environments, allowing students to advance at their own pace and to ultimately improve their learning outcomes.

In the case of both Blockchain and AI technologies, two key conclusions emerge from this report: the need for government to invest in a supportive ecosystem and to develop effective regulations to balance citizen protection and private sector innovation. Thus:

- (i) Investments across the ecosystem are required to fully unlock the potential of both Blockchain

and AI, particularly in terms of infrastructure and skills development. Connectivity is at the foundation of the explosive growth of technology. As the technology evolves, the demand for connectivity increases.

Constant investments in infrastructure are therefore necessary to narrow the digital divide and improve social inclusion. Improvements in digital infrastructure and last-mile access, including a three billion USD investment in the expansion of undersea cable networks, have ensured Internet connectivity to an estimated 240 million users in Africa. However, Africa's Internet penetration continues to lag below the global average; with only 35.2% penetration, 885 million or 72 percent of Africans still do not have access to the Internet. In addition to the infrastructural challenges, inadequate skills compromises both people's ability to use technology and their ability to find and retain employment in an increasingly digital world. Without targeted investments for improving infrastructure and for developing skills,

large segments of the population will be left behind in an increasingly digital world, worsening the digital divide. Although Kenya's internet penetration of 85 percent is higher than that of Africa, more needs to be done to improve rural access to





broadband as well as internet-enabled devices.

(ii) Governments also play an essential role in establishing policies that balance regulation and innovation; thus, governments must consider their dual roles as customers and regulators of technology and its impact. Another important role for government is protection of its citizens from the impact of technologies disruptions. As new technologies can be both transformational and disruptive, care must be taken to ensure that governments can effectively protect their citizens without hindering any innovation in the private sector. As a customer, the government should consider methods in which effective relevant solutions can be co-designed through public private partnerships. Such solutions should be 'use-case' specific and solve a pressing requirement of the government. While directly regulating the technology, the government should consider innovative approaches, such as regulatory sandboxes that can test methods by which the needs of both the public and private sectors can be balanced. While regulating the effect of technology, the government should consider a collaborative cross-industry partnership between the public and private sectors in Kenya and with global partners to effectively identify potential issues and implement the best-in-class policies.

This report also aims to help the government to completely understand the risks and benefits of emerging technologies in order to stay at the forefront of regulation. For each of these emerging technologies, we have answered the following key questions:

- What disruptive technologies hold the greatest potential for driving inclusive economic growth and, in particular, the Big Four Agenda?
- What are the distinct value propositions of these technologies, and where can they create value?



- What are the current and expected future applications and use cases for these technologies?
- What are the underlying factors/solutions

6 Mulligan, Gabriella. The start-up bringing AI-powered SMS-BASED learning to Kenya, Disrupt Africa: 2018. [Online] <http://disrupt-africa.com/2018/03/the-startup-bringing-ai-powered-sms-based-learning-to-kenya/>

7 Many Possibilities: African Undersea Cables, 2017 [Online] <https://manypossibilities.net/african-undersea-cables/>

8 WeAreSocial: Digital Global map, 2017 [Online] <https://wearesocial.com/special-reports/digital-in-2017-global-overview>

9 Huawei: Global Connectivity Index, 2017 [Online] <https://www.huawei.com/ch-en/press-events/news/ch/2017/Huawei-Global-Connectivity-Index2017>

that need to be in place to ensure a viable ecosystem for growth and innovation? (Infrastructure, talent, policy, and so on)

- How have other countries approached regulation, and how successful have these approaches been? What approaches have been tested to build a long-term ecosystem for management and innovation?
- What has been the real impact on inclusive growth to date (in Kenya)? What is the potential impact of this technology? (parts of this question may be out of scope)
- What are the potential risks of this technology that should be carefully considered?
- What is next? What are the key activities that should be considered for the regulation or use of this technology?



As a customer, the government should consider methods in which effective relevant solutions can be co-designed through public private partnerships. Such solutions should be 'use-case' specific and solve a pressing requirement of the government.

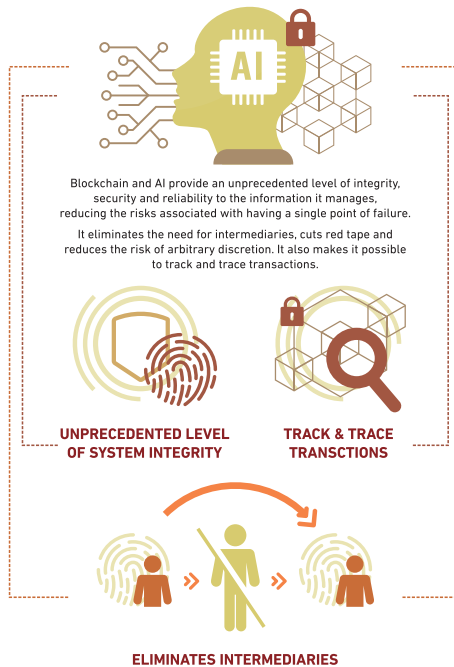


**MINISTRY OF ICT,
GOVERNMENT OF KENYA TASK FORCE
ON DISTRIBUTED LEDGERS AND
ARTIFICIAL INTELLIGENCE**

CORRUPTION

**CORRUPTION IS THE
BIGGEST OBSTACLE TO OUR
NATION BUILDING**

EFFECTIVE TOOLS TO FIGHT CORRUPTION BLOCKCHAIN & AI



TASKFORCE REPORT & RECOMMENDATIONS



**ELIMINATION OF
CORRUPTION**

**NEW OPPORTUNITIES TO MINIMIZE
NATIONAL DEBT THROUGH
DIGITAL ASSET FRAMEWORK**



**STREAMLINE DEMOCRACY
AND ELECTIONS**

**FACILITATE FINANCIAL
INCLUSION**



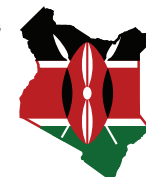
**REDUCTION OF
TRANSACTION COSTS**

**IMPROVING PUBLIC
SERVICE DELIVERY**



**THE PROPOSED RECOMMENDATIONS
WILL TRANSFORM KENYA**
TRANSPARENCY CORRUPTION PERCEPTION INDEX

AIM OF REACHING
A RANKING OF
60
BY 2022



**LEAST
CORRUPT
COUNTRY**



BIG 4 AGENDA

AREAS OF INTERVENTION

FOOD SECURITY
STREAMLINE
AGRICULTURE SUPPLY CHAINS



HOUSING
RAISE DEVELOPMENT FUNDING,
LOWER FINANCE COSTS

HEALTHCARE
TRACK DRUG SUPPLY
CHAINS, ANALYTICS FOR
DISEASE CONTROL



MANUFACTURING
ELIMINATE COUNTERFEITS,
LOGISTICS MANAGEMENT

CYBER SECURITY
PROMOTE NATIONAL SECURITY
& DIGITAL ECONOMY



LAND TITLING
ESTABLISH ACCURATE LAND RIGHTS

4 ACTION ITEMS

TO PROMOTE PRIVATE/PUBLIC SECTOR INNOVATIONS



REGULATORY SANDBOX

ENACT SUPPORTIVE REGULATIONS TO FACILITATE INNOVATION AND REVISE THOSE THAT MAY HINDER ADVANCEMENT.



MULTI-SECTOR PARTNERSHIP

DEVELOP A SUPPORTIVE ECOSYSTEM THROUGH MULTI-SECTOR PARTNERSHIPS AND CROSS-COLLABORATION.

ADOPTION OF BLOCKCHAIN AND AI SOLUTIONS INCLUDING INVESTMENTS IN INFRASTRUCTURE AND SKILLS DEVELOPMENT.

INVESTMENT & SUPPORT

ACTIVE INVESTMENT AND GOVERNMENT SUPPORT IN USE OF BLOCKCHAIN SOLUTIONS, WITHOUT WHICH THE PRIVATE SECTOR WOULD FIND IT DIFFICULT TO DEMONSTRATE PROOF OF CONCEPT OR PROOF OF SCALE.



EMERGING TECHNOLOGY BRAIN TRUST

CREATE A BRAIN TRUST, HANDLING ALL EMERGING TECHNOLOGIES THAT IMPACT INITIATIVES THAT THE KENYA GOVERNMENT EMBARKS ON NOW AND IN THE FUTURE.

THE BRAIN TRUST WILL:

GENERATE STRATEGIES FOR GOVERNMENT ON USE OF GLOBAL EMERGING TECHNOLOGIES TO BEST SERVE CITIZENS

HARMONIZE USAGE OF TECHNOLOGIES ACROSS GOVERNMENT

SUPPORT IMPLEMENTATION OF INITIATIVES





KEY RECOMMENDATIONS

Below is a brief summary of the key recommendations proposed in this report:

Eliminate Corruption



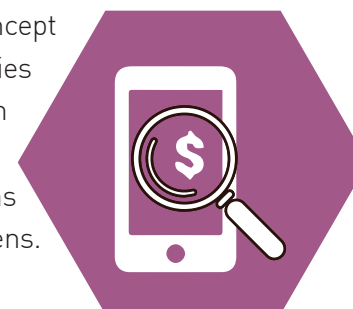
Kenya, like many developing countries, has struggled to fight public corruption. This fight can be won with the introduction of Blockchain and AI that have been heralded as game changers in fighting corruption. Several governments across the world have embraced the use of technology for improved governance. Blockchain and AI have emerged as some of the technologies that offer actual means to fight corruption and ensure that citizen's interests are protected, given that technology such as blockchain offers transparency and immutability.

Spain for example slid eight points to become one of the EU's lowest ranked countries due to a spate of high-profile corruption scandals over the last decade, and has had to leverage Blockchain and AI technology solutions to combat corruption. They have done this through the amendments of their Anti-corruption laws to incorporate these emerging technologies. Other countries that are using Blockchain and AI to fight corruption include: Ghana, Georgia and Ukraine are looking to reform land registry by building immutable title systems on blockchain to prevent fraud and enable the banking industry to have confidence on land assets; Some of the Scandinavian countries have built blockchain-powered land registries to make the details of real estate transactions visible to all interested parties including the tax agencies to eliminate tax evasion.

Minimize National Debt Through Digital Asset Frameworks

Governments especially in developing countries are burdened by the weight of public debt and yet many of these countries have resources that can be leveraged to create local cryptocurrencies to raise resources without necessarily overburdening themselves. The Kenyan Government should develop a digital asset framework to enable citizens to raise funds through Initial Coin Offers (ICOs) as a strategy to help local investors put their resources in cryptocurrencies underpinned by the utility of local resources. These will help transform many viable Small and Medium Enterprises (SMEs) and start-ups to scale to other countries. Governments too could raise infrastructure resources to locally issued ICOs and minimize foreign debt.

In February 2018, the Venezuelan Government launched a cryptocurrency backed by the country's oil and mineral reserves. This move was intended to supplement Venezuela's failing bolívarfuerte currency, in the wake of U.S. sanctions and subsequent difficulty in accessing international financing. Although this was a desperate move, the concept remains viable. Other countries can begin issuing such currencies and backing them with local resources as a means of avoiding heavy debt burdens. Estonia will perhaps be the first






Government to issue an ICO. Kenya needs to pilot this promising concept and issue an infrastructure coin or one that deals with the problem of unemployment as we have recommended in this report.

Strengthen Democracy and Elections

Kenya has in the past 20 years suffered electoral violence whenever one party alleges stolen votes. This could be a problem of the past if we embraced Blockchain and AI. Last year, Sierra Leone became the first country in the world to use blockchain in tallying presidential elections alongside the normal process to demonstrate that indeed blockchain can be used in tallying votes. The Sierra Leone announcement prompted the Independent Electoral and Boundaries Commission of Kenya (IEBC) to announce plans to also utilize blockchain technology and AI to offer real-time polling results and thus improve vote integrity and trust in the voting process. In this report we have recommended a gradual implementation starting with election of Members of County Assembly in order to build the much-needed confidence before it is used nationally for presidential vote tallying.



The Kenyan Government should develop a digital asset framework to enable citizens to raise funds through Initial Coin Offers (ICOs) as a strategy to help local investors put their resources in cryptocurrencies underpinned by the utility of local resources. These will help transform many viable Small and Medium Enterprises (SMEs) and start-ups to scale to other countries. Governments too could raise infrastructure resources to locally issued ICOs and minimize foreign debt.

Facilitate Financial Inclusion



As part of the financial inclusion drive, the taskforce recommends the creation of a National Payment Gateway using a public private partnership model. This payment gateway becomes the central point for all digital transactions/payments, whether mobile or not. This would create an ecosystem where all payment modes interact with each other i.e. ATMs, banks, mobile money and so on. This will ensure a reduction in the cost of transactions and the beginning of the journey from a cash based economy to a full digital economy. India, for example, created a National Payments Corporation, which brings together all retail payments in India. The Reserve Bank of India and the country's Banks Association were instrumental in the creation of the corporation. If this were to happen in Kenya as we hope, then there will be a need to do the following:

- Launch awareness campaigns and education programs to increase citizen's financial literacy and capability.
- Leverage citizen ID for KYC for opening bank accounts and providing credit.
- Establish robust financial consumer protection frameworks.
- Enhance regulatory and supervisory bodies by

utilizing technology to improve supervision.

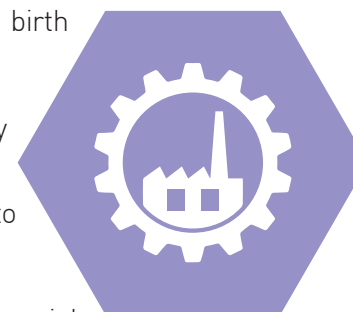
- Implement a Financial Technology (Fintech) Legal and Regulatory Sandbox.

Reduce Transaction Costs

A PWC study¹⁰ reveals that Blockchain and AI has unique characteristics that will enable institutions to operate a lot quicker and in a cheaper way, with a lower error rate, resulting in less risks and lower capital requirement. Blockchain and AI are also less vulnerable to cyber-attacks.

Kenya should:

- Leverage Blockchain and AI to identify fraud indicators and conduct a public awareness campaign.
- Create a digital locker (complementing digital ID) for every citizen to securely store official documents (e.g. credit report, birth certificate).
- Introduce a regulatory requirement for issuers to provide tools to merchants to prevent fraud.
- Introduce legislation to compel financial institutions to report fraud incidences.
- Encourage CBK to leverage Blockchain AI to verify institutional reporting.



¹⁰ <https://www.pwc.com/m1/en/media-centre/articles/blockchain-new-tool-to-cut-costs.html>

Improve Public Service Delivery with Blockchain

Blockchain solutions have the potential to transform government operations and make them more efficient for better public service delivery. This in essence will lead to increased trust in the public sector. Already many states in the US have started to leverage blockchain technology for efficiency purposes or to achieve a competitive advantage. In Kenya we could leverage on the same to achieve the following:



- Provide a single-source-of-truth for all government documents and services.
- To enhance public service delivery with transparent service level agreements for all citizens in all Huduma Centers.
- Faster, more efficient processing of import and export documents by agencies (KEBS, KRA, KPA, Police and Anti-Counterfeit units).
- Enhance Ease-of-Doing-Business by leveraging Blockchain.
- Implement a digital identity service.
- Enable a digital fiat (surrogate) currency.

Big Four Agenda & Other Focus Areas

The Big Four Agenda entails the flagship projects identified by President Uhuru Kenyatta as legacy

projects. These include: agriculture and food security, affordable housing, universal health coverage, and manufacturing. Other focus areas include cybersecurity and land titling.

Improve Agriculture and Food Security

Kenya faces a daunting task of ensuring food security in the face of increased food losses (post-harvest food losses are estimated at 40 percent) throughout the supply chain. Blockchain technology has been successfully deployed throughout the world, including Kenya, for food supply chain traceability and authenticity. Several companies locally have deployed the emerging technologies but this needs to be sold widely in order to achieve one of the Big Four objectives – food security.

Therefore, Kenya needs to start:

- Tracking agricultural produce from end-to-end (from seeds to marketplace) and apply AI and analytics to detect fraud, trace unsafe products and deliver training to farmers to improve quality.
- Distributing farming subsidies including those for fertilizers through a Blockchain controlled Agri-token (see demonstration in this report) that reduces fraud and ensures farmers receive the needed assistance leveraging citizen ID.
- Introducing a citizen service to track the origin of food products and report unsafe food products.



- Introducing AI, the Internet of Things and Weather data to predict and manage water, provide drought warnings and advice farmers.



Deliver Affordable Housing

In Kenya, previous attempts to provide affordable housing failed when the rich, through corruption, denied poor people access to the allocations of new housing. This will not happen in future since the State Department of Housing has committed to using Blockchain for allocation and financial management of affordable housing.

Blockchain in combination with AI will provide other services such as:

- Ensuring predictive population planning and ensuring the right locations are selected for the construction of houses.
- Predicting building maintenance issues and consolidated purchasing.
- Matching the buyer and seller without extra costs incurred under the existing methods of buying and selling of houses, (minimizing third-parties in the



transactions)

- Lowering transaction costs through smart contracts.

Improve Health & Drug Safety

Several studies (see for example) show that Blockchain will play a key role in transforming healthcare. Deployment of the technology will lead to cost reduction, improve the integrity of medical records, better consent management for greater patient privacy and reward systems for patients who consent the use of their data for medical research. It will also transform drug safety through better traceability.

We therefore recommend that the government:

- Introduce Blockchain technology to enable customers to trace the supply chain of medication, to help tackle the issue of counterfeit medication.
- Leverage AI to help augment the skills of medical professionals through training and AI assistance applications.
- Introduce a Healthy token incentive to reward citizens for healthy lifestyle.

This will not happen in future since the State Department of Housing has committed to using Blockchain for allocation and financial management of affordable housing.

Expand Manufacturing and Eliminate Counterfeits

The greatest potential for Blockchain lies in delivering business value in manufacturing. Louis Columbus in his 2018 article , 'How Blockchain Can Improve Manufacturing In 2019', says that by increasing visibility across every area of manufacturing starting with suppliers, strategic sourcing, procurement, and supplier quality to shop floor operations including machine-level monitoring and service, blockchain can enable entirely new manufacturing business models. Supply chains are the foundation of every manufacturing business, capable of making use of blockchain's distributed ledger structure and block-based approach to aggregate value-exchange transactions for improved supply chain efficiency. By improving supplier order accuracy, product quality, and track-and-traceability, manufacturers will be able to meet delivery dates, improve product quality and sell more.

The Government should therefore:

- Introduce a supply chain security act to initiate the creation of a regulatory framework that outlines the process of building an electronic, interoperable system to identify and trace manufacturing outputs (and inputs) as they are distributed in Kenya



leveraging Blockchain and AI.

- Create permissible networks with Blockchain technology that can interoperate with manufacturer's systems in a secure manner, or work with a middle layer of companies that provide this service to both government and industry.
- Use Blockchain supply chain networks to flag and report counterfeit goods.

Improve Cybersecurity

Experts (see for example) say blockchain technology can fully decentralize Domain Names Systems (DNS), distributing the contents to a large number of nodes and making it nearly impossible for hackers to attack. Domain editing rights would only be granted to those who need them (domain owners) and no other user could make changes, significantly reducing the risk of data being accessed or changed by unauthorized parties. By using blockchain to protect the data, a system can ensure that it is invulnerable to hackers, unless every single node is simultaneously wiped clean. The Government should therefore:

- Operationalize the Computer Misuse & Cybercrimes Act of 2018 and ensure the national computer and cybercrime co-ordination committee is in place together with regularized enforcement/compliance.



11 Mettler, M. (2016). Blockchain technology in healthcare: The revolution starts here. 2016 IEEE 18th International Conference on e-Health Networking, Applications and Services (Healthcom). doi:10.1109/healthcom.2016.7749510

12<https://www.forbes.com/sites/louiscolombus/2018/10/28/how-blockchain-can-improve-manufacturing-in-2019/#41ee7c2d5db6>



Improve Land Titling

Land titling has emerged as one of the most common blockchain applications throughout the world to improve security and usability. It is a more secure method of transferring property ownership and one that will eliminate the current land fraud and corruption that exists in the country's land management agencies.

It is time to:

- Leverage land digital data to introduce Blockchain and create immutability and increased transparency of land transactions.
- Review and amend the land titles regimes under the Land Registration Act and the Community Land Act to formulate guidelines for electronic land titling.
- Hold public awareness campaigns and training for Land officials and Land practitioners, regarding the technology.
- Digitize all land records throughout the country.

Operationalize the Computer Misuse & Cybercrimes Act of 2018 and ensure the national computer and cybercrime co-ordination committee is in place together with regularized enforcement/compliance.



KENYA'S JOURNEY TOWARDS DIGITAL TRANSFORMATION

Kenya's journey towards digital transformation began with the formation of the Ministry of Information and Communication Technologies under President Kibaki in 2003 and persisted under the leadership of President Uhuru Kenyatta who retained the same ministry in his cabinet. The Ministry's current mandate is derived from the May 2016 Presidential Executive Order No.1/2016. The mandate comprises the formulation of policies and laws that regulate standards and services in the Information, Communication and Technology (ICT) sector and the Telecommunications and Media industries. The Ministry is also responsible for developing and administering ICT standards, building mass media and ICT capacity and the dissemination of public information through the Kenya Broadcasting Corporation (KBC).

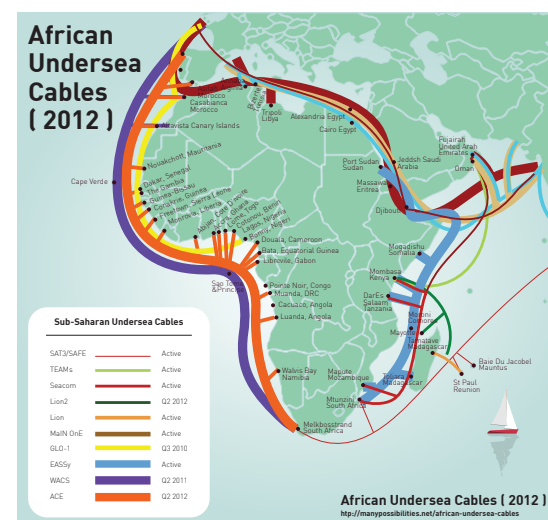
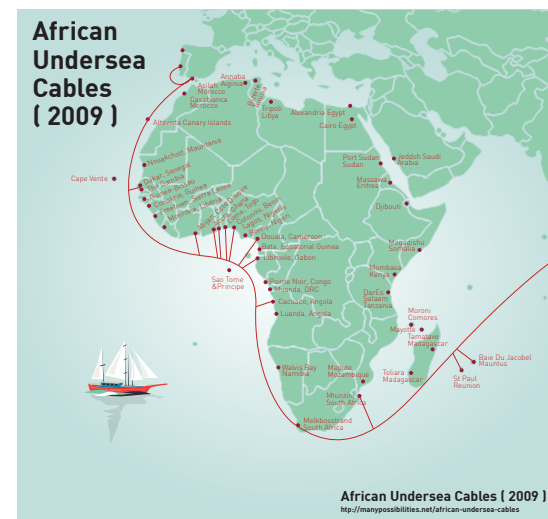
The Ministry's first policy document was gazetted in 2006. It primarily focused on five key areas.

1. Infrastructure development
2. Development of content and applications
3. Capacity building
4. Leveraging public-private partnerships to finance major infrastructural development
5. Creating massive employment in the sector

Since 2006, the Ministry has made considerable progress by initially providing the entire East African region with comprehensive fibre optic networks (Figure 1) to connect the country with the outside world. This was followed by developing a

comprehensive country-wide terrestrial fibre optic network (Figure 2) that reduced the cost of broadband services. The network spanned overall corners of the country and linked Kenya to all its neighbours. Currently, Kenyans enjoy high-speed connectivity in almost all parts of the country.

Figure 1: Africa Connectivity



Source: Oxford Internet Institute

For several years, investors were scared that developing extensive broadband capacity in Africa would not be viable because very little satellite capacity was utilised. However, Kenya insisted that there was latent demand and, in 2009, proceeded to build the first cable to land in the Eastern Seaboard of Africa. This risky venture proved to investors that Africa could indeed require large broadband capacity. This in turn caused a flurry of investments, and currently Africa enjoys more than 120 terabytes of broadband.

The heavy investments in broadband have yielded remarkable returns, particularly in Kenya. According to the Communication Commission of Kenya's 2018 report, mobile penetration increased to 90.2% in the first quarter of 2018. Internet penetration is 85%, which is significantly more than the African average of 35.2%. In addition, 3G and 4G last mile connectivity is available throughout the country, and plans are underway to begin testing 5G connectivity. Terrestrial cabling to all corners of the country is complete, as depicted in Figure 2.

Figure 2: Terrestrial Connectivity



- CENTRAL REGION
- COAST AND NORTH EASTERN REGION
- WESTERN REGION
- - - TELCOM KENYA NETWORK

However, Kenya insisted that there was latent demand and, in 2009, proceeded to build the first cable to land in the Eastern Seaboard of Africa.



A 2017 White Paper entitled 'Trends from the Kenyan Smartphone and E-Commerce Industry', published by GSMA Mobile and Jumia Business Intelligence, revealed that smart phone penetration in Kenya has risen to more than 60%. The report also noted that more than 90% of the youth own smart phones.

Recognising the importance of the transformational implications, the Cabinet Secretary in the Ministry of Information, Communication and Technology appointed a taskforce to explore and analyse these emerging digital technologies that demonstrate high potential to transform Kenya's economy, including potentially disruptive technologies that are currently

shaping the global economy such as Distributed Ledger Technologies (DLT) (which includes Blockchain and hashgraph), artificial intelligence (AI), emerging broadband wireless technology and the Internet of Things (IoT).





INTRODUCTION TO EMERGING DIGITAL TECHNOLOGIES



The sense of inevitability and the force with which new digital technologies are making their way into all facets of life is remarkable. The estimated adoption rates, whether they are conservative or optimistic, are astronomical. However, discussions about adoption data tend to be overly concerned with the interpretation of numbers and growth figures rather than focusing on the transformational implications. Globally, digital technologies are transforming economies by enhancing transparency, efficiency, inclusivity, as well as the ability to make better decisions and deliver better services to citizens. The development of digital technologies can be divided into four phrases. As reported by the Internet Society, from the late 1950s to the early 1990s, the groundwork for digital technology was conducted in laboratories, primarily in the United States and the United Kingdom.

The second phase, from the mid-1990s to the early 2000s, was largely a period of digital exploration. This phase was characterised by the initial use of networks and computers to link organisations with their customers, which was a phenomenon that can be referred to as digital channels or websites. During this time, improvements were made to intensify digital applications by supporting customer interactions through processes and systems to enhance productivity as a competitive advantage. However, many third world countries, did not have cheap connectivity and could therefore not enjoy a

similar experience. In Africa, the Internet was so expensive that only a few could afford to access the existing satellite links.

The third phase, which can be referred to as the multiplatform phase, began between 2003 and 2013. This phase coincided with the availability of mobile phones, the entry of social media sites and the arrival of various other applications that have had a considerable impact across the world. Although some social network applications, such as Fidonet, Friendstar, Classmate.com and Myspace were available in Kenya, the general public could not access Facebook, which was the most popular social networking application, until 2006. During this phase, several other applications, such as PayPal, Uber, Airbnb and Kenya's MPESA exploited the market opportunities associated with mobile devices.

The second phase, from the mid-1990s to the early 2000s, was largely a period of digital exploration. This phase was characterised by the initial use of networks and computers to link organisations with their customers.

The fourth phase of the Industrial Revolution, also referred to as the age of disruption, began around 2014. As explained by Hanna and Summer, many countries, particularly in the developed world, significantly benefited from digital technologies. However, the digital revolution continues to influence

the world economy, and a majority of the drastic effects of ICT advances and disruptions, such as cloud computing, big data/analytics and IoT, have not yet been realised. Thus, all the economies and societies face expanding opportunities from ICT-driven innovation and transformation and are under stress from the dramatic pace of change and the risks associated with this technological revolution.

These fourth-phase technologies will underpin the emerging fourth industrial revolution. Africa missed the first, second and third industrial revolution. Consequently, the continent has an opportunity to 'leapfrog' to the fourth phase to take advantage of the rapidly emerging technologies.

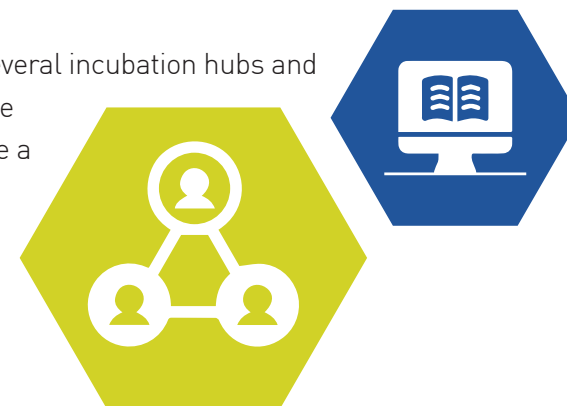
Two examples demonstrate the manner in which Kenya can unlock the potential of the transformative nature of these technologies:

- i. Working with Twiga Foods, a Kenyan fast-moving consumer goods start-up, IBM has managed to fuse Blockchain, AI and big data, to develop credit profiles to access non-collateralised loans to hundreds of small-to-medium businesses, many of whom were owned by female vegetable vendors. Under normal circumstances, these businesses would not be issued credit from any banking institution due to lack of a credit history and inadequate documentation for KYC purposes. Without the use of Blockchain and AI

to digitize and process non-traditional data, such an inclusive solution would not have been possible.

- ii. M-Shule, a start-up in Kenya, leverages AI to provide an adaptive learning engine that continuously analyses each learner's abilities to track and build skills, and generate personalised learning. M-Shule solves a major problem that normal schooling has not been able to address. Educators understand that different students possess different abilities and consequently exhibit different requirements, strengths and objectives. The AI systems can be employed to identify each individual child's competency and deliver the right lesson at the right time.

With support from the several incubation hubs and accelerators in Kenya, the country is poised to make a significant global contribution to the emerging fourth industrial revolution.

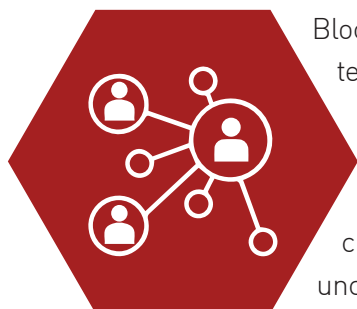


15 A Brief History of the Internet [Online]
<https://www.internetsociety.org/internet/history-internet/brief-history-internet/>

16 Hanna, N. K., Summer, R [2016] Transforming to a Networked Society, Sriban, Inc., 42 Beacon Hill Court, Gaithersburg, MD 20878-5401, USA.



BLOCKCHAIN: DEFINITION AND VALUE PROPOSITION



Blockchain, as with any new and emerging technology, is little understood and has many definitions. Fundamental to any definition, however, is the concept of chain of transactions linked by cryptographical signatures that are unchangeable across networks and that are decentralised in terms of ownership and control. Thus, Blockchain is a distributed ledger or a decentralised database that permanently records transactions between users without requiring a third-party. In this ledger, transactions are cryptographically chained such that they cannot be tampered with and are shared with the linked users. Verified transactions in the ledger cannot be modified without obtaining a consensus from users. Although Blockchain's most commonly known app is Bitcoin, Blockchain's utilisation has grown and has rapidly diversified in recent years. The Blockchain market is expected to grow from USD 411.5 million in 2017 to USD 7.68 billion by 2022, at a compound annual growth rate of 79.6%.

Gartner, a global industry analyst, describes Blockchain as follows.

'An expanding list of cryptographically signed, irrevocable transactional records shared by all participants in a network'

Each record contains a time stamp and reference links to previous transactions.

With this information, anyone with access rights can trace back a transactional event, at any point in its

history, belonging to any participant.'

'The capabilities of Blockchain include:

- Represent assets digitally
- Enable new forms of value exchanges
- Interact/transact without a central authority or a middleman
- Ensure distributed copies of identical records that are immutable and traceable
- Enable management, governance and execution of partnerships and contracts across entities'



17 CRS: Blockchain Background and Policy Issues, 2018

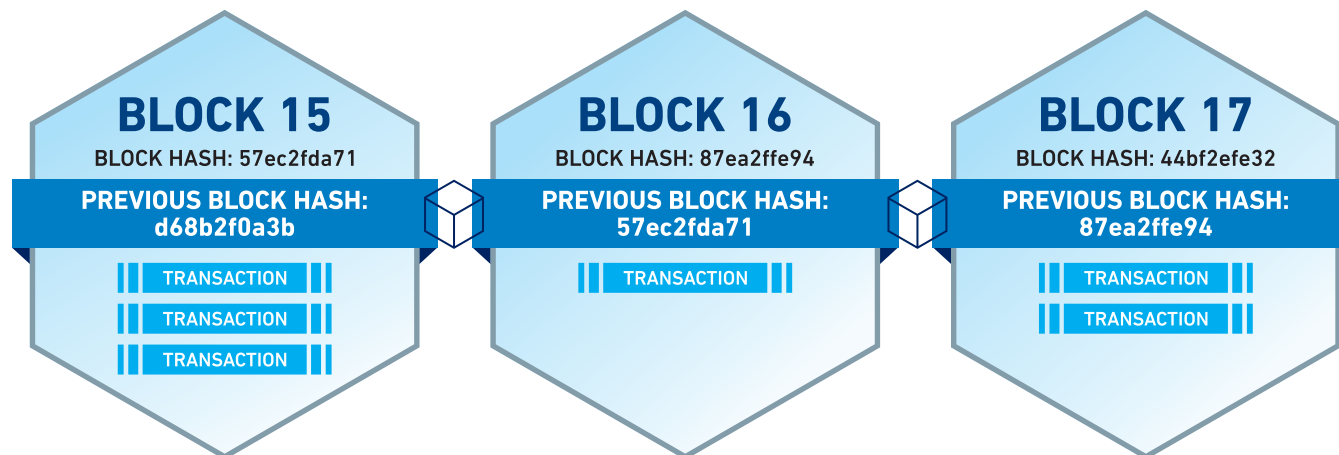
18 Michael Pisa and Matt Juden: Blockchain and Economic Development, Hype vs Reality, 2017 [Online]
<https://www.cgdev.org/publication/Blockchain-and-economic-development-hype-vs-reality>

19 Research and Markets: Blockchain Market by Application, Global Forecast to 2022, 2017

20 Hype Cycle for Blockchain Technologies, Gartner, 2017

21 BlockchainBlockchain-Based Transformation: A Gartner Trend Insight Report, Gartner, March 2018

Figure 3: High-Level Blockchain Structure



Source: Evaluating the Security Risks to Blockchain Ecosystems, Gartner, March 2018

All transactions are instantly and automatically shared with the linked users, thereby preventing double spending.

Blockchain's core value proposition of increased efficiency, transparency and accountability is well suited to support the national development agenda. Blockchain's value proposition is founded on three primary characteristics: all transactions are instantly and automatically shared with the linked users,

thereby preventing double spending. Also, the data on the chain are immutable and consist of a complete history of that data.

- Efficiency: Blockchain reduces dependence on intermediary institutions and their accompanying costs, increasing the speed and reducing the cost of transactions. For example, remittances through Blockchain-enabled cryptocurrency can reduce costs and increase efficiency. For example, BitPesa usage exhibits that the usage of cryptocurrency for remittances can reduce transaction costs by 4.5%–6.5%. Globally, this represents a potential annual cost reduction in the remittance industry of USD 20–29 billion.



- **Transparency:** When a transaction is performed, it is stored on the chain and is instantly and automatically shared with all the parties on the network. Thus, all the parties can view the transaction. Furthermore, each transaction has a date and time stamp, a unique identifier and links to previous data. Blockchain technology can increase the transparency and legitimacy of national elections by enabling auditable digital voting. This would improve the trust of citizens in the results, as is the case for the Columbia referendum.
- **Accountability:** All transactions are automatically linked. Records are not edited or deleted directly in Blockchain. Rather, in the case of an edit, the original record is kept together with the associated change. In the case of deletion, the original record is again kept along with the subsequent reversal of the entry. If a deletion were ever to be attempted, all users in the network would be alerted. In view of the robustness of this security feature, the government of Estonia uses Blockchain to ensure the integrity of digital registries and repositories, allowing rapid detection of any attempts to attack,

modify or compromise the system.

Blockchain's ability to create or enhance trust within a community is discussed in Manav Gupta's book 'Blockchain For Dummies'.

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Blockchain's ability to create or enhance trust within a community is discussed in Manav Gupta's book 'Blockchain For Dummies'.

'Blockchain builds trust through the following five attributes:

22 Deloitte University Press: Will BlockchainBlockchainTransform the Public Sector, 2017 [Online]

23 Global Radar: The potential impact of cryptocurrency on the remittance industry, 2017

24 GSMA:BlockchainBlockchainfor Development, 2017

25 Michael Pisa and Matt Juden: BlockchainBlockchainand Economic Development: Hype vs Reality, 2017

- Distributed and sustainable: The ledger is shared, updated with every transaction, and selectively replicated among participants in near real time. Because it's not owned or controlled by any single organization, the Blockchain platform's continued existence isn't dependent on any individual entity.
- Secure, private, and indelible: Permissions and cryptography prevent unauthorized access to the network and ensure that participants are who they claim to be. Confidentiality is maintained through cryptographic techniques and/or data partitioning techniques to give participants selective visibility into the ledger; both transactions and the identity of transacting parties can be masked. After conditions are agreed to, participants can't tamper with a record of the transaction; errors can be reversed only with new transactions.
- Transparent and auditable: Because participants in a transaction have access to the same records, they can validate transactions and verify identities or ownership without the need for third-party intermediaries. Transactions are time-stamped, ordered and can be verified in near real time.
- Consensus-based and transactional: All relevant network participants must agree that a transaction is valid. This is achieved through the



use of consensus algorithms. Each Blockchain network can establish the conditions under which a transaction or asset exchange can occur.

- Orchestrated and flexible: Because business rules and smart contracts (that execute based on one or more conditions) can be built into the platform, Blockchain business networks can evolve as they mature to support end-to-end business processes and a wide range of activities.'

Blockchain and cryptocurrencies such as Bitcoin are often confused as being inextricably connected. However, many uses of Blockchain do not involve cryptocurrencies. While most digital cryptocurrencies use Blockchain as a mechanism for recording currency transactions, Blockchain is not limited to creating currencies and can be utilized to solve problems that are entirely independent from cryptocurrencies.

Blockchain's relationship with cryptocurrencies is clarified in Manav Gupta's book 'Blockchain For Dummies'.

The takeaway lesson:

- i. Bitcoin and Blockchain are not the same.
- ii. Blockchain provides the means to record and store Bitcoin transactions, but Blockchain has many uses beyond Bitcoin.
- iii. Bitcoin is only the first use case for Blockchain.

26 OECD: Embracing innovation in government, 2017

27 GSMA: Blockchain for Development, Emerging Opportunities for Mobile, Identity and Aid, 2017

- iv. Think of Blockchain as an operating system, such as Microsoft Windows or MacOS, and Bitcoin as only one of the many applications that can run on that operating system. 29

countries where no such infrastructure exists, Blockchain technology presents an opportunity to forego costly traditional infrastructure and adopt the world's most cutting-edge and efficient systems.

While most digital cryptocurrencies use Blockchain as a mechanism for recording currency transactions,

Aligning with the Big Four Agenda:

Use Cases and Blockchain Relevance for Kenya

Although there are few case studies done at an equivalent scale as for implementing the Big Four, it is evident that Blockchain technology can support emerging and frontier markets and tackle the distinct set of challenges they face. Blockchain technology can align with inclusive growth agendas and can be a powerful asset in emerging markets. Examples of Blockchain applications in developed countries demonstrate its potential to improve existing systems that already have some degree of efficiency. This can be seen in the figure 4 below for land registry systems across three countries. The difference between improving an existing system and developing a new system primarily depends on existing legacy infrastructure. In



28 BlockchainBlockchain For Dummies®, 2nd IBM Limited Edition, Manav Gupta, 2018

29 Blockchain For Dummies®, 2nd IBM Limited Edition, Manav Gupta, 2018

Figure 4 : Case Study – Land Registry

CASE STUDY: Land Registry system in Sweden, Georgia, and Ghana

BACKGROUND

In many countries around the world, land registries are unreliable, inefficient or non-existent. Blockchain presents an opportunity for countries to build immutable, transparent, and permanent land registries. Blockchain registries can benefit both national administration and citizens by providing access to reliable and secure land records run on an efficient system.

KEY LEARNINGS

Three countries have implemented or are in the process of implementing blockchain land registries. Given their different contexts, they each aim to solve different problems:

- **SWEDEN:** The Lantmateriet, Sweden's land authority, has recently completed the third phase of a blockchain land registry and real estate registry pilot. The authority is seeking to render their current system, which is partially digital, more efficient and resilient. For the pilot, the Lantmateriet partnered with a blockchain startup, a tech consulting firm, a telecom, an IT firm, banks and a real estate portal.
- **GEORGIA:** The government of Georgia was faced with past and recent encroachments of Russia on its territory, property disputes, corruption, and a digital but inefficient land registry. They worked with The Bitfury Group to develop a land titling project that is now integrated into the system of the National Agency of Public Registry. Following the success of this application the government is exploring the use of blockchain technology in other public departments.
- **GHANA:** Ghana has made efforts to improve its land administration and registration system over the years, however, due to the system still being inefficient and unreliable, more than 80% of landowners lack land titles. Private sector start-ups such as Bitland and Land LayBy Holdings are now coming to the forefront to present blockchain technology solutions. However, these start-ups have been unable to scale without government endorsement.

KEY TAKEAWAYS

To develop an efficient blockchain-enabled land registry system, governments need to:

- Identify the problems in their current system, and understand if blockchain presents a viable solution through a costs benefits analysis of blockchain versus alternative technologies.
- Analyze their existing system to assess their readiness of using a blockchain solution, and the associated challenges and expenses. For example, Georgia and Sweden were both easily able to develop a blockchain solution as their land records were already at least partially digitized. This would be substantially more challenging in Ghana, where the records would first need to be digitized
- Collaborate with the private sector to co-design and implement a blockchain solution, to ensure that the solution is relevant, and considers the context of the country in which it must operate. This is also important for the management of the solution, as skills either need to be built within the government, or outsourced to the private sector to manage the solution.

In Kenya, national development agendas can be supported and significantly improved through Blockchain applications. While Blockchain-based system deployments are mostly in their early stages, a wide range of experiments and pilot projects indicate the potential of Blockchain technology to lay the foundation for more efficient, transparent and accountable development approaches. For example, in education, Blockchain solutions are providing a simple, verifiable way of issuing and checking certificates for students who complete training programs.

Blockchain has the potential to help Kenya achieve its Big 4 Agenda in the following ways:

- Health: Blockchain technology can be used to track the pharmaceutical supply chain. Such tracking capability would help tackle the issue of counterfeit medication, which kills approximately 100,000 people every year in Africa . For example, the MediLedger Project brought leading pharmaceutical manufacturers together to track prescription medicines. The project concluded that Blockchain technology could be used to trace products back to their original manufacturers and to confirm the authenticity of a drug with each transaction.³¹
- Food Security: As in healthcare, agriculture could

benefit from transparent and auditable supply chains. Counterfeit seeds have flooded many markets, resulting in reduced productivity in soil and compromising farmers' yields for many seasons. In 2012, it was reported that 40% of seed packets in Kenya contained counterfeit seeds and 75% of farmers had planted counterfeit seeds at some point. This is what contributed to a national food deficit in 2011 . Origin Agritech, a Chinese seed provider, is using Blockchain technology to track and document the original source of seeds to eliminate the prevalence of counterfeit seeds .

- Manufacturing: Blockchain can be used to improve supply chain systems. In manufacturing industries, supply chain systems involve a wide range of activities, such as material procurement, processing, packaging, labelling, transport and payments. Typically, such systems have significant transaction costs and, where manual processes are involved, are prone to errors. Wipro, a business process services consulting company, has developed Blockchain applications for supply chains that address registration, certification and tracking of goods. Kenya's manufacturing industry could benefit from harnessing Blockchain technology.





- Housing: As the above examples illustrate, Blockchain technology can be used to create land registries that benefit both government agencies and citizens. Kenya's recently digitised land registration services make it well positioned to implement a Blockchain-enabled system .

All transactions are instantly and automatically shared with the linked users, thereby preventing double spending.

31 Chronicled: The MediLedger Project 2017 Progress Report, 2018

32 African Farming and Food Processing. "African alliance sets up agency to eliminate fake seeds." 2012

33 PRNews Wire: Origin and Elastos Announce Collaboration in Developing an Agribusiness Platform, 2018

34 Protus Onyango (The Standard): Ministry of Lands Re-open Activities at Nairobi Registry, 2018



REGULATORY APPROACHES



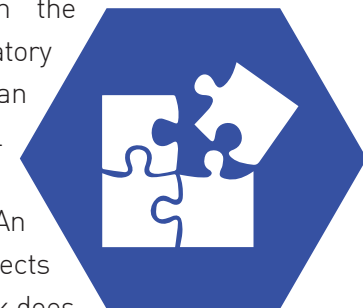
Governments will play two key roles in Blockchain development: (i) driving solution development as primary users and (ii) developing supportive policies and ecosystems to enable the growth and development of the private sector.

Governments need to be at the forefront of driving the Blockchain agenda and co-creating solutions with the private sector. Blockchain's core value proposition (increased transparency, accountability and efficiency) is directly linked to the desired core attributes of government; thus, governments will be key users of Blockchain solutions. Governments can also partner with the private sector in co-developing and adapting solutions that are relevant to their countries' needs and capabilities. Without governments being at the forefront, Blockchain solutions risk being relegated to niche participants. For example, in the import/export sector, select shipping companies can implement their niche Blockchain solutions without necessary government support. If this happens, there is risk of fractured or non-adoption of the technology.

Governments can also partner with the private sector in co-developing and adapting solutions

Governments also need to develop supportive policies to enable the growth of the Blockchain industry, either through regulating the industry in general or through regulating its use in a specific sector. Although there is currently no global consensus on how to regulate Blockchain technology, there is an agreement that regulations are required.

When considering overall regulation of the industry, it is important to ensure that the regulations encourage innovation and development in the private sector. Mauritius' Regulatory Sandbox License (RSL) is an example of how a national regulation can accommodate innovative Blockchain projects. An RSL allows investors to run projects that the Mauritian legal framework does not accommodate. Applicants are expected to 'demonstrate the innovative nature of the project at the local, regional or international level', and if an RSL is issued, the terms and conditions under which an investor may operate are stipulated³⁵. As of January 2018, Mauritius had issued two RSLs to companies embracing Blockchain technology, i.e. SelfKey, a digital identity firm³⁶, and SALT Lending, an online lender.³⁷



Regulations for specific sectors are often more stringent as they are defined by the normal operation of the sector rather than its potential for innovation. The most extreme example of this is the financial sector, which must be very cautious about potential misuse and abuse of new technologies. Currently,



most discussions on regulation have focused on cryptocurrency. For example, a June 2018 meeting of the G20 agreed to consider a unified regulatory scheme for cryptocurrencies. These conversations are important as they indicate the perception of the industry towards cryptocurrencies (including bitcoin), which often influence perceptions of the supporting system (including Blockchain). Although the G20's Financial Stability Board has stated that 'crypto-assets do not pose a risk to global financial stability at this time', some countries, including India and Brazil, consider cryptocurrencies to be illegal³⁸. Other countries are more supportive of cryptocurrency. South Africa is looking into regulating the cryptocurrency industry and Turkey is considering launching a national cryptocurrency .



35 Economic Development Board Mauritius: Regulatory Sandbox License, 2017

36 JD Alois, Crowdfund Insider: SelfKey Receives Regulatory Sandbox License in Mauritius, 2018

37 Board of Investment Mauritius: Interview with Mr. Benjamin Yablon, Salt Lending, 2017

38 Intellectsoft: BlockchainBlockchainRegulation, Technology is Welcomed, Cryptocurrency Regulated, 2018

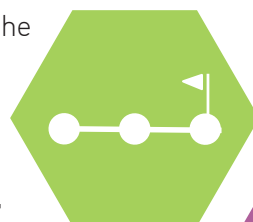
39 Medium: A snapshot of the Current Crypto Regulations of all G20 member states, 2018



KEY CONSIDERATIONS AND NEXT STEPS

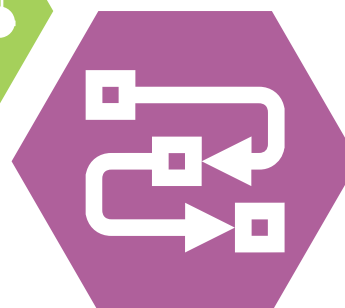
The government should consider using four key steps in their potential use of Blockchain solutions.

- 1) Identify a pressing problem that needs to be solved, either to support national development agendas or to improve the effectiveness of the government and its service delivery. A Blockchain solution may not be effective without clear identification of a pressing problem.
- 2) Analyse the relative costs and benefits of using Blockchain versus alternative technology to ensure that Blockchain is the best possible technology to solve the identified problem. Initial and on-going issues as well as ecosystem constraints should be considered.
- 3) Develop collaborative partnerships with the private sector and co-design solutions to ensure they are relevant to the context of the country and the problem space. Both private and public sectors need to actively pursue these partnerships, as the relevance of their solutions and their ability to scale depend on them.
- 4) Enable the development of a supportive ecosystem to allow cross collaboration for the interoperability and scale of Blockchain solutions. This includes the required supportive infrastructure (connectivity and electricity), developing the necessary talent, adequate financing mechanisms and an analysis of existing infrastructure and policies that may support solutions.



As Kenya considers ways to support the development of private sector innovations, three key activities should be considered.

- 1) Ensure that the regulations in place support this development, both by creating new supportive regulations (such as a Regulatory Sandbox) and by removing regulations that may compromise the development of Blockchain solutions. For example, cross border data flow restrictions may become challenging for Blockchain solutions.
- 2) Develop a supportive ecosystem through multi-sector partnerships and cross-collaboration. The development of a supportive ecosystem depends on a country's readiness to adopt a Blockchain solution and may include infrastructure, skills development and financial constraints and considerations.
- 3) Invest in the development of Blockchain solutions by becoming a user and champion of these solutions. The private sector has emphasised the need for active investment and government support. Without investment and support, it is difficult for private sector projects to demonstrate proof of concept or proof of scale.





AI DEFINITION AND VALUE PROPOSITION



AI is the ability of machines to adapt to new inputs and perform tasks that require intelligence without additional programming; in other words, AI involves human-like thought processes and behaviours. Investments in AI have been growing rapidly, dominated by large digital players (e.g. Google and Baidu). In 2016, total investment in AI stood at an estimated USD 26-39 billion, out of which global technology companies invested USD 20-30 billion. Approximately 90% was spent on research, development and deployment, and 10% on AI acquisitions. Venture capital and private equity investments increased more than threefold from 2013 to USD 5-8 billion in 2016. In addition, in 2016, the AI sector received USD 1 billion in grants and seed money.⁴⁰

AI's value proposition is that it provides enhanced data analytics, more informed decision making and improved predictive analysis.

- Data Analytics: AI can process and analyse large data sets faster and more accurately than other computer-based systems.⁴¹
- Decision making: AI can improve the efficiency and effectiveness of decision making by mapping a complex decision tree of all possible outcomes based on many factors, thereby revealing the optimal decision or providing a more manageable set of choices from which a decision can be made.

AI can also enhance decision making by reducing the inherent inconsistencies and biases associated with human decision-making.⁴²

- Predictive analysis: AI can make more accurate predictions through its ability to discern important and complex patterns.⁴³

AI is the ability of machines to adapt to new inputs and perform tasks that require intelligence without additional programming; in other words,

⁴⁰ McKinsey Global Institute: Artificial Intelligence, The next global frontier, 2017

⁴¹ ESCAP: Artificial Intelligence in Asia and the Pacific, 2017

⁴² Centre for Public Impact: Exploring the impact of artificial intelligence on government, 2017

⁴³ Deloitte: AI-augmented government: Using cognitive technologies to redesign public sector work, 2017



USE CASES AND RELEVANCE FOR KENYA



AI can provide several benefits, including improved profitability in the private sector. AI can improve private sector profitability through improved supply chain management and forecasting. More accurate predictions of consumer demand could result in better supply chain management. In turn, this would ensure appropriate supply of the right products at the right time, reduction in lost sales due to product unavailability, as well as improved and personalised customer experiences. In addition, a reduction in forecasting errors could lower costs related to supply chain management and warehousing (through lower inventory and storage costs).⁴⁵

AI can solve several pressing issues for governments, including improving national competitiveness and service delivery, and attainment of national development agendas. As national competitiveness and innovation⁴⁶ capability are highly correlated, AI can potentially increase national competitiveness by accelerating the rate of innovation.⁴⁶ AI could also improve the delivery of administrative government services, such as renewing drivers' licenses, visas and national ID cards, which would free up government employees to perform more important, higher value tasks. For example, an AI query system could improve citizen inquiry and information services significantly by providing answers to common questions and routing requests that would otherwise demand a

substantial amount of time for both employees and citizens. In the health sector, AI can help to fill the gap in healthcare services that results from the shortage of health workers in developing countries. Using AI in clinical decisions would allow health professionals to focus on more advanced medical tasks. This can be achieved by using AI in patient triaging, diagnosis (through analysis of X-rays, MRIs and CT scans) and decision making for optimal treatment.⁴⁷ AI can also be used in disease control. For example, AI was employed in the discovery of the specific bat species that carried the Ebola virus, which helped curb transmission and end an outbreak. In the education sector, AI has the potential to improve learning outcomes through more personalised, virtual lessons. For example, M-Shule, an SMS-based learning platform in Kenya, uses AI to track and analyse student performance and to deliver lessons that meet their individual needs and thereby grow their competency. The M-Shule platform reduces the fear of failure inherent in many learning environments. Students can advance at their own pace and ultimately improve their learning outcomes.⁴⁸



AI has an important role to play in education, and the growing recognition of its value in Africa has spurred several local innovations (as seen in the figure below – Figure 5). To achieve an appropriate scale, some key local challenges must be addressed. However, the

recent growth in infrastructure, an expanding Kenyan middle class and government interest provide promising conditions for the advancement of AI.

Using AI in clinical decisions would allow health professionals to focus on more advanced medical tasks.

Figure 5: Case Study - AI Learning in Africa

case study: All learning in Africa

BACKGROUND

All can be useful in the delivery and enhancement of education in a variety of ways which include: 1) automating and expediting administrative tasks such as homework grading ii) providing outside classroom support iii) supporting the adaptability of assessment and educational support software iv) expanding the options of where and how education can take place v) adding diversity to the forms that curriculum materials can take vi) introducing immersive technology into the classroom, which can make the process of education more engaging for students.

Example of its use in Africa include:

- Founded in 2016, M-Shule is an affordable SMS-based learning platform in Kenya which uses AI to analyze primary students' performance, to deliver lessons that meet their needs and grow their competency at their own pace.
- Founded in 2014, Da[top], a South African eLearning company uses AI to understand the proficiency levels of students, based on which it provides tailored contents to students to supplement in-classroom teaching.

KEY LEARNINGS

For AI to successfully improve education in Africa, there are several key factors that need to be considered:

- **Inclusive Access:** while most western AI education solutions can provide access through internet connections and/or laptops/computers the lack of access that African learners have to these platforms means that many AI-powered education solutions largely need to provide access via mobile phone, which has a deeper penetration across African markets
- **Local online content:** Since students' learning and understanding can be improved when concepts are applied to their local context and language, the lack of locally developed content online can limit the extent to which learning outcomes can truly be improved. Therefore, there is a need for investment in the development of local educational content online
- **Lack of training and professional development in ICT use:** For AI solutions which are meant to supplement teachers in the classroom, there is a need for more teacher training and professional development in the use and value that AI technology can have in supplementing in-classroom learning.
- **Partnership:** For the use of AI in education to scale, partnerships and consultations with schools, users, government, and the private sector are required to ensure the development of solutions based on the right assumptions. The mobilization of funding the development of solutions and the legitimization of the quality of learning that can be gained through such platforms.

KEY TAKEAWAYS

There is potential for the growth of AI in Kenyan education. Kenya is currently undergoing a phase of rapid infrastructure development, which could expand mobile as well as internet connectivity. This trend is being complemented by a growing middle class who would be willing to invest in e-learning for the children, and the growing interest of government in AI uses.

44 McKinsey Global Institute: Artificial Intelligence, The next global frontier, 2017

45 McKinsey Global Institute: Artificial Intelligence, The next global frontier, 2017

46 ESCAP: Artificial Intelligence in Asia and the Pacific, 2017

47 Centre for Public Impact: Exploring the impact of artificial intelligence on government, 2017

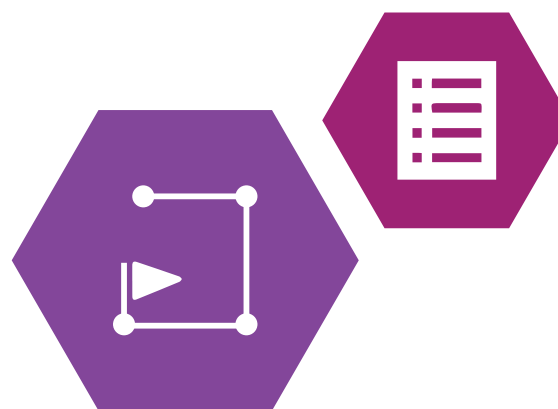
48 Disrupt Africa: The start-up bringing AI-powered SMS-BASED learning to Kenya, 2018

AI has the potential to contribute to the achievement of Kenya's Big 4 Agenda:

- **Affordable healthcare:** AI is already improving healthcare access in Rwanda. Babyl Rwanda is a healthcare provider that has partnered with Rwanda's national healthcare scheme to provide affordable healthcare. Babyl Rwanda currently uses AI to triage, provide medical advice, book appointments and deliver prescription to patients through mobile applications. Currently, although the long-term plan is to include AI diagnoses, as yet no such diagnoses are provided directly. However, digital consultations with doctors are available. Kenya's healthcare system could benefit by adopting a similar AI-based system.⁴⁹
- **Food security:** AI can be used to analyse data captured by the Internet of Things, satellites, drones and mobile phone applications to monitor, diagnose and predict the occurrence of various issues and events, such as extreme weather, disease outbreaks, pest attacks and soil nutrient deficiencies. For example, in Kenya, an app called Eska can diagnose crop diseases from photographs captured by a mobile phone, allowing for early detection and treatment.⁵⁰
- **Manufacturing:** AI has the potential to significantly improve production capabilities and efficiency. Automation of operations could improve the transformation of inputs into outputs by optimizing processes, anticipating machinery

failure and ensuring product quality. In addition, AI manufacturing systems can minimise yield loss and waste due to product defects and reduce the time loss due to the slower pace and downtime associated with humans.⁵¹

- **Housing:** AI also has applications to help smooth challenges in delivering affordable housing rapidly. AI can help create more effective search tools for landlords to reach prospective renters and buyers. AI can help investors in the housing market to assess investment plans, optimise location selection and design. In addition, AI can assist with accurate valuation of land and property.



⁴⁹ The New Times: Babyl Rwanda on providing digital healthcare, 2018

⁵⁰ Farmers review Africa: Artificial intelligence is revolutionising agriculture, 2018

⁵¹ McKinsey Global Institute: Artificial Intelligence, The next global frontier, 2017

Regulatory Approaches



Advances in AI have been accompanied by increased scrutiny and debate over whether AI should be regulated.

Those in favour of regulating AI express concerns about data privacy, the threat of weaponization and the expected reach of AI. They argue that the enormous amounts of data available to AI could pose a threat to people's right to privacy. Without regulations, AI companies could use and sell data as they please, for example to attract target groups to certain products/services while excluding others.⁵² Fears over weaponized AI operating without reasonable human control is also driving the call for regulations. Furthermore, some people fear that AI could eventually surpass human capabilities and out-compete humans and possibly drive them to extinction.

Those opposed to AI regulations argue that excessive regulations could have untold economic costs, that policy makers lack sufficient knowledge to base their regulatory decision and that the current fears are unrealistic. They argue that excessive or inappropriate regulations could have human and economic costs and could stifle innovation and the adoption of new technologies that could increase efficiencies in healthcare, manufacturing and other sectors.⁵³ Furthermore, some believe that regulators do not have sufficient knowledge to be able to regulate AI in a

way that would resolve the perceived issues or threats. In addition, many perceive the threat of AI superseding human capabilities to be farfetched, at least in the short to medium term.

Ultimately, the challenge for regulation is how to balance supporting innovation and competition while protecting customers, market integrity, financial stability and human life.⁵⁴ There is also the added complexity of the transnational nature of AI and the national character of laws, which leads to the question of whether regulations should be national or international. National AI regulations are likely to have transnational effects and can potentially cause cross-national conflicts. However, determining and implementing international regulations would be extremely complicated, given that AI is used in a variety of ways, domains and countries, and the associated risks differ depending on the application and the country.

Ultimately, the challenge for regulation is how to balance supporting innovation and competition while protecting customers, market integrity

Overall, many countries are still grappling with the issue of AI. There is evidence that appropriate ways to develop policies to regulate AI are being considered;

however, agreement over best practices is yet to be achieved.

Key Considerations and Next Steps

Key risks and potential mitigation strategies should be reviewed when considering effective and inclusive implementation of AI technology. Key risks include unemployment, infringement on privacy, unethical AI applications and weaponization.

- **Unemployment:** A potential risk posed by the advancement of AI is the elimination of human jobs.⁵⁵ AI is likely to replace lower-skilled workers. Labour displacement is more likely to occur in developing countries if up skilling programs and new jobs are not developed at a rate that compensates for the shift brought on by AI.⁵⁶ At the same time, there is potential for AI to create new sources of employment overall, albeit mostly in higher skilled roles.⁵⁷
- **Infringement on privacy:** AI may encourage the proliferation of surveillance states and digital totalitarianism.⁵⁸ To fully optimise the benefits from AI, government data will be centralised, and such centralisation carries the risk that governments could



abuse its power and infringe on the privacy of its citizens.

- **Unethical AI:** Although human biases in decision-making may be reduced with AI, it is also possible that such biases will be hardcoded into AI algorithms, or unintended biases may unwittingly be encoded by introducing non-representative training data, thereby systemising inequalities. For example, hiring algorithms may base decisions not to hire on the correlation between long commutes and high staff turnover. However, longer commutes can also correlate with minority group⁵⁹ status. Thus, such algorithms would effectively exclude certain minority groups. AI monitoring tools are now emerging from IBM, Google and others, to monitor AIs for bias and increase transparency of decision making.
- **Weaponization:** It is considered that AI could be weaponised in three primary spheres: digital, physical and political. In the digital domain, AI could be used to execute cyber attacks. There is also a possibility that AI-powered drones and other physical systems could be used to attack



52 PBS/NOVA: Can government keep up with artificial intelligence [Online]

<https://www.pbs.org/wgbh/nova/article/ai-government-policy/>

53 Etzioni, Amitai & Etzioni, Oren, "Should artificial intelligence be regulated," Issues in Science and Technology Vol. XXXIII, No. 4, Summer, 2017

54 Erdelyi, Olivia J. & Goldsmith, Judy, "Regulating artificial intelligence: Proposal for a global solution" [Online] http://www.aies-conference.com/wp-content/papers/main/AIES_2018_paper_13.pdf

physical targets. In addition, AI could be used to manipulate public opinion to achieve desired political outcomes.⁶⁰

Although there are no agreed-upon solutions to these risks, such risks may be mitigated by skills development and research and development initiatives. To prepare for the development and penetration of AI in Africa and to minimise the exclusion of minorities, governments need



to ensure that relevant training and skills development opportunities are provided to citizens, particularly low-income populations. Governments also need to invest in local research to improve the applicability of AI to local conditions. However, local public data tends to be in short supply. The availability and amount of such public data would also need to be improved to ensure the development of AI solutions that address local needs.

Three key activities should be analysed when considering the regulation, use and supportive development of AI solutions in a country:

- 1) Develop supportive policies to enable both short- and long-term use of AI by analysing existing policies and creating new policies to ensure citizens' rights are protected. AI requires large amounts of centralised data to function effectively. However, centralizing such large amounts of data can pose a risk to privacy if effective policies regarding access, use, ownership and control of data by a third party (which could be a government) are not implemented.
- 2) Create an effective ecosystem to support, manage and grow AI solutions, including infrastructure, skills development and cross-sector linkages. As mentioned previously, AI operates most effectively when it has access to large amounts of data, which also requires supportive infrastructure (increasing connectivity and improving data collection mechanisms) and interoperability through cross-sector linkages. Effective and inclusive skills development is also required to create and manage AI solutions to mitigate the risk of AI programs with hardcoded biases that can result in unethical AI.
- 3) Manage and analyse the potential long-term effects of AI and develop systems to manage these risks early in the implementation. For



55 Dalberg: Future of digitalisation, Impacts on ICSOs, 2018

56 Citi GPS: Technology at work, 2016

57 Gartner: Predicts 2018: AI and the Future of Work, 2018

58 Dalberg: Future of digitalisation, Impacts on ICSOs, 2018

59 Centre for Public Impact: Exploring the impact of artificial intelligence on government, 2017

60 Brundage et al: The Malicious Use of Artificial Intelligence, 2018

example, one of the most discussed risks is the resulting unemployment that occurs when tasks previously performed by humans are performed by AI systems. If a country does not effectively analyse and manage this risk prior to its occurrence, the social welfare system could easily become crippled by an unmanageable unemployed population. Emerging digital jobs could be tracked globally, and countries could develop effective training programs to re-skill citizens at high risk of unemployment.



However, local public data tends to be in short supply. The availability and amount of such public data would also need to be improved to ensure the development of AI solutions that address local needs.



FOCUS ON THE BIG FOUR AGENDA

Healthcare

The exponential growth of Blockchain applications can benefit health, medical records and patient-generated data. Newer applications, particularly those that enable tracking pharmaceuticals, will help the government deliver healthcare efficiently and save the tax payer billions that are usually lost through theft of drugs. More importantly, such systems can eliminate circulation of counterfeit drugs and ensure that patients receive the right medication.



Food security and agriculture

Recently, Kenya has experienced an influx of counterfeit products, including foodstuff such as sugar. With Blockchain-based tracking, Kenyans will be confident that the products they purchase are authentic. Further, as indicated earlier in the Twiga case study, Blockchain can be used to streamline the agricultural supply chain. Research shows that Kenya loses up to 40% of harvested produce before it gets to the table and 10% after it reaches the table. With appropriate tracking, most waste will be prevented, thereby guaranteeing Kenyans more

Further, as indicated earlier in the Twiga case study, Blockchain can be used to streamline the agricultural supply chain.

available food without needing to produce more. This is the essence of food security.

An example of food retailers and suppliers using Blockchain is Food Trust, a food safety initiative led by Wal-Mart, which is attracting an ecosystem of retailers including Carrefour. The Food Trust platform uses Blockchain to track the products 'from farm to fork' and is being extended to the Internet of Things by companies such as 3M who are adding their food-safety diagnostic equipment and Emerson who add temperature tracking to create a 'cold-chain' or temperature controlled supply-chain.⁶¹

Manufacturing



Blockchain technology will transform manufacturing by streamlining the supply chain and improving identity and data management. IBM's Blockchain Foundry focuses on Blockchain-based services for prototypes and production in manufacturing applications⁶² that will be essential in building local manufacturing operations. From sourcing of materials to actual production, the Blockchain technology will be essential in managing logistics, enabling manufacturers to leverage the IoT and predictive analytics in their service parts supply chain to proactively maintain equipment before it breaks down.



Housing

Blockchain is expected to be transformative for the affordable housing sector. Here, secure and transparent storage of smart contracts, investments and deliverables must be considered. In addition, Blockchain can be implemented to facilitate consensus based collaborative decision-making, reduce administrative costs and payment delays during construction. These benefits will help



manufacturers raise development financing from a pool of global investors at more favourable rates than conventional bank loans. Blockchain will also effectively reduce fraud due to immutable records and generate a trusted reputation system that will drive up standards across the industry.

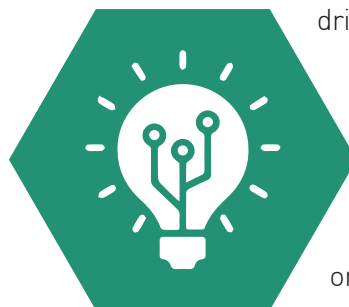


THE STATUS OF EMERGING DIGITAL TECHNOLOGIES IN AFRICA

It is well understood that AI and Blockchain technologies will hasten the pace of innovation and disrupt virtually every industry. Although these technologies have different technological complexities and business implications, related applications tend to converge, and their joint use is expected to radically change human and technological paradigms. There is potential for both separate and joint applications of Blockchain and AI as well as other supporting technologies.

Blockchain

The opportunities to utilise Blockchain in Africa and the special benefits that such implementations would accrue have received an enormous amount of press. However, actual Blockchain implementations on the continent have not received as much attention. In this section, we focus on what we have been able to glean about actual or planned Blockchain implementations. Although there has been a lot of experimental use of cryptocurrencies in Africa, particularly in Kenya, such experiences are not our focus here. Instead, we highlight what we believe to be some of the most ground-breaking implementations, including those where cryptocurrency is a component of an attempt to



drive deeper business value.

Potential of Blockchain

The great potential of Blockchain in Africa has been chronicled in a plethora of recent online articles.⁶³ However, while acknowledging the potential of Blockchain, almost as many articles warn against uncritical belief in the accompanying hype surrounding the technology.⁶⁴

Charania et al focus on key elements which they associate with 'Blockchain's big potential in Africa.'⁶⁵ These are; (1) the emergence of Blockchain hubs or communities in Kenya, South Africa, Nigeria and Sudan; (2) tackling real problems, such as fighting corruption and combating inflation; and (3) crypto mining of bitcoin and other currencies, for example in Nairobi and Cairo, and the resultant opportunities such mining brings to tech savvy communities across the continent.

There is also the view, advanced by Vincent Matinde,

There is potential for both separate and joint applications of Blockchain and AI as well as other supporting technologies.

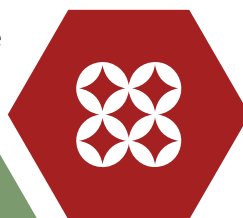
⁶³ N. Charania and C. Naupari. Blockchain's big potential in Africa. <https://venturebeat.com/2018/04/01/Blockchain-big-potential-in-africa/>, Venture Beat: April 1, 2018. Accessed: 8-8-2018.; V. Matindo. 5 Blockchain use cases in Africa. <https://www.idgconnect.com/blog-abstract/30700/Blockchain-africa>, IDG Connect: June 8, 2018. Accessed: 8-8-2018.; C. Mitchell. How Blockchain technology could help Africa solve its problems. <https://www.thenational.ae/business/how-Blockchain-technology-could-help-africa-solve-its-problems-1.707723>, The National: February 25, 2018. Accessed: 8-8-2018.; B. Simons. Blockchain will be a great tool for African entrepreneurs, but only if we make it our own. <https://qz.com/africa/1252724/1252724/>, Quartz Africa: April 17, 2018. Accessed: 8-8-2018.;

⁶⁴ M. S. Crum. Look who is riding the Blockchain hype train. <https://www.ictworks.org/look-who-is-riding-the-Blockchain-hype-train/#.W2vocy-B1-U>, May 31, 2018. Accessed: 8-9-2018.; M. S. Crum. Are some Blockchain for good projects fooling us? <https://medium.com/coinmonks/are-some-Blockchain-for-good-projects-fooling-us-7576932d0093>, Medium: May 31, 2018. Accessed: 8-12-2018.; A. Krishnakumar. Blockchain Africa- great usecasesand somebaselessPR.



that Blockchain is moving from a buzzword to an 'engine that will power great innovation in the continent'.⁶⁶ Matinde identifies five key use cases:

- (1) Land management: It is well-known that land records across Africa are in a very poor state. Across the continent, various entities, from national governments to a variety of private sector parties, are attempting to use Blockchain to establish accurate land rights records and facilitate credible land transactions.
- (2) Cross-border trade: Again, Import/export practices in most African countries are usually opaque, leading to inordinate shipping delays and often untoward costs. Blockchain has the potential to make these processes more transparent and there have been notable successes in this area.
- (3) Tracking mining activities: Such activities include tracking health and safety records, use or non-use of child labour, environmental degradation and environmental reparation initiatives.
- (4) Commodity value chains:



Blockchain technology can be used to ensure that commodity value chains are seamless and transparent. Such value chains could eliminate the need for many of the omnipresent middlemen, especially apparent in industries like coffee.

- (5) Fund raising: Blockchain technology can be employed to raise funds for community projects and track associated expenditure

According to Mitchell, 'many African countries suffer from instability and poor financial infrastructure. Blockchain, with its exchanges secured by cryptography, thrives in such environments. The best uses for Blockchain are seen where many parties from different sectors lack trust, or have different interests as it can reduce corruption, increase transparency, automate accounting and improve processing times'.⁶⁷ Mitchell identifies the following exemplary use cases: automation of land registries, voting (specifically, the electronic voting issues that led to the cancellation of the initial 2017 presidential election in Kenya) and automation and non-falsifiable student education records.

A much more sombre picture is painted by Simons,

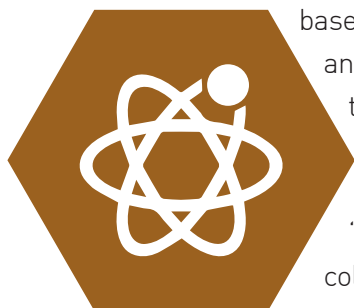
<https://dailyfintech.com/2018/04/06/blockchain-africa-great-use-cases-and-some-baseless-pr/>, Daily Fintech: April 6, 2018. Accessed: 8-11-2018.

⁶⁵ N. Charania and C. Naupari. Blockchain's big potential in Africa. <https://venturebeat.com/2018/04/01/blockchain-big-potential-in-africa/>, Venture Beat: April 1, 2018. Accessed: 8-8-2018.

⁶⁶ V. Matindo. 5 Blockchain use cases in Africa. <https://www.idgconnect.com/blog-abstract/30700/Blockchain-africa>, IDG Connect: June 8, 2018. Accessed: 8-8-2018.



who also takes a strong philosophical and cautionary stance.⁶⁸ She argues that although on the surface there is lack of trust in much of Africa-an obvious rationale for Blockchain's increased value on the continent-the reality is more complex. There is a somewhat different notion of trust in Africa, which is



based on the Bantu concept of 'ubuntu,' an African concept that loosely translates to humane personhood. According to Simons, Africa's ubuntu ideology interprets trust 'as an emergent property of collaboration systems. It [trust] is not a static quality that some network has. It

is something that grows over time as a result of evolving rules created and recreated by the participants.' She refers to Nooteboom,⁶⁹ an influential Dutch industrial organisation professor, who argued that 'trust is both an outcome and an antecedent of relationships'.⁷⁰ Simons states that Nooteboom 'sees the dynamic nature of trust, but most importantly he strongly deviates from the notion of trust as resulting merely from some calculation of the risks of some party acting contrary to an

There is potential for both separate and joint applications of Blockchain and AI as well as other supporting technologies.

agreement'. What does this mean for implementations of Blockchain in Africa? Simons strikes a cautionary note with the following observation:

"The promise of a trustless system continues, however, to create dissonance. On one hand, Blockchain systems are projected as wholesale replacements for institutions, and, on the other hand, 'co-innovation' is demanded from the same institutions to enable Blockchain systems to become viable. This is a palpable contradiction.

Blockchain systems will not thrive except in the context of 'more trust', properly defined. Trust in the competence, availability, orientation, positioning and intents of the multiple layers of intermediation is needed before Blockchain applications can actually enhance hopelessly broken systems like SME to SME international trade.

For example, to replace letters of credit (LOCs) with Blockchain smart contracts, freight forwarders, banks, customs clearance agents, invoice discounters and a whole bunch of peripheral players need to understand the system better, make investments to

67 C. Mitchell. How Blockchain technology could help Africa solve its problems. <https://www.thenational.ae/business/how-Blockchain-technology-could-help-africa-solve-its-problems-1.707723>, The National: February 25, 2018. Accessed: 8-8-2018.

68 B. Simons. Blockchain will be a great tool for African entrepreneurs, but only if we make it our own. <https://qz.com/africa/1252724/1252724/>, Quartz Africa: April 17, 2018. Accessed: 8-8-2018.

69 B.Nooteboom. Philosophy on the move. <https://www.bartnooteboom.nl>, Accessed: 8-112018.

70 R. K. Woolthuis, B. Hillebrand, and B. Nooteboom. "Trust: contract and relationship development." *Organization Studies*, 26(6):813-840, 2005.



support them, project reasonable future gains, hire the right consultants to guide development, and alter current business models. Without a considerable increase in the level of trust among these actors, forget about smart contract LOCs going mainstream. In the end, any truly effective version of the system that emerges must allow intermediation and trust.”

In articles that advise against putting too much faith in the hype associated with Blockchain technology, M. S. Crum points out that many organizations in the global development space are using Blockchain solutions when a centralised database solution could do the same thing faster and more efficiently.⁷¹ The differences between the benefits of private versus public Blockchain are also clarified. In public Blockchain, there is a certain ‘trustless consensus’ in that you don’t have to trust a specific individual or corporation to use it safely. According to Crum, “if someone is talking to you about why they love

Blockchain, and they mention its censorship resistant properties, deeper transparency that allows for public auditing, the democratization Blockchain brings, etc, they are probably referring to public Blockchain.”⁷²

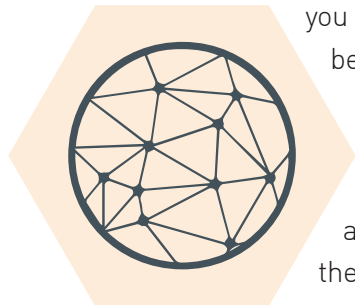
Crum then makes the following argument:

‘In public Blockchain, anyone in theory can become a validator, while in private Blockchain implementations, only certain entities have that ability. This means there is no ‘trustless’ system among all the users of the Blockchain, and all users must trust the organizations or individuals who have been chosen to be validators. Why does this matter? Assume a theoretical government is corrupt. (Hard to believe, right? Just use your imagination.) They implement a private Blockchain solution to collect votes, and they have a bunch of machines distributed across their country that are validators to make sure everything is correct. Now let’s assume an unwanted outcome in the eyes of the government has occurred in this election. Said government then could change data on the machines in their possession. At this point



⁷¹ M. S. Crum. Look who is riding the Blockchain hype train. <https://www.ictworks.org/look-who-is-riding-the-Blockchain-hype-train/#.W2vocy-B1-U>, May 31, 2018. Accessed: 8-9-2018; M. S. Crum. Are some Blockchain for good projects fooling us? <https://medium.com/coinmonks/are-some-Blockchain-for-good-projects-fooling-us-7576932d0093>, Medium: May 31, 2018. Accessed: 8-12-2018.

⁷² M. S. Crum. Are some Blockchain for good projects fooling us? <https://medium.com/coinmonks/are-some-Blockchain-for-good-projects-fooling-us-7576932d0093>, Medium: May 31, 2018. Accessed: 8-12-2018.



you may be asking ‘what’s the difference between this solution compared to a standard, common database implementation?’ In this case, it’s not different in its benefits, and just carries all of the inefficiencies and burdens of the Blockchain’.⁷³

Another commentator cites some nice African Blockchain implementations, which we will discuss in a later section.⁷⁴ However, he warns against false statements and the habit of crediting Blockchain undeservedly. For instance, he cites the example of Agora, a technology company which claimed that Sierra Leone had recently conducted the first ever election to use its Blockchain-based voting platform.⁷⁵ However, the National Electoral Commission of Sierra Leone refuted that they had used Blockchain for the elections, leading Agora to clarify that they had only developed a prototype to illustrate that the technology could be used in a democratic election process.

The potential of Blockchain is further evidenced by the fact that there have been four highly successful African conferences dedicated to Blockchain

Now let’s assume an unwanted outcome in the eyes of the government has occurred in this election. Said government then could change data on the machines in their possession.

technology. Prominent corporate sponsors have been Microsoft and IBM. More than 150 participants attended the first Blockchain Africa Conference (then called the Bitcoin Africa Conference) held in Cape Town in 2015 and more than 450 attended the 2018 conference held in Uganda. However, no formal proceedings for these conferences have been published.

In addition to implementing Blockchain solutions, there are also some reference architectures and associated implementations, also referred to as recommended structures and integration of blockchain to arrive at viable solutions. One of the most important is Sovrin, ‘a protocol and token for self-sovereign identity and decentralised trust’.⁷⁶ Sovrin also has some important, if slightly lesser known competitors, including Ethereum-based uPort⁷⁷ and Veres One.⁷⁸ The notion of what it means for an identity or identity system to be ‘self-sovereign’ requires some unpacking. A January 2018 Computer World article provides a good reference.⁷⁹ First, we should point out that the concept of a self-sovereign identity is relatively new and is undergoing rapid change. Here, the ‘self’ component refers to the fact that we are the makers of our own identity, both online and offline, despite the famous Peter Steiner New





Yorker cartoon shown below.⁸⁰ According to Windley, 'Offline, our interactions flexibly support the use of attributes and credentials from numerous third parties, all presented by the very person they're about, typically by taking those credentials out of a wallet or purse and presenting them to someone else to verify. For example, take a driver's license. [US] states issue it as a credential that you are authorised to drive. But, it's useful for a lot more. When you show up at a bar and the bartender wants proof you're over 21, you show them your driver's license'.⁸¹

Windley goes on to explain further that 'The bar has no legal contract, business relationship, or technical integration with the Department of Motor Vehicles (DMV). They didn't get anyone's permission. They just started asking people for their license. The person they're trying to verify gives them the credential. This works because the bar trusts the DMV to know your birthday. And the important information is packaged in a way that makes it easy to authenticate and difficult to forge.'

Windley expounds on the limits of sovereignty in the following terms: 'Self-sovereignty doesn't mean that you are in complete control. But, it does define the borders within which you make decisions and outside of which you negotiate with others as peers. To continue the bar example, you get to decide what

credential to present. The bar gets to decide what credentials it'll accept. It doesn't have to accept your driver's license. If the bartender thinks it's fake, he'll reject it along with you'.

To make the online world more like the offline world as far as authentication of identity is concerned, the notion of self-sovereignty has the following four requirements:

73 M. S. Crum. Are some Blockchain for good projects fooling us? <https://medium.com/coinmonks/are-some-Blockchain-for-good-projects-fooling-us-7576932d0093>, Medium: May 31, 2018. Accessed: 8-12-2018.

74 A. Krishnakumar. Blockchain Africa – great use cases and some baseless PR. <https://dailyfintech.com/2018/04/06/blockchain-africa-great-use-cases-and-some-baseless-pr/>, Daily Fintech: April 6, 2018. Accessed: 8-11-2018.

75 Agora. Bringing voting systems into the digital age. Agora. <https://www.agora.vote>. Accessed: 8-13-2018.

76 Sovrin Foundation. Sovrin: A protocol and token for self-sovereign identity and decentralized trust. <https://sovrin.org/wp-content/uploads/2018/03/Sovrin-Protocol-and-Token-White-Paper.pdf>, January, 2018. Accessed: 8-9-2018.

77 uPort. Open identity system for the decentralized web. <https://www.uport.me>. Accessed: 8-12-2018.

78 Veres One. A globally interoperable Blockchain for identity. <https://veres.one>. Accessed: 8-12-2018.

79 P. Windley. How Blockchain makes self-sovereign identities possible. <https://www.computerworld.com/article/3244128/security/how-blockchain-makes-self-sovereign-identities-possible.html>, Computer World: January 10, 2018. Accessed: 8-12-2018.

80 Wikipedia contributors. On the Internet, nobody knows you're a dog. https://en.wikipedia.org/w/index.php?title=On_the_Internet,_nobody_knows_you%27re_a_dog&oldid=850653049, Wikipedia: June 8, 2018. Accessed: 8-12-2018.

81 P. Windley. How Blockchain makes self-sovereign identities possible. <https://www.computerworld.com/article/3244128/security/how-blockchain-makes-self-sovereign-identities-possible.html>, Computer World: January 10, 2018. Accessed: 8-12-2018.



- 1) Persistence: Identifiers in a self-sovereign identity system are long-lived, non-reusable and owned by the person who creates them. Organizations and connected things also require them, and such entities can use the same infrastructure as individuals
- 2) Peer-to-Peer: People are in control of the relationships they form and information they



share. Therefore, self-sovereign identity systems are peer-to-peer systems rather than client-server systems.

- 3) Privacy protection: This prevents one from correlating information from an individual to potentially identify that person, minimises the disclosure of personal attributes and provides for explicit consent when collecting and sharing personal information.
- 4) Portability: Self-sovereignty implies choice and control. In contrast, vendor lock-in destroys both. Identifiers and associated credentials must be portable, and self-sovereign identity systems must be interoperable to protect both choice and control.

Each of the previously mentioned identity systems, i.e. Sovrin, uPort and Veres One, are examples of self-sovereign identity systems.

Unlike self-sovereign





identity systems, which are fully implemented architectures, there are a number of published reference architectures that do not have associated published implementations. One such reference architecture for a Blockchain-based data marketplace has been proposed by Dinesh Chandrasekhar.⁸² In another article, Chandrasekhar clarifies that 'a data marketplace is a platform where data providers (those that own/license that data) can offer their data sets for a price. Data consumers can purchase or subscribe to such data sets and use it for their research, modelling or analysis. The marketplace itself may be hosted by a third party proving this secure platform for such data exchanges to smoothly happen. Data is made available through a data catalogue. Data can be sold in chunks or segments. Data can also be made available as Data-as-a-Service'.⁸³



Each of the previously mentioned identity systems, i.e. Sovrin, uPort and Veres One, are examples of self-sovereign identity systems.

82 D.Chandrasekhar. Blockchain-driven Data Marketplaces: A reference architecture. <https://hortonworks.com/blog/Blockchain-driven-data-marketplaces-reference-architecture/>, Horton Works: May 30, 2018. Accessed: 8-13-2018.

83 D. Chandrasekhar. The Emergence of Data Marketplaces. <https://hortonworks.com/blog/emergence-data-marketplaces/>, Horton Works: April 6, 2018. Accessed: 8-13-2018.



Non-Cryptocurrency-Based Blockchain Implementations

Halfway between an architecture and implemented system is a partially implemented but thoroughly documented system. Such a system for proving land ownership in Kenya has been described in significant detail.⁸⁴

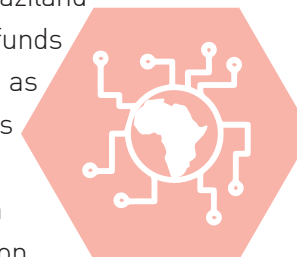
This partially implemented CMU land ownership system provides a smooth transition to fully implemented systems because the Bitland company has actually created Africa's first Blockchain-based system for land registration in Ghana. The project has been piloted in 28 communities in Kumasi, which is a large metropolitan area in southern Ghana.⁸⁵ Note that this system uses a public Blockchain network.

An early Blockchain-based educational system was developed by IBM Researchers and deployed in Mombasa, Kenya in 2015-6. This system used Blockchain to biometrically identify students and track their educational progress.⁸⁶



There are several highly

innovative Blockchain applications in the donor/humanitarian sector. The Disperse organization provides a Blockchain-based fund management platform that drives transparent, efficient and effective flow and delivery of donor financing for humanitarian aid.⁸⁷ This platform enables donors, governments and NGOs to transfer and trace funds through the entire chain, from donor to beneficiary via intermediaries. In 2017, Disperse implemented their initial pilot, distributing and tracking funds from the UK to Swaziland for a girls' education project. The funds supported vulnerable girls left as orphans due to the HIV/Aids epidemic. In addition to tracking funds in real time, the system enabled donors to save 2.5% on transfer fees. Disperse has recently formed a partnership with the Start Network a network of 42 aid agencies working across five continents.⁸⁸



Proceedings of the 9th International Conference on Information and Communication Technology and Development, 2017.

84 H. S. Mukiibi, R. Kigali, and R. Wangari. Can Blockchain technology be used to prove land ownership in Kenya?
https://www.researchgate.net/profile/Hood_Mukiibi/publication/317358712_Can_Blockchain_technology_be_used_to_prove_land_ownership_in_Kenya/links/593689240f7e9beee7f22bf0/Can-Blockchain-technology-be-used-to-prove-land-ownership-in-Kenya. Accessed: 8-13-2018.

85R. Aitken. Bitland's African Blockchain initiative putting land on the ledger.
<https://www.forbes.com/sites/rogeraitken/2016/04/05/bitlands-african-Blockchain-initiative-putting-land-on-the-ledger/#2480ad3d7537>, April 5, 2016. Accessed: 8-13-2018.

86N. Bore, S. Karumba, J. Mutahi, S. S. Darnell, C. Wayua, and K. Weldemariam. Towards Blockchain-enabled school information hub.

87Disperse: The future of aid finance is here. <http://www.disperse.com>. Accessed: 8-13-2018.



The highly publicised Blockchain-based Building Blocks project of the World Food Program (WFP) is also noteworthy.⁸⁹ In this project, WFP is trialling Blockchain as a means of making constrained and unconstrained cash transfers to refugees more efficient, transparent and secure. Cash transfers are made via vouchers or pre-paid debit cards and allow people to purchase their own food (or potentially other items) locally, which is an effective way to empower people in need to make their own purchasing decisions to relieve hunger. Cash transfers are an increasingly important means of assistance, with the number of people receiving WFP cash transfers growing steadily in recent years (from 3 million people in 2010 to 9.3 million in 2015). Trials of this Ethereum-based system have been run in Syria and Jordan. Although neither of these countries are formally African, the WFP is planning to expand their Blockchain operations beyond cash transfers to all humanitarian logistics, starting in Djibouti and Ethiopia.

In addition, several Blockchain-based solutions have been developed in the financial service/financial inclusion domain. For example, IBM Research Africa

has partnered with the wholesale food distributor Twiga Foods to create a Blockchain-based platform to offer loans to micro, small and medium sized enterprises.⁹⁰ IBM's intention is to bring in additional distributors, one or more banks and create a complete ecosystem, where all involved parties participate in the Blockchain network with different levels of privacy and with each party accessing data on a need to know basis. As more data can be gathered about an enterprise's purchasing behaviour, the lending institutions can make better inferences relative to credit worthiness, thereby potentially making credit more available and contributing to financial inclusiveness. IBM refers to this platform as the SME Wallet.

In South Africa, the De Beers diamond company has announced a pilot using Blockchain to ensure its diamonds are authentic, conflict-free and natural. Blockchain provides an immutable record for each diamond registered from the moment they are mined. De Beers aims to push this Blockchain-based system to full production by the end of 2018.⁹¹ In addition, in the Democratic Republic of the Congo, a Blockchain network is poised to track cobalt's journey





from that country's artisanal mines through to products used in smartphones and electric cars. Companies are under increasing pressure from consumers to demonstrate that the cobalt they use has come through supply chains free of rights abuses, especially child labour.⁹²

In February 2018, the International Criminal Police Organisation (commonly referred to as Interpol) partnered with the VoguePay online payment provider to develop a Blockchain-based information portal for crime control in Nigeria called interPort.⁹³ VoguePay has implemented a scalable, cross-agency Blockchain-enabled data collaboration platform that delivers a trust-less, virtual chain-of-evidence record with compatibility among all Interpol stakeholders. Interpol is now better positioned to offer cross-agency data and biometric collaboration with its key partners in Nigeria.

Cross-border trade logistics is another important area where Blockchain technology is making its presence felt, particularly in the developing world. Import/export is a notoriously inefficient and corruption plagued component of doing business in Africa and



In January 2018, IBM and Maersk announced that the two companies had begun a global joint venture applying Blockchain technology

elsewhere. In January 2018, IBM and Maersk announced that the two companies had begun a global joint venture applying Blockchain technology to shipping logistics, with a focus on the shipping lane from Mombasa, Kenya to Rotterdam in The Netherlands.⁹⁴ After a 12-month beta, this joint venture culminated in the August 9, 2018 announcement of TradeLens, which is a Blockchain-based shipping platform. More than 20 ports around the world are already using TradeLens, with the primary return on investment being claimed, quite remarkably, as a 40% reduction in shipping times.⁹⁵

88 Start Network. Start Network: The network for change: leading for change in humanitarian aid. <https://startnetwork.org>. Accessed: 8-13-2018.

89The World Food Program. Building Blocks: WFP is taking first steps to harness Blockchain technology to enhance our ability to provide effective, efficient assistance to the people we serve

90T. Jackson. Kenya's Twiga Foods partners IBM for Blockchainbased microfinancing. <http://disrupt-africa.com/2018/04/kenyas-twiga-foods-partners-ibm-for-Blockchain-based-microfinancing/>, Disrupt Africa: April 19,. Accessed: 8-13-2018.



A final critical area where Blockchain technology is beginning to have observable impact is healthcare.

The CareAi project (Joint Research Centre from the European Commission) has the potential to

improve healthcare services in Africa by

using both artificial intelligence and Blockchain technology.⁹⁶ As stated

elsewhere in this report, 'the concept of data as a currency is becoming ever

prevalent as technology integrates

further into our daily lives. The more data

currency an entity, platform or social structure has, the more it has leverage within our

world. This leverage can come in the form of powerful insights that can be used to drive interactions, provide

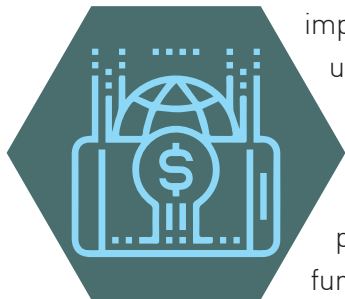
correlations, or even change government and agency policy. Unfortunately, as people continue to use the

majority of modern technologies, their data, its ownership, and thus its leverage is simply given

away'.⁹⁷

CareAi envisions a future with a significant amount of intelligent and anonymous healthcare. In this future,

one may be paid with a smart-contract-based token



system in return for providing data, called CareAi

Points. Governments and enterprises could pay to

gain access to the data to obtain insights into individuals and communities that may prefer to retain

anonymity. Conceivably, this data currency could then be leveraged to address policy issues around the

invisibility of heterogeneous individuals and their communities, e.g. undocumented migrants, ethnic

minorities or the homeless.

Another attempt to directly deliver healthcare data ownership to patients is a project by the IBM Research

Lab in Nairobi. In partnership with IBM's Watson Health business unit, the IBM Research Africa lab is

building a Blockchain-based 'digital health wallet'

where patients are given

ownership of their health data.⁹⁸

A first pilot of the technology

took place from the end of

August 2018 at the Lwala

Community Alliance, which is

a level 3 care facility, and its

referral hospital, a level 4 care

facility, Migori Hospital.



91 Reuters Staff. De Beers tracks diamonds through supply chain using Blockchain. <https://uk.reuters.com/article/us-anglo-debeers-Blockchain/de-beers-tracks-diamonds-through-supply-chain-using-Blockchain-idUKKBN1B1CY>, Reuters: May 10, 2018. Accessed: 8-13-2018.

92 B. Lewis. Blockchain to track Congo's cobalt from mine to mobile. <https://af.reuters.com>.

93 A. Mbogo. Interpol and voguepay to launch Blockchain-based crime control platform in Nigeria. <https://bitcoinafrica.io/2018/02/21/interpol-voguepay-Blockchain-crime-platform-nigeria/>, BitcoinAfrica.io: February 21, 2018. Accessed: 8-13-2018; VoguePay. Interpol to launch crime control platform in Nigeria in partnership with voguepay. <https://www.finextra.com/pressarticle/72585/>

interpol-to-launch-crime-control-platform-in-nigeria-in-partnership-with-voguepay, Finextra: February 12, 2018. Accessed: 8-13-2018.

94 IBM Corporation. IBM and Maersk form global joint venture applying Blockchain to shipping logistics. <https://www.ibm.com/industries/travel-transportation/freight-logistics>. Accessed: 8-13-2018.

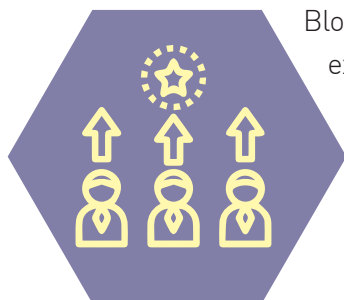


⁹⁸IBM Watson Health. IBM Watson Digital Health Wallet Roadmap. Internal IBM Publication Not yet publicly available. Accessed: 8-13-2018.

Lastly, we should not close this section without mentioning the South African Blockchain consultancy Bankymoon, which was founded in 2014 to help clients integrate bitcoin and other cryptocurrencies into their ICT systems.⁹⁹ Since then, Bankymoon has broadened the spectrum of their development work to include arbitrary Blockchain engagements. In 2015, Bankymoon introduced what they claimed to be 'bitcoin's first killer app', an app for topping off smart utility meters using bitcoins to avoid bank charges.

Prominent Alternative and Cryptocurrency Implementations

Two of the most prominent alternative currency implementations in Africa are BitPesa and BanglaPesa. BitPesa is a Blockchain-based digital foreign exchange and payment platform



geared to 'frontier markets'.¹⁰⁰ It was founded in November 2013 with headquarters in Nairobi and offices in Lagos, London, Luxembourg and Dakar.

BanglaPesa is not Blockchain-based, i.e. it is a so-called "complementary currency" that works in addition to the standard Kenyan currency (the Kenyan shilling).¹⁰¹ Here, physical bills are issued that represent units of the Bangla-Pesa currency. It has become the medium of exchange for goods and services among the residents of the poor district of Mombasa known as Bangladesh. This currency is only accepted in this particular area of the city, and, unlike vouchers that are tied to a particular good or service, Bangla-Pesa is accepted for most local transactions. Bangla-Pesa was initially introduced under the name Eco-Pesa in May of 2010.¹⁰² The founder of Bangla-Pesa, William O. Ruddick, was famously arrested on May 29, 2013 under suspicion of forgery and alleged links to the Mombasa Republican Council (MRC). The link to MRC was quickly dropped. However, a forgery charge was eventually brought by the Central Bank of Kenya. With the help of an online petition and accompanying online fundraising, the

⁹⁵L. Dignan. IBM, Maersk launch TradeLens Blockchain shipping platform. <https://www.zdnet.com/article/ibm-maersk-launch-tradelens-Blockchain-shipping-platform/>, ZDNet: August 9, 2018. Accessed: 8-13-2018.

⁹⁶A. Mbogo. AI and Blockchain-powered project CareAi could improve healthcare in Africa. <https://bitcoinafrica.io/2018/08/09/careai-could-improve-healthcare-in-africa/>, BitcoinAfrica.io: August 9, 2018. Accessed: 8-13-2018.

⁹⁷A. Mbogo. CareAi – Mixing healthcare data with emergent technologies for impact. <https://medium.com/@lucaslorenzop/careai-ideasforchange-26d2baf9e757>, Medium: March 22, 2018. Accessed: 8-13-2018

⁹⁹ Bankymoon. Blockchain powered solutions and services. <http://bankymoon.co.za>. Accessed: 8-13-2018; K. Njeri. Meet Africa's Blockchain startups: Bankymoon. <https://bitcoinafrica.io/2017/10/06/africas-Blockchain-startups-bankymoon/>, Finextra: October 6, 2017. Accessed: 8-13-2018.



charges were ultimately dropped.

In June 2018, the Bancor Network announced plans to launch a network of Blockchain-based community currencies in Kenya.¹⁰³ The founder of Bangla-Pesa and Eco-Pesa, Will Ruddick, is also behind this initiative. Bancor is a network that allows users to convert between two crypto-tokens in an exchange-like manner without requiring a counter-party to the transaction.¹⁰⁴ This system calculates prices automatically and has built-in liquidity guarantees.

This currency is only accepted in this particular area of the city, and, unlike vouchers that are tied to a particular good or service, Bengla-Pesa is accepted for most local transactions.

100Wikipedia contributors. BitPesa. <https://en.wikipedia.org/w/index.php?title=BitPesa&oldid=847418676>, August 9, 2018. Accessed: 8-9-2018.

101BitCoin Events. Blockchain Africa Conference 2019. <http://Blockchainafrica.co>, February-March, 2019. Accessed: 8-8-2018; W. Ruddick. Bangla-Pesa documentary. <https://www.youtube.com/watch?v=i8vlsqxpocs>, YouTube: June 5, 2014. Accessed: 8-9-2018.

102Wikipedia contributors. Eco-Pesa. <https://en.wikipedia.org/w/index.php?title=Eco-Pesa&oldid=840423756>, Brookings: May 9, 2018. Accessed: 8-9-2018.

103R. Odhiambo. Bancor set to launch Blockchain-based community cryptocurrencies in kenya. <https://sovrin.org/wp-content/uploads/2018/03/Sovrin-Protocol-and-Token-White-Paper.pdf>, BitcoinAfrica.io: June 18, 2018. Accessed: 8-9-2018.

104O. Dale. Beginner's guide to Bancor: Network for converting tokens with no counter-party. <https://blockonomi.com/bancor-guide/>, BLOCKONOMI: July 3, 2018. Accessed: 8-9-2018.



A concept that straddles the cryptocurrency and financial inclusion spaces is the Stellar Network and Lumen virtual currency.¹⁰⁵ Stellar is an open-source protocol for value exchange founded in early 2014, and the Stellar network can quickly exchange government-based currencies at processing times of 2- 5 seconds.

Throughout the developing world, non-profit organizations and businesses, such as the Praekelt Foundation (an organization dedicated to using mobile technology to improve the lives of people living in poverty), are implementing Stellar as their financial infrastructure. Oradian, a cloud-based banking software company, has announced plans to use the Stellar network to connect microfinance institutions in Nigeria.

Another emerging concept involves tying healthy living to a cryptocurrency. One such idea is that of HealthWealth networks and the associated HealthWealth coin, which is the brainchild of Kenya's Jason Kunga.¹⁰⁶ According to company (HealthWealth International) marketing literature, 'HealthWealth is an ecosystem that rewards its users by monetizing and incentivising health and [its member's exercise] data. The system is user controlled and ... enable[s] value exchange using its token generation system'. HealthWealth is based on three pillars: (1) a fitness wallet connected to health apps and wearables to provide HealthWealth coins to users engaging in healthy activities (including getting sufficient sleep); (2) a marketplace where users can redeem HealthWealth coins to purchase healthful goods and

services, such as personalised training services; (3) a social media platform to provide access to data, places to redeem HealthWealth coins and provide ratings for different health facilities and healthful offerings.

Artificial Intelligence Potential

PricewaterhouseCoopers (PwC) report¹⁰⁷ estimated that Global GDP will be 14% higher in 2030 due to AI, an additional \$15.7 trillion worth of global output. In Africa, AI initiatives are already underway in several countries, and the AI discourse is beginning to gain ground. Recent AI events like the expo on September 10-11, 2018 in Cape Town and the contemporaneous Deep Learning Indaba held at Stellenbosch University attracted participants from across the continent. The third edition of the Deep Learning Indaba will take place in Nairobi in 2019.¹⁰⁸



¹⁰⁵Wikipedia Contributors. Stellar (payment network). [https://en.wikipedia.org/w/index.php?title=Stellar_\(payment_network\)&oldid=852791496g](https://en.wikipedia.org/w/index.php?title=Stellar_(payment_network)&oldid=852791496g). Accessed: 8-13-2018; Stellar. Stellar: Move money across borders quickly, reliably, and for fractions of a penny. <https://www.stellar.org>. Accessed: 8-13-2018.

¹⁰⁶ J. Kunga. HealthWealth International marketing communique. Not yet public. Received via private communication, August 10, 2018.



A handful of innovative AI solutions from the continent are described below.

1. The Ethiopian Commodities Exchange e-Trade Platform:¹⁰⁹ This was a joint project by IBM and Wavetech that built a coffee traceability solution based on advanced data analytics, mobile and IoT technology. This solution tracks coffee from farms to the market supply chain. With this solution, farmers can obtain Fair trade and organic certification for their products. In addition, the solution provides Ethiopians with a competitive edge internationally and improves its exports. To date, the exchange has tracked more than 5 million bags of coffee and plans to extend services to 5 million farmers. They plan to expand to other commodities produced in the country.
2. In Kenya, IBM scientists in conjunction with Twiga Foods, using Blockchain,¹¹⁰ machine learning and mobile data, developed credit



scoring mechanisms that introduced an inclusive and transparent lending of microloans to small businesses. These microloans are by far the most inclusive product offered to largely women vegetable vendors (Mama Mboga in Swahili), which increased their order sizes by 30%. The vegetable vendors' profits, on average, went up by 6 percent.

3. Six African countries are already using an AI-powered mobile-based solution to examine women for early signs of cervical cancer. Here, an optical sensor fitted into an Android Smartphone helps health professionals scan for signs of cancer. The device is being enhanced by integrating AI to guide healthcare professionals through the diagnostic process. The optical device transforms a conventional camera into a colposcope, which is a medical diagnostic device, designed to provide an illuminated, magnified view of the cervix and surrounding tissues.¹¹¹



¹⁰⁷<http://www.deeplearningindaba.com/2019.html> 54

<https://www.pwc.co.za/en/press-room/ai-to-drive-gdp-gains-of--15-7-trillion-with-productivity--perso.html>

¹⁰⁸<http://www.deeplearningindaba.com/2019.html>

¹⁰⁹<https://www.ibm.com/case-studies/ethiopia-commodity-exchange>

¹¹⁰<https://www.businessdailyafrica.com/analysis/columnists/How-BlockchainBlockchain-can-grow-small-business/4259356-4487920-tse5cw/index.html>

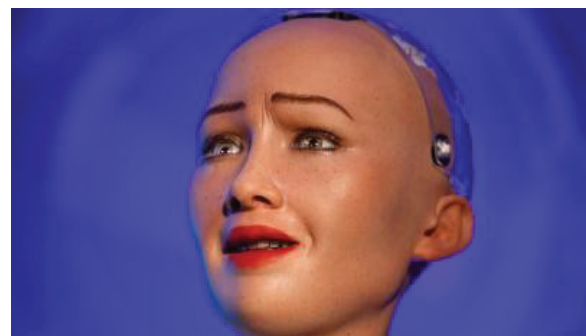
¹¹¹<http://www.digitaljournal.com/tech-and-science/technology/mobile-ai-technology-boosts-african-healthcare/article/491777>



4. In Rwanda, drones are used to deliver blood to patients in rural areas through what has been termed as the world's first 'national drone delivery network' for medical aid. The California-based robotics¹¹² company, "Zipline," is working directly with Rwanda's National Centre for Blood Transfusion to realise 50 to 150 deliveries of blood per day to 21 transfusing facilities in western Rwanda. Rwanda has formalised drone regulations and is currently building a drone airport to be completed in 2020.

¹¹³

5. In Morocco, Cameroon and South Africa, medical institutions have integrated the SOPHiA AI for clinical genomics into their clinical workflow to improve patient care. SOPHiA is expected to enable hospitals to analyse genomic data to identify disease-causing mutations in patient genomic profiles and determine the most effective care.^{114, 115}



Sophia, the robot whose artificial intelligence was partly developed in Ethiopia

REUTERS/NAVESH CHITRAKAR

The recent decision by Google to open its first African AI research centre in Accra, Ghana will play a key role in developing the necessary human resource capacity in AI on the continent. Google is the second multinational company with a big focus on AI to open research facilities on the continent, following IBM's opening of its Nairobi (2013) and Johannesburg (2016)

¹¹²<http://www.flyzipline.com/>

¹¹³<https://www.forbes.com/sites/tarahaelle/2016/04/12/there-will-be-blood-drone-deliveries-in-africa-could-transform-healthcare/#130af42d30b2>

¹¹⁴<https://www.sophiagenetics.com/news/media-mix/details/news/african-hospitals-adopt-sophia-artificial-intelligence-to-trigger-continent-wide-healthcare-leapfrogging-movement.html>

¹¹⁵<https://www.howwemadeitinafrica.com/rise-artificial-intelligence-africa/59770/>



labs. For Africa to benefit from this recent investment, there is need for governments to develop closer collaboration when undertaking research, building capacity and sharing intellectual property.

Initial reports indicate that Google will gather top machine learning researchers and engineers at the new centre, which is dedicated to AI research and its applications. Google has made enormous investments in AI. In 2016 the company invested \$30 billion in AI and machine learning research.¹¹⁶

The narrative that AI will eliminate current jobs and render the majority of people jobless in Africa more than in any other place in the world is unfounded. In contrast, Africa is beginning to leverage data analytic capabilities to solve some of her most pressing problems such as poverty, disease and access to quality education. There is evidence (e.g. the PWC report) that AI will create as many jobs as it destroys. However, Africa must relentlessly build capacity to make her citizens relevant for emerging new jobs in AI

and other emerging digital technologies.

Among other technologies that work jointly with AI is Blockchain. In an article by the online journal Medium titled 'The convergence of AI and Blockchain: what's the deal? Why a decentralised intelligence may affect our future', Francesco Corea states the following:

The fusion of these technologies is redefining organizations around the world and giving rise to new business models that were unimaginable only a few years ago.

"It is undeniable that AI and Blockchain are two of the major technologies that are catalysing the pace of innovation and introducing radical shifts in every industry. Each technology has its own degree of technical complexity as well as business implications but the joint use of the two may be able to redesign the entire technological (and human) paradigm from scratch."

¹¹⁶<https://qz.com/africa/1305211/google-is-making-a-big-bet-on-artificial-intelligence-in-africa-with-its-first-research-center/>



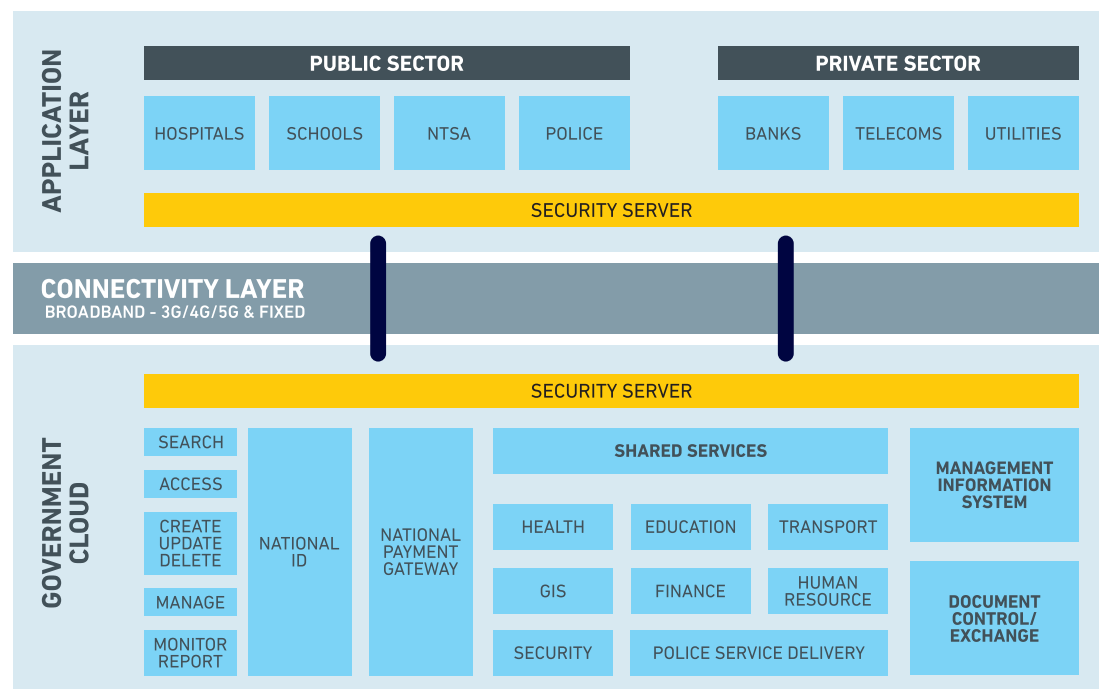
IMPLEMENTATION STRATEGY

In this section, we present a clear and concise strategy for the implementation of DLT and AI to address the core needs and concerns of the Kenyan people and build an effective roadmap to drive the country into the fourth industrial revolution.

Strategy Component 1: National Digital Infrastructure

The National Digital Infrastructure is the key component to fully harnessing emerging technologies, such as DLT and AI. A high-level schematic perspective of the proposed infrastructure is shown in the following diagram. The goal of the National Digital Infrastructure is to provide governance and services on demand, which will be seamlessly integrated across departments and/or jurisdictions to provide easy and single-window access to all citizens. Furthermore, government services should be available in real time from online and mobile platforms. This will ensure that all citizen entitlements are available on the cloud for easy access, thereby digitally empowering citizens with universal access. In addition, this infrastructure will help realise collaborative, participative governance.

Figure 6: National Digital Infrastructure Framework





The following describes how the platform is expected to work.

- Government Cloud: This layer stores, processes and handles all information across the distributed data centres. Information such as the Digital ID, National Payment Gateway, data servers for the various sector ministries, shareable private space on a public cloud, safe and secure cyberspace, management systems and middleware are deployed in a typical shared services model, with government cloud being at the heart of this digital infrastructure.

- ◊ National (Digital) ID – single source of truth with biometric data

- ◊ National Payment Gateway – all payments in the country (mobile, card, money transfers, etc.) are processed through a single (resilient) gateway to provide effective interoperability and leverage economies of scale to reduce transaction costs. The government will create a KePay card through which all digital payments will interface.

Actions for Government

- Create a PPP (Not-for Profit) between Government and all financial institutions facilitating the inter-bank and payment transactions. This interface should be regulated by Central Bank of Kenya and should work instantly transferring funds between bank accounts and/or mobile wallets via a digital platform such as digital banks, mobile banks etc. thus moving transactions from cash based to digital.

- Create a KePay domestic card to be accepted at

any ATM, Point of Sale terminals and online merchants in the country.

- ◊ Shareable private space – This is a digital locker that allows each citizen to store government documents in the cloud. The documents can be accessed easily based on permission-levels.

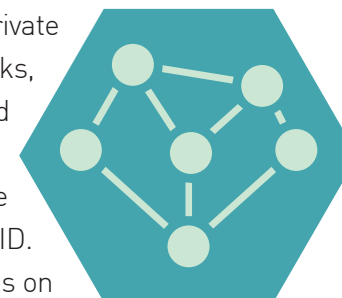
Actions for Government

- Create a Data Sharing Framework (intra Government) and between Government, business and public. The Government of Kenya should designate that Data as a National Strategic Asset, and therefore sharing of information should not be hindered by people or processes especially inter-governmental.

- As part of the government cloud, create a service operated by Government of Kenya to enable citizens to store certain official documents in the cloud, with the ambition to reduce the need to carry physical documents.

- Connectivity layer: Connectivity to all government institutions, offices, schools, hospitals, Huduma Centres, etc. should be provided by broadband services such as 3G/4G/5G, and/or various fixed broadband services.

- Application Layer: In the Application layer, private institutions, such as banks, telecoms and utilities, should connect, for example, for authentication of the individual using a Digital ID. Banks and payments systems on



the other hand should be connected to the National payment gateway. Sharing/access of data should be regulated by the Data Protection act, to ensure that there is no misuse of data and consent is provided by the individual up to their desired level (i.e. one time, anonymous, full access etc).

The National Digital Infrastructure Framework will be complemented by a Single Source of Truth for an identity system (referred to as Trusted Identity in some cases) that could be named HUDUMA NAMBA (Kiswahili for Service Number). This will empower Kenyan citizens with a unique identity and digital platform that provides data on an individual and multiple validation points on a Blockchain.

However, this requires new policies that will require mandatory digital identity such as the ongoing exercise of issuing citizens with a digital passport that will also become one of the validation points. It will also be necessary to pass the data protection bill in

Parliament. Figure 7 outlines the anticipated action plan to realise the single digital identity.

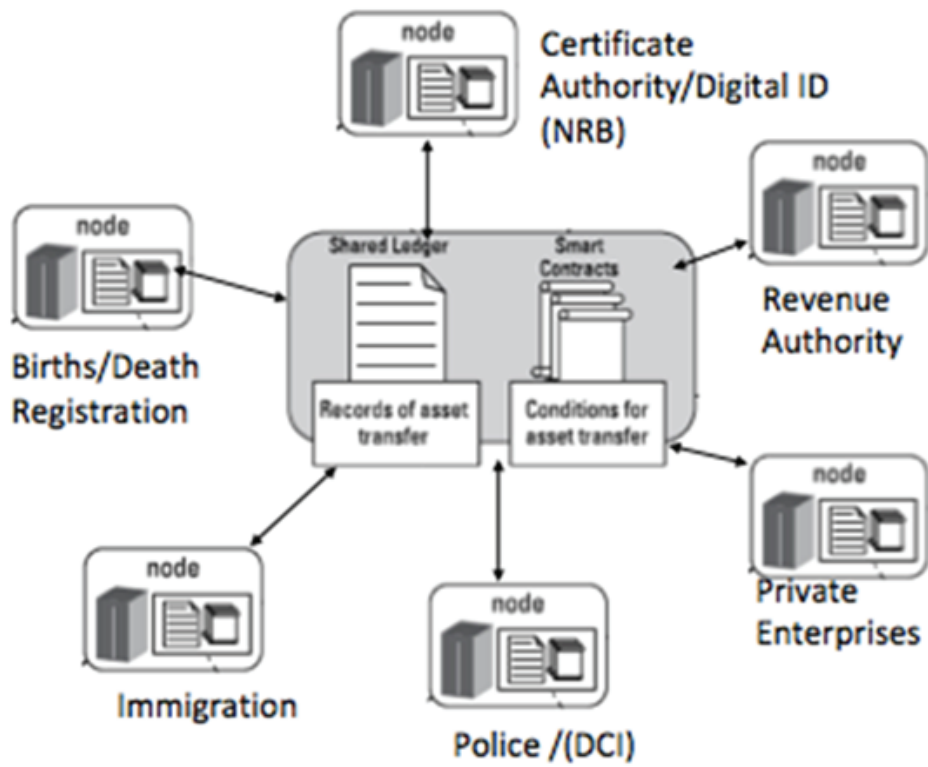
Steps to realise the Single Digital Identity/Trusted Identity



Now let's assume an unwanted outcome in the eyes of the government has occurred in this election. Said government then could change data on the machines in their possession.



Figure 7: Single Digital ID Roadmap

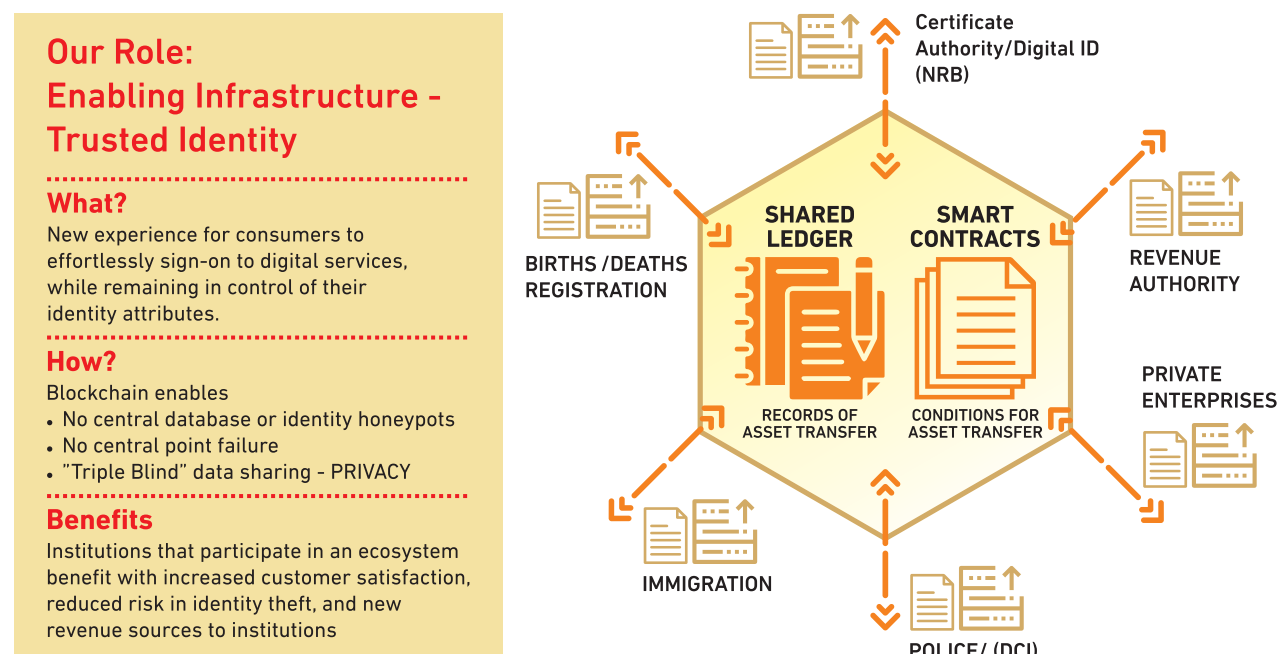




The National Identity Card has, for the most part, been the gateway to public services. More recently, private enterprises have utilised the National Identity card to validate individuals seeking services. For the most part, this has worked, although it has some weaknesses. For instance, sometimes it is unclear whether the person using the card is in fact the person identified by the card. There is often need for other validation points to prove an individual's identity.

India has used a biometric identification system to deal with the weaknesses of existing systems. The Indian national identity system, referred to as Aadhaar, has improved efficiency in welfare programs, empowered disadvantaged groups and enabled digital innovation. However, there are fears of government intrusion. To allay such fears, parliament must pass the Data protection Bill before the system is fully operational. Figure 8 below is the schematic representation on how the identity Blockchain will work.

Figure 8: Single Source of Truth-Trusted Identity





Strategy Component 2: Digital Asset Framework—Enabling Cryptocurrency and other alternative currencies in Kenya

Even without any form of framework, Kenya is rapidly becoming a leading country in Africa, relative to adopting cryptocurrency. Several currencies have been developed or are in the process of being developed, albeit without a framework. Evidently, this is a matter that policymakers cannot wish away. Instead, the government should enable the development of a Digital Asset Framework as a strategy to protect consumers.



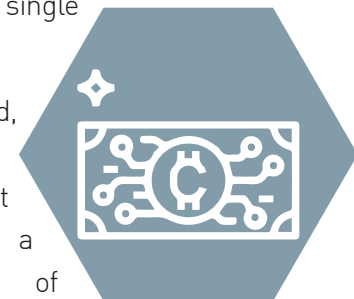
A Digital Asset Framework is the criteria which a cryptocurrency must meet in order to be listed on an exchange. The Digital Asset Framework is released publicly and allows both developers and currency holders to understand why an asset may or may not be traded. The Capital Markets Authority (CMA) has been working in this space in anticipation of requests for an Initial Coin Offering (ICO), which is a type of funding that that initialises the use of

The Digital Asset Framework is released publicly and allows both developers and currency holders to understand why an asset may or may not be traded.

cryptocurrencies. ICOs could catapult Small and Medium Enterprises (SME) that are currently unable to raise funds through an Initial Public Offering at the stock market.

The strategy is to leverage the existing CMA legal framework and perhaps the proposed legal sandbox to pilot this form of funding, which could be a game changer in the growing Kenyan SME sector. In developing the framework (see the GDAX model framework in the Appendix), several key assessment points should be considered:

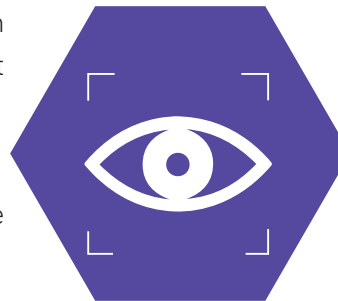
- Does the Asset mission align with constitutionally enshrined national values and satisfy the criteria of an open financial system (available to everyone and not controlled by a single entity)?
- The technology used, especially the engineering and product quality should have a demonstrable record of responding to and improving the source code after a disclosure of vulnerability, and a robust bug bounty program or third-party security audit.
- Is the team of founders able to articulate a vision, strategy and use cases? Can the team drive developmental progress? The team must have a track record of demonstrable success and experience. If this information is available, the Government will apply 'know your client' standards to publicly visible founders and leaders.





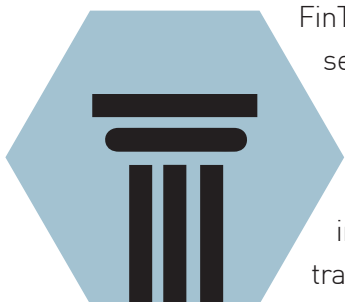
- **Governance:** Assessing the long-term operating expectations and decision making process. There must be a structured process to propose and implement major updates to the code, as well as a clear voting process for conflict resolution.
- **Scalability:** The network's potential barriers to scalability and user adoption should be assessed, including whether there is a clear timeline with development stages, reasonable project milestones, or built-in development incentives.
- **Legal and compliance:** Determine the extent to which CMA laws, regulations, and compliance best practices are applied.
- **Market Supply:** Determine which metrics are important to consider to mitigate the risk of price manipulation.
- **Market Demand:** Define the metrics that are important for monitoring adoption or network effects.
- **Crypto Economics:** Assess how the ecosystem's participants are incentivised to behave.
- **Token issuance structure:** This aspect of incentive has never been assessed in the country

and there is no transparency regarding how it is issued or the protection of consumers. The recent collapse of retail stores demonstrates the need for regulation and an ethical or professional code of conduct.





Strategy Component 3: Regulatory Sandbox for FinTech Innovations

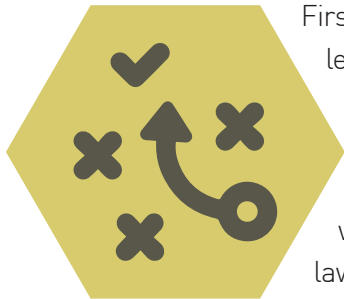


FinTech firms and data-driven financial service providers profoundly challenge current risk management practices and regulatory paradigms. Globally, financial regulators are increasingly seeking to balance traditional regulatory objectives of financial stability and consumer protection with growth promotion and financial innovation. The resulting regulatory innovations include regulatory technologies (RegTech), regulatory sandboxes and special charters. This section summarises regulatory approaches, ranging from doing nothing, cautious permissiveness based on case-by-case analysis, structured experimentalism (such as sandboxes or piloting) and the development of specific new regulatory frameworks. Markets need to implement rebalanced objectives around finance, risk management and technology. This can be done by using automated and proportionate pragmatic regulatory regimes that build on shared principles from a range of jurisdictions, inherently supporting innovation in financial markets. The fragmentation of market participants and increased use of technology require regulators to adopt a sequential reform process, beginning with digitization, prior to building digitally smart regulations. Regulation's (and related RegTech) transformative potential lies in its capacity to enable real-time monitoring of financial markets, thereby facilitating reconceptualization of financial regulation.

The case for Regulatory Sandboxes and Smart Regulations

An increasing number of jurisdictions are considering how to best balance support for FinTech with the major objectives of financial stability and consumer protection. Texts about regulatory sandboxes are often characterised by a certain lack of clarity, which can prevent a FinTech claim from being admitted to the sandbox, reflect regulator's rule of law and risk control concerns and make the substance of the regulatory sandbox more difficult to define. This is particularly true because, in many cases, the sandbox does not go further than the exemptions and no-action letters granted under the traditional restricted licensing regime. The stricter the regulation in the pre-sandbox state, the greater the need for smart regulation and the greater the potential of a regulatory sandbox. In fact, the regulatory sandbox is one way to achieve proportionality of regulation when abolishing or amending rules that are politically infeasible. When the conditions imposed on sandbox beneficiaries are too stringent, the sandbox may fail to promote meaningful innovation. It is certain that the regulatory sandbox should be sufficiently open to create a level playing field between licensed and unlicensed innovators. Thus, other smart regulation tools, especially no-action letters, restricted licensing and special charter policy provisions, should accompany the sandbox. A sandbox approach may be particularly helpful in three respects.





First, an official sandbox policy with legislative endorsement reduces the risk of litigation for breach of a regulator's supervisory duties. The sandbox assists regulators, whose hands are tied by the rule of law, in achieving an efficient level of dispensation. It also allows regulators to

weigh the advantages and disadvantages for society rather than primarily acting in only their own best interests. The regulatory sandbox may remove regulators' disincentives to set aside certain rules, thereby furthering an optimal level of dispensation.

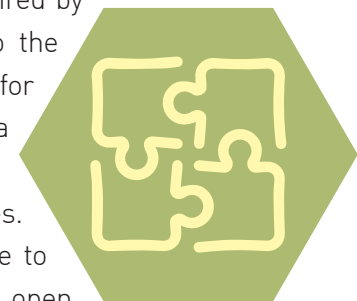
Second, a regulatory sandbox often facilitates a level of knowledge exchange in both directions that goes well beyond the level of information supervised entities typically like to share with their regulator. This encompasses knowledge that may assist regulators to enforce existing rules more efficiently, or design better rules.

Third, the regulatory sandbox may signal a friendly general regulatory approach to innovation for innovative businesses. Anticipating friendly treatment outside the (sand) box, financial entrepreneurs and

. It also allows regulators to weigh the advantages and disadvantages for society rather than primarily acting in only their own best interests.

established institutions may decide to locate their innovation (and new jobs) in countries that have communicated their openness to innovation in this way. This signalling function may explain entrepreneurs' enthusiasm for countries with a regulatory sandbox, even when the actual rules of the sandbox are very strict, or do not, in substance, go beyond existing dispensation practices.

The co-location of businesses inspired by these sandbox signals can add to the cluster development necessary for speedy innovation. This provides a comparative advantage in competition among financial centres.



For the same reason, it is possible to observe regulators seeking to open markets for their firms by engaging supervisory agreements with other regulators that are friendly to innovation. This encourages cross-border investment as foreign firms receive equal treatment as indigenous businesses as long as they qualify to be placed in the same sandbox.

While the sandbox signal itself is easy to copy (as demonstrated by more than a dozen regulatory sandboxes), its strength lies in the substance of the sandbox and its ability to support beneficial innovation. Generally speaking, in this context, the sandbox signal is less credible for regulators with less expertise. Such regulators may either make promises they cannot keep or allow an irresponsible degree of risk to arise. True Smart Regulation pairs the sandbox with strong, fact-based, research-driven piloting and a



restricted licensing practice that provides proportionate regulation to innovative firms in each of their development stages while maintaining risks at an adequate, although not minimum, level.

Finally, regulatory flexibility cannot act as a substitute for demand. In the absence of market demand (for whatever reason), a regulatory sandbox will not provide benefit. Sandboxes cannot be a substitute for a sound business model. Sandboxes can only function effectively where a solid foundation of financial and technical expertise meets regulatory openness and market demand.

It is demonstrated that the tools of innovation-supportive Smart Regulation could possibly include

- (1) deregulation/non-regulation
- (2) restricted licensing/special charters,
- (3) leniency for testing and piloting,
- (4) regulatory sandboxes and
- (5) sandbox umbrellas.

Generally, a regulatory sandbox and traditional restricted licensing differ in terms of the official policy approach and marketing. If regulators are highly experienced, their expertise can facilitate a pro-innovative approach even in the absence of a regulatory sandbox. Relative to testing and piloting, conduct previously treated in a generous manner may find itself in the regulatory sandbox given that the sandbox creates advantages for both FinTechs and regulators. Moving forward, regulatory sandboxes are a single early step in a process that will over time

embrace new smart (digitised and data-driven) regulatory systems.

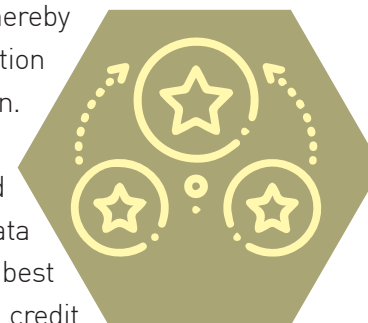
Way forward

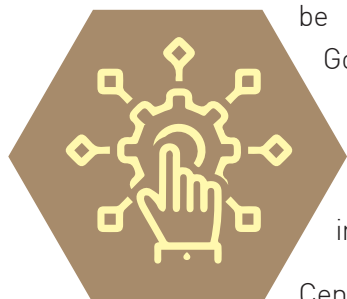
Regulators are expected to come under increasing pressure to adapt to the newly fragmented market comprising major banks, established tech firms and lean start-ups. Regulation and its related technologies can be used not only to help authorities both monitor and regulate industry participants but also identify when to do so.

In the wake of increased compliance burdens, regulators must work with FinTech players to:

- (1) understand how data are being collected and processed;
- (2) take a coordinated approach to harmonizing compliance requirements across markets;
- (3) develop standardised reporting formats; and,
- (4) enhance data sharing frameworks.

The transformative potential of regulation and its related technologies (RegTech) lies in its capacity to enable real-time monitoring of financial markets, thereby facilitating reconceptualization of financial regulation. Markets are evolving to be more reliant on data, and institutions with the most data on borrowers will be best positioned to assess their credit risk and extend them credit. Such institutions are increasingly becoming more likely to





be large tech companies (e.g. Google, Alibaba and Apple) or retail conglomerates operating customer loyalty schemes rather than traditional financial institutions.

Central banks must keep pace with changes and be vigilant of FinTech developments to capture their most valuable characteristics. This may imply improving payment infrastructures, enhancing cyber security, adapting regulations and using and managing new data to assess micro and macro financial risks. In addition, the last decades have seen an increase in the diversity of financial intermediaries and a surge in non-bank finance (IMF, 2016), a phenomenon that will develop further with FinTech innovations. Therefore, it is likely that the growth of FinTech will increase the relevance of central bank coordination with other financial regulators. The impact of monetary policy in risk perceptions should be enhanced to the extent that FinTech may increase the awareness and interdependence of risks in the economy.

Technology is now creating opportunities for changes in financial services that are more far reaching for the public, financial institutions and central banks. Information technologies are doing this because finance is, to a large degree, an information and record-keeping business. For example, by challenging the conventional centralised, multi-layered settlement and clearing system, Blockchain/DLT and other technological developments create the possibility of unbundling financial services that

question the very notion of banks and other intermediaries. In the 21st century, a large part of the population in developed and developing economies has access to smart phones, computers and digital communication; therefore, there is vast diversity of applications and industries touched by FinTech (from financial markets and banks to financial education). These are exciting opportunities for financial start-ups and the public, as well as the leaders of developing countries to advance financial development and remove a major roadblock to inclusive economic growth.. However, to realise this, policymakers, including central banks, must ensure that they are not exposing people to greater risk, especially when they are using financial services for the first time. Moreover, citizens may desire enhanced access to financial services to facilitate formalization of economic activity rather than grow the shadow economy further. To this end, FinTech innovations should in principle be governed by the same regulatory framework as traditional entities and adapt such regulations as required. Kenya has a solid ground to build from, with services like safe identity registration, massive access to the Internet, broad supply of complementary net-based services and, above all, M-Pesa. All these services strategically position Kenya and other emerging economies along the FinTech highway. Evidently, financial services providers will play a key role in defining new financial and regulatory technologies.



Empirical Observations from Literature Review

1. Blockchain and AI innovations and implementation in the Financial Services industry will be driven by the influence of FinTech firms. Such firms will simultaneously and profoundly challenge current risk management practices and regulatory paradigms.
2. Globally, financial regulators are increasingly seeking to balance the traditional regulatory objectives of financial stability and consumer protection with promoting growth and financial innovations. Markets that are expected to implement rebalanced objectives around finance, risk management and technology using automated and proportionate pragmatic regulatory regimes that build on shared principles from a range of jurisdictions will inherently support financial market innovation.
3. The resulting regulatory innovations include regulatory technologies (RegTech) and regulatory sandboxes are referred to as Smart Regulations. The regulatory authorities and jurisdictions using sandboxes include Abu Dhabi, Australia, Malaysia, Hong Kong, Singapore, Switzerland, UK, Canada, Thailand and several states in USA.
4. True Smart Regulation coupled with the sandbox provide strong, fact-based, research-driven piloting and restricted licensing practices that allow proportionate regulation to Blockchain technologies and AI, while maintain risks at an adequate minimum level.

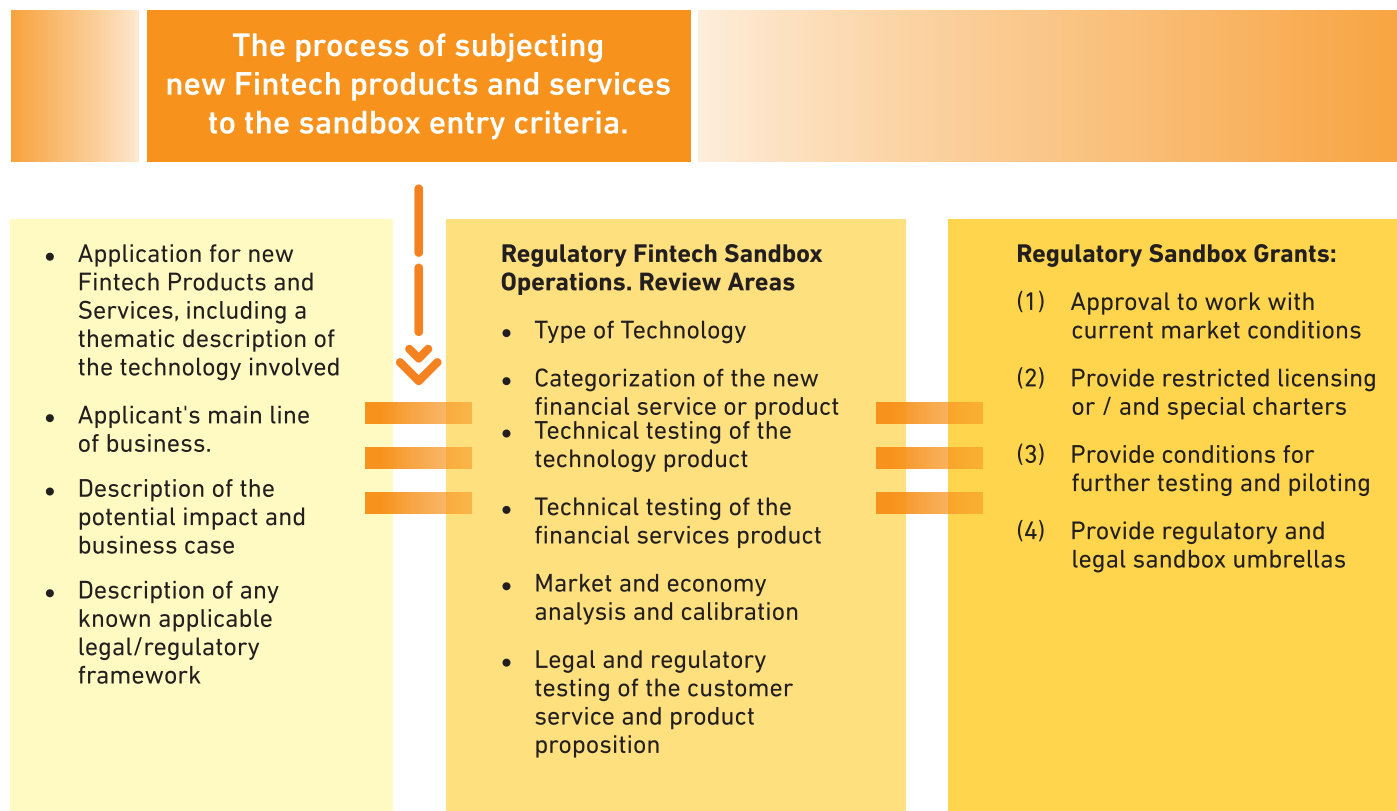
Proposed steps of implementing Financial Technology (Fintech) Legal and Regulatory Sandbox

1. Ministries of ICT and National Treasury institute a joint Fintech Policy.
2. Identification and appointment of Government Implementing agencies (from the Ministry of ICT and National Treasury).
3. Some key Government agencies are expected to be the ICT Authority, CMA and CBK.
4. Given the principal role of the CBK in the financial, monetary and fiscal policy transmission, it is recommended that CBK becomes the coordinating body for the operationalisation of the Fintech Regulatory Sandbox.
5. In its role as the coordinating body of a regulatory Fintech sandbox, CBK shall operationalise an operating model and framework.
6. Figure 9 below shows a thematic conceptual model that could guide operationalisation as envisioned in point 5.





Figure 9: Sandbox Entry Criteria





Strategy Component 4: Digital currency (Digital Fiat Money)

Digital currency, sometimes referred to as Central Bank Digital Currency (CBDC) or Digital Fiat Currency (DFC), is the digital form of fiat money, which is a currency established as money by government regulation or law. CBDC is not a new concept. It has been implemented in some countries including England, Sweden, Uruguay, China and Singapore. Indeed, Tunisia was the first country in Africa to create a Blockchain national currency that is legal tender. In December 2016, Senegal became the second. In Kenya we need CBDC to facilitate the implementation of many DLT and AI solutions that we envisage. Some of the areas in which this will have a big impact include:

1. Payments, Clearing and Settlement
2. Lending (and sections of Commercial banking practice)
3. Alternative Currency Configurations (digital) and transition of fiscal and monetary policy

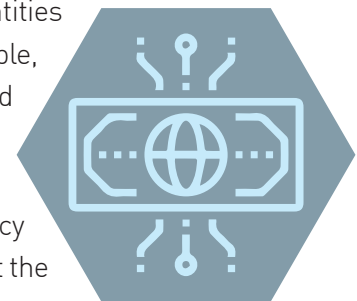
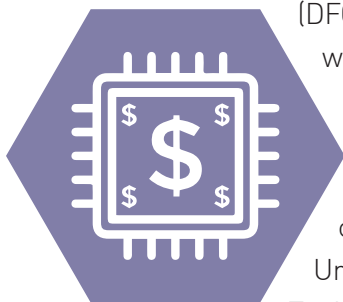
Other benefits that CBDC presents include: financial inclusion, economic growth, technology innovation and increased transaction efficiencies. The case for CBDC in Kenya is strong considering the fact that most of the money and corresponding transactions are already in electronic/digital form. It is estimated that up-to 90 percent of actual spending is in digital forms, including credit cards, bank transfers, mobile

and internet banking. With an economy that is already adapted to some form of digital money, there are a myriad possibilities brought about by Blockchain Technologies as used by private crypto currencies, that Central banks across the world are now considering sovereign digital currencies. These currencies could transform all aspects of the monetary system and facilitate the systematic and transparent conduct of monetary policy, radically improve tax collection/fiscal discipline, including the transmission of government policies into the monetary posture of the economy.

In particular, a central bank digital currency can serve as a practically costless medium of exchange, a secure store of value, and a stable unit of account. To achieve this, the currency would be account based and interest bearing, and the monetary policy framework would target true price stability.

CBDC will be essentially different from the virtual currencies created by private entities such as bitcoin, ethereum, and ripple, whose market prices have fluctuated sharply in recent years. As a country, we cannot afford to be passive to Crypto / Digital Currency global discourse especially now that the World Bank has ventured into the space by issuing a bond.

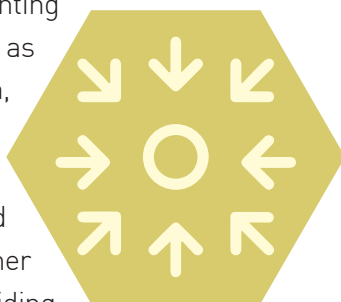
Kenya should at least adopt the work that is being done by the G20 countries in conjunction with Banking for International Settlement (BIS) and Financial Sector Stability (FSB). These financial bodies have





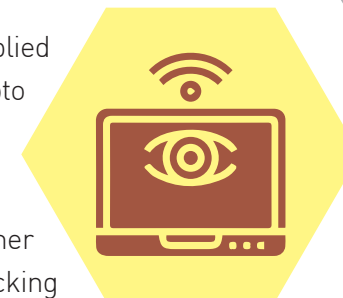
taken the following positions on the subject:

1. Digital (crypto) currency using Blockchain should be evaluated for adoption by countries depending on each country's conditions: G20 participants have recognized that digital (crypto) currencies have the power to bring populations that are currently outside the mainstream economy into the formal economy faster. This has the radical effect of the transmission of monetary and fiscal policies within economies.
2. Nations recognize the demise of the traditional economy: Finance Ministers and Central Bank Governors also agreed that the traditional economy is undergoing a transition process and that it is no longer possible to separate the digital age from the economy.
3. Regulation is inevitable; therefore regulate but not prohibit.
4. Regulation will not prevent technology breakthrough. It was also clear that the regulatory process will be handled very carefully so that hard rules which could hinder the technology are not imposed.
5. Preventing crimes: Regulatory proposals will mainly focus on preventing any illicit activity, such as financing terrorism, avoidance of currency and money laundering. Focus will be also geared towards consumer protection, that is, avoiding



scams being applied through ICOs, crypto currency projects, among others.

6. Know Your Customer (KYC) tracking enforcement and Digital Identity standards.
7. Self-regulation: While cognizant of the global standards, regional and multilateral regulations, each country should find ways of self-governing and regulating the use of crypto currencies.



A pragmatic and secure pathway to the introduction of Digital (fiat) currency in Kenya

The following are some of the practical pathways to the introduction of Digital Currencies in Kenya:

1. Introduction of Legal and Regulatory FinTech and RegTech Sandbox by CBK & CMA
2. Tokenization of Government Fiscal operations; starting with: (a) Social welfare payments programs (InuaJamii); (b) Govt Health fiscal operations; (c) Govt Education fiscal operations; and, (d) Govt partnership with private-driven integrated and electronic/ecommerce value chain platforms, aligned to Big Four agendas.
3. Alignment of the National Digital Identity program (Huduma Namba) to the digital (fiat) currency requirements
4. Alignment of NMO payment platform and other



A good example is a share certificate (a piece of paper representing the ownership of an asset). These papers are essentially tokens representing an asset.

tokenized payment schemes (private & public) programs to the foundations of digital(fiat) currency requirements

5. Institute a National Digital (fiat) currency framework, roadmap and operationalization program, aligned with National Treasury, CBK, CMA, KRA, NIIMS and key private sector stakeholders.

Strategy Component 5: Tokenization of the Economy – Ajira Platform

Tokens have been used for centuries under different names. A good example is a share certificate (a piece of paper representing the ownership of an asset). These papers are essentially tokens representing an asset. In the past, it was very difficult for many people to risk their hard-earned income as an investment in exchange for a mere piece of paper. Very few people had the information required to understand how this worked. It was an exclusive club for a select, privileged few.

Blockchain is about to become disruptive by creating a more inclusive world of investment. Similar to the

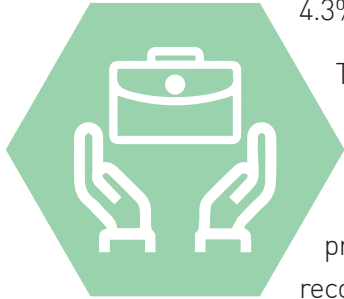
early days of investing in shares, it will be confusing at the beginning. It is likely to be more confusing when Blockchain removes the middlemen who provide custody services as they maintain ownership records and make share trading convenient. The new order Blockchain is an accurate representation of how ownership and custody remain with the investor. Trading will more likely be performed via crypto exchanges. Note that virtually everything can be tokenised. Here, we examine Kenya's biggest problem, unemployment, and demonstrate how tokenization can reduce its effects on the population.

Tackling Unemployment through Tokens

Globally, youth unemployment has been rising steadily over the years. As of 2017, Kenya's unemployment rate was estimated at 26.2% (one of the highest in the world).

The informal sector absorbs almost 82.8% of the employed workforce, and what is called the 'modern' or formal economy accounts for only 17.8%. Kenya has seen unprecedented economic growth, with GDP per capita (adjusted by PPP) increasing approximately 800% (\$390 to approximately \$2,940) in the past decade. The economic distance between the employed and unemployed is widening, and societal fragility is exacerbated by rapid urbanization of the population, which, between 2000 and 2010, increased from 19.3% to 31.3% (a factor of 30 compared to the previous decade) and is expected to increase by





4.3% year-on-year.

The Ministry of ICT, in partnership with the Ministry of Public Service, Youth and Gender Affairs, the Ministry of Education and the private sector, has been reconceptualizing employment and work in consideration of emerging global developments and technological advances. Efforts have been made to promote new, more flexible forms of employment, such as microwork and online contracting. The Digital Hustle Program was developed to address the employment needs of our youthful population and is envisioned to provide a living wage for nearly 2 million currently unemployed and underemployed people. The Digital Hustle Program is expected to increase the Kenyan economy by at least KSh 184 billion.

As part of this initiative, the Ajira program was established to get more people working online under the following broad objectives:

- **Increase Awareness:** Make the possibility of online work more widely known among the unemployed, remove the stigma of online work and make it a viable career choice.
- **Increase Capacity:** Provide incentives, facilities, mentoring and training to make Kenya an online work powerhouse through various initiatives and innovation techniques.
- **Measure and Reward Success:** Create systems, procedures and opportunities to recognise success in online work and provide appropriate

recognition and scaling support to successful groups and individuals.

- **Payment Facilitation and Systems:** Create innovative financial systems, payment methods, work insurance and guarantees to ensure that workers are provided with some of the security, stability and support they would have in traditional employment environments.
- **Provide Support:** Brand Kenya as an English-speaking country (why do Kenyans need to sit TOEFL?), provide government-level support to make Kenya a digital work crowdsourcing destination and provide employers with confidence in the quality of Kenyan workers.
- **Evolutionary Monitoring:** We must continue to monitor business models, working environments and the evolving workspace to ensure that our population is prepared for the future workplace.

The Ajira program has since grown and offered training, partnered widely with employers, and is well on its way to achieve its objective, i.e. create sustainable jobs.

The immediate source of sustainable jobs is creating a local ecosystem of digital workers and employers. This calls for massive digitization efforts by both the public and private sectors. The Kenyan government is particularly focused on digitizing all of its operations.

Tokenization of labour

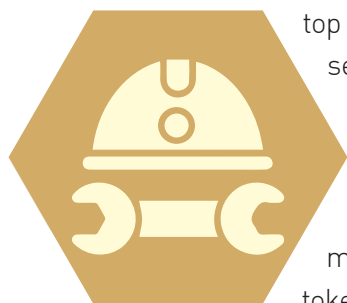
Blockchain technology and its provision for tokens enables three key objectives of the Ajira program.



- 1) Measure and reward success
- 2) Payment facilitation
- 3) Evolutionary monitoring

Tokens are an integral part of Blockchain technology that serve to offer access to the services provided by the platforms and represent digital assets or money.

We propose a simple tokenization platform that allows users to exchange 'work' for tokens. The platform will also allow for other applications to be built on top of it, thereby creating an ecosystem of services necessary to realise increased participation and liquidity of the token.



Service providers will use this platform to create markets, store data, manage transactions and trade with the tokens, i.e. the medium of exchange for consuming or providing services in the ecosystem.

Blockchain and Artificial Intelligence for Ajira

The Ajira platform will be built on the Ethereum Blockchain to permit inter-device, inter-person and

A good example is a share certificate (a piece of paper representing the ownership of an asset). These papers are essentially tokens representing an asset.

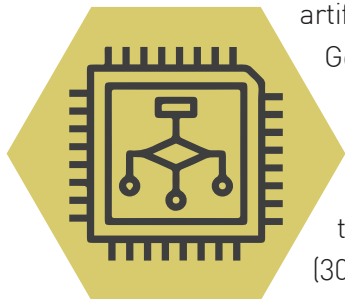
inter-service settlements and payments. Businesses will use the platform to offer Blockchain-enabled products that are secure, transparent and accountable. Examples of services that can run on this infrastructure include supply-chain management systems, labour and service marketplaces.

Blockchain technology and AI can be used together to create new labour and data marketplaces, thereby providing sustainable jobs. In the following section, we illustrate a use case that leverages human language skills and machine learning to provide digital labour and tackle youth unemployment.

Language Opportunity

Global unemployment will soon reach socially unsustainable levels. The majority of the unemployed are young, educated, urban, Internet-connected people. The global demand for human labour is shrinking, a consequence of automation and increased productivity from technological efficiencies. Furthermore, modern technological advances, such as AI digital assistants, are unavailable in African and other underrepresented languages. This new wave of services that depend on voice interfaces and speech-to-text (e.g. Google Assistant and Amazon Alexa) will leave much of the non-European language world behind.

There are over 2,000 languages (out of a recorded global 7,097) spoken in Africa by nearly 1 billion people. The only African languages for which Microsoft Bing provides machine translation are Afrikaans and Swahili (compared to two dialects of the



artificial Star Trek language Klingon). Google only provides machine translation for 13 African languages out of the 104 it currently supports. There are over 1000 languages in Africa, spoken by tens of millions of people, e.g. Oromo (30M) and Lingala (10M), for which there is no machine translation available. In contrast, much smaller non-African languages, such as Georgian (3M), Welsh (3M) and Croatian (4M), are represented in both Bing and Google.

With the advent of a single African digital market, there is need to create the capacity to machine translate between languages and enable participation in the global economy. We see language translation as an entry point to employment creation because it guarantees that the people being paid to work speak the language. With over 83% Internet penetration in Kenya, these Internet-connected youth can earn from their language skills through digital translation tasks.

Solution

The first phase of developing the Ajira platform is well underway, with a flagship service running on this infrastructure (the Ajira Machine Learning (AML) service), which is an AI service that connects crowd workers to digital tasks.

AML is a crowd sourced machine learning system that provides human language interfaces in African languages and compensates people for training the AI to translate these languages. AML enables locally targeted services, such as personal assistance, financial management, virtual customer support and other personalised services. In addition, AML uses the

Blockchain platform to monetise human involvement in building the AI.

Anyone can participate in the platform, and workers can perform digital tasks (e.g. translation or AI training) or provide data to the AML system in exchange for services or direct payment. The machine translation system can be used to provide various solutions, such as voice-activated services in local languages.

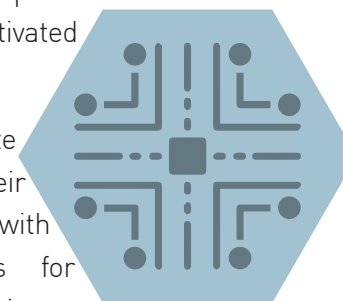
Businesses that need to translate content can easily integrate their applications into the AML system with simple programmatic interfaces for low-cost localization solutions. Businesses will pay directly into the ecosystem to access different services, such as language translation APIs, and speech-to-text conversion for their applications.

The demand for translation services and the provision of crowd workers will promote and foster the development of the labour marketplace and the token economy within the Ajira ecosystem.

Strategy Component 6: Cybersecurity

Cybersecurity is a fundamental requirement in the Digital Age. As we digitise more and more, the data generated and systems in place are constantly susceptible to threats. Governments all over the world are now seriously looking at cybersecurity, to ensure personal data security and national data and system security.

As proposed, the goal is to build human resource capacity and leverage emerging technology, such as AI, to secure and strengthen the cybersecurity arm of





the government. This will ensure that critical infrastructure is protected, critical data protected and regulations put in place to protect citizen data in the hands of the private sector. The Government has a critical role to play in ensuring that citizens are protected in both traditional forms and in the digital space. Figure 10 shows the action plan for realizing the capacity to manage cybersecurity.

With recommendations such as operationalising the Computer & Cybercrime Act of 2018 as a short-term priority, and in order to ensure that the national

computer and cybercrime co-ordination committee is operational and providing enforcement/compliance leadership, Kenya can be able to ensure the security of both data and systems.



Figure 10: Cybersecurity Roadmap

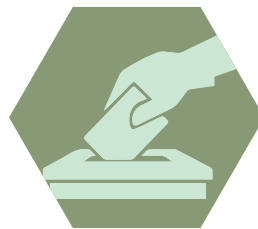
CYBERSECURITY	Description		Means of Verification		
	<ul style="list-style-type: none"> To enhance cybersecurity capabilities (encryption, consensus based protocol na dartificial intelligence) for Kenya. To build human resource capacity Eliminating Human Factor from Authentication Decentralized Storage Traceability Anonymization fo data 		<ul style="list-style-type: none"> Annual Surveys by KNBS, Communications Authority, KE-CIRT, ICTA Annual Reports from Central Bank Anti-Fraud Banking Team 		
	Indicators		Risks & Mitigations		
	<ul style="list-style-type: none"> Reduce Number of Cybercrime Incients by 10% annually 		<ul style="list-style-type: none"> Risk <ul style="list-style-type: none"> Possibility of privacy violations Mitigation <ul style="list-style-type: none"> Public awareness 		
	<ul style="list-style-type: none"> Increase no of Cybersecurity Certified Professionals by 10% annually No of Data Protection Compliant Enterprises 				
	Priority				
	Short Term Operationalize the computer misuse & Cybercrime Act 2018.		Medium Term ISupporting the National computer and cyber crime coordination committee.	Long Term Enforcement/Compliance become regularized.	
	Recommendation				
<ul style="list-style-type: none"> Use of tools like https://gottovte.cc/ that help send peace messages, voter registration confirmation and finding registration centers Platforms for the citizens to express their dissatisfactions on the election process Platforms for the citizens to access Civil Education 					



Strategy Component 7: Democracy and Elections

The implementation of emerging technology, particularly Blockchain, in democracy and the election process (Figure 11) could be essential to strengthening the rights of citizens. The goal is to enhance governance and transparency and allow citizens to participate in the election process and actively participate in enhancing democracy. This is critical for enhancing governance, delivery of services and efficient use of government resources to achieve Vision 2030 and the Big Four Agenda.

The taskforce proposes the following indicators to demonstrate successful implementation of technology, reflected in outcomes



such as an increased number of registered voters, increased voter turnout, reduced incidents of spoiled votes and malpractice, increased engagement and voting for leaders based on their merits.

In the short term, the priority set forth by the taskforce would be to implement this in elections for schools, Saccos, professional associations, and public and private institutions, together with benchmarking of best practices from other successful elections. For the medium term, the voter register would be updated and verified, and the relevant registers will be linked with civic education, initially focusing on by elections. In the long term, we propose to transparently procure an all-inclusive state-of-the-art electoral kit with participation from all stakeholders and hold county assembly elections.


Figure 11: Blockchain in Democracy and Elections Roadmap

DEMOCRACY / ELECTION PROCESS	Description		Means of Verification
	To enhance governance in our democratic systems and a transparency in our electoral processes. Democracy is the rule of the people by the people for the people. Human freedom is the source of human dignity. Kenya being a democratic State its citizenry practices their democratic rights through an election process hence the need to equip Kenyans with Civil education that will give them proper understanding of the system of governance and how they can actively participate in enhancing democracy. The main purpose is <ul style="list-style-type: none"> • To develop policy, procedure and systems that outline to its citizens on their mandate to elect their leaders/representatives. • To develop policy, procedure and systems geared towards more inclusivity, transparency and accountability in governance. • To enlighten the citizens of their Civil rights, responsibilities and their participation. This would not abide to the Constitution of Kenya 2010 principles of Democracy, Transparency and Governance but also significantly boosting people's confidence thereby increasing efficiency and reducing errors in electioneering phase. It is envisaged that Democracy/Election Process become the critical pillar for enhancing governance, delivery of services and efficient use of government resources for achievement of the Vision 2030 and Big Four Agenda set forth by the Government of Kenya.		<ul style="list-style-type: none"> • Platform that checks <ul style="list-style-type: none"> • Check voters registry synchronized with other government registries (deaths ID registration etc) • Preparedness by Electoral body (all resources including manpower, Technology etc) • Rapid resolution of electoral disputes • Low incidences of post-election riots • Make information easy to find and understand on electoral process • Tracking of incidences during the whole process from preparation-voting-results to ensure peaceful process
	Indicators		Risks & Mitigations
	<ul style="list-style-type: none"> • Growing number of registered voters • Increased voter turnout during elections • Reduced incidents of spoilt votes • Reduced incidents of malpractice (disputes and petitions) 	<ul style="list-style-type: none"> • Reduced violence after the election results • More voters engaged on elections • Leaders voted on Merit and not based on Ethnicity 	<ul style="list-style-type: none"> • Security Threats against Personnel, voters infrastructure, information and electoral materials <ul style="list-style-type: none"> • Mitigation: Data protection, physical protection, enactment and enforcement of electoral laws • Technology <ul style="list-style-type: none"> • Mitigation: redundancy, backups of data, use of cloud (AWS or Google Cloud) Transparency, verifiable data/systems
	Priority		
	Short Term	Medium Term	Long Term
	Schools, SACO's, Professional Associations, Public and Private institutions, etc... Bench mark on best practices from other successful elections	<ul style="list-style-type: none"> • Update and verify voter register and link with relevant registries • Civic education on process and technology • Pilot with byelections 	<ul style="list-style-type: none"> • Procure an all-inclusive state of the art electoral kit transparently with participation of all stakeholders • County assemblies elections
	Recommendation		
	<ul style="list-style-type: none"> • Use of tools like https://gottovte.cc/ that help send peace messages, voter registration confirmation and finding registration centers • Platforms for the citizens to express their dissatisfactions on the election process • Platforms for the citizens to access Civil Education 		

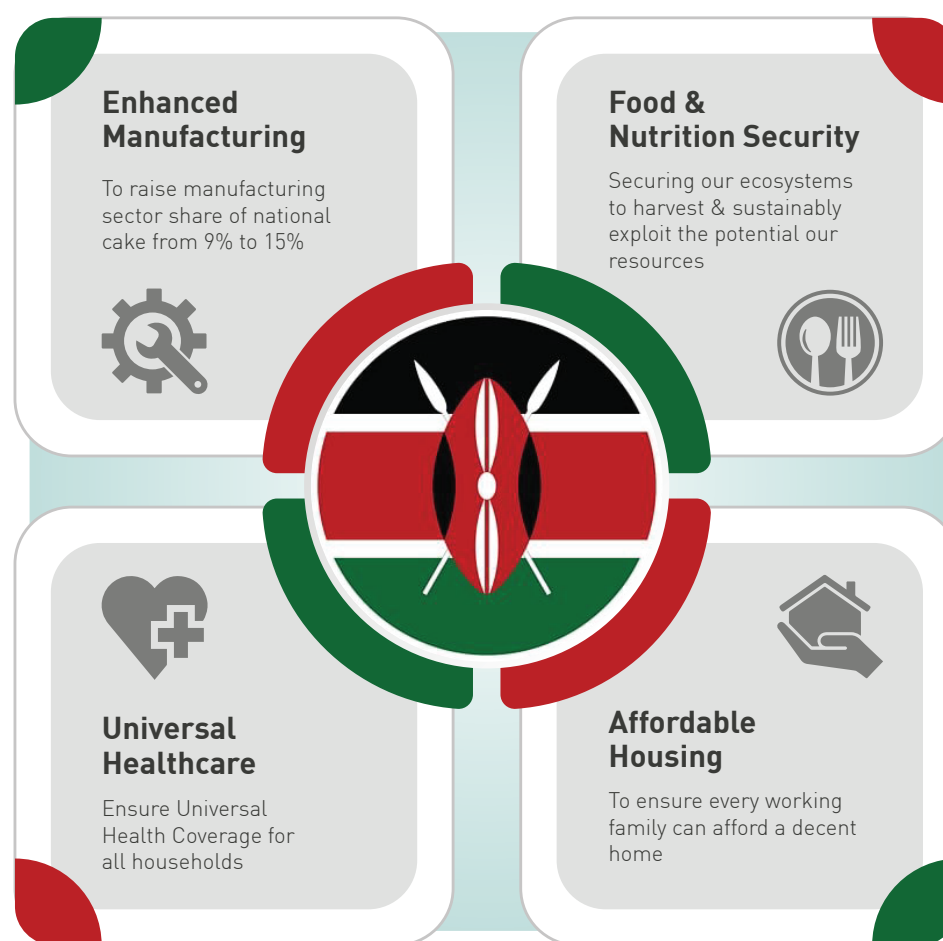
The technology will enable the constitutional rights of the citizens and is expected to continually ensure transparent elections in the country. Elected officials will also be held accountable relative to the use of public resources and effective delivery of government services.



Strategy Component 8: Government of Kenya's Big Four Agenda

In this section, we look at some of the ways in which Blockchain and AI technologies can enable the Government of Kenya to deliver on the Big Four Agenda (Figure 12). Note that this list is not exhaustive and is based on requirements that may arise. Systems should be able to evolve to ensure that delivery is not negatively impacted. In addition, connectivity should be uniform in the underlying infrastructure, such as the Government Cloud, thereby ensuring efficient use of resources.

Figure 12: Big Four Agenda





Food and Nutrition Security



‘Never again should we allow the vagaries of weather to hold us hostage. Over the next 5 years we shall invest heavily in securing our water towers and river ecosystems to harvest and sustainably exploit the potential of our water resources. We shall provide, together with other actors, key enablers within the farming process that will address distribution, wastage, storage and value-addition of agricultural commodities’

(Uhuru Kenyatta, President of the Republic of Kenya).

Artificial Intelligence

AI can be used to analyse data from the Internet of Things, satellites, drones and Smartphone apps in order to monitor, diagnose and predict the occurrence of various issues and allow for the most appropriate interventions. Such issues can include extreme weather events, disease outbreaks, pest attacks and soil nutrient deficiencies. For example, in Kenya, the Eskaapp can diagnose crop diseases instantaneously from smartphone camera photos, thereby realizing early detection and treatment.¹¹⁷

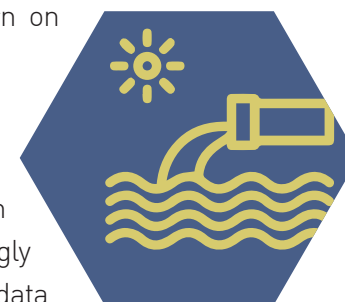
There are two things that must be done to improve food security.

1. We can grow more food; thus, we need to provide farmers with the tools required to maximise production per acre of land.

2. We can better manage the food we currently grow.

AI can help with both approaches. The use of AI in agriculture is sometimes referred to as “precision agriculture.”

For produce fields, farmers may use AI systems that absorb extensive quantities of field data, model all possible growing scenarios and recommend the best course of action for harvesting larger yields. With some level of autonomy, AI systems might be trusted to program farm equipment so that the precise amount of inputs are distributed at the right time on a location-by-location basis in the fields. Such a precision approach is most likely to produce the highest yields and the best return on investment.



However, the potential of AI does not stop at the border of the farmers’ fields. The ability to learn how to manage seemingly unpredictable scenarios using data, science and statistical probabilities can pay huge dividends in resource efficiency at the national level, which is expected to ease the identified food security issues.

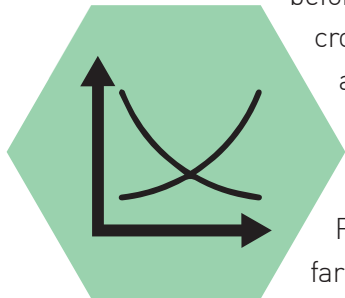
A sizeable percentage of food we produce is discarded or spoiled before it can be consumed; therefore, there is significant room to optimise the supply chain using AI. Many issues can contribute to waste, such as overproduction of certain commodities, difficulty in harvesting, transportation losses, processing losses, packaging failure, the ever-present danger of pests



and insects invasion, the outbreak of disease and losses at the consumer level.

¹¹⁷Farmers review Africa: Artificial intelligence is revolutionising agriculture, 2018

AI is expected to stabilise commodity markets by better matching supply to demand. More precise logistics will ensure deliveries are made on time before spoilage occurs. Early detection of crop anomalies will help prevent disease and insects from wiping out harvests by allowing growers to act before entire harvests are lost.



Farmers can use AI to better manage farms relative to the demand at the country's market place. In addition, the Government of Kenya can use AI to create a more accurate picture of production in regions of interest so as to better manage trade and food distribution. At the most local level, individuals may harness the same powerful tools to better understand where their food comes from, perhaps using the system to order safer and healthier food.

Will AI replace the knowledge and intuition that farmers have always had? Probably not; however, AI will complement and challenge how decisions are made thereby improving farming practices.

Blockchain

As in healthcare, agriculture can benefit from transparent and auditable supply chains. Counterfeit seeds have flooded many markets, resulting in reduced soil nutrient levels and compromising

farmers' yields for many seasons. This contributes to food deficit.¹¹⁸ Origin Agritech, a seed provider in China, is using Blockchain technology to track and document the original source of seeds to eliminate the prevalence of counterfeit seeds.¹¹⁹

The Government must map the process chain (from seeds to marketplace) and then ensure data are captured at various stages for analytics, while recording transactions on the Blockchain.

Practical Problem

The Kenyan government provides and/or subsidises fertilizer and other farm inputs for farmers as a strategy to mitigate food insecurity. From manufacturer to farmer, the supply chain has faced perennial accusations of graft, and is riddled with



A good example is a share certificate (a piece of paper representing the ownership of an asset). These papers are essentially tokens representing an asset.

¹¹⁸African Farming and Food Processing. "African alliance sets up agency to eliminate fake seeds." 2012

¹¹⁹PRNews Wire: Origin and Elastos Announce Collaboration in Developing an Agribusiness Platform, 2018



inefficiencies. The chain could benefit from a technical solution that allows for transparency, immutability and a clear audit trail that ensures farmers have efficient and effective access to required resources when they are needed.

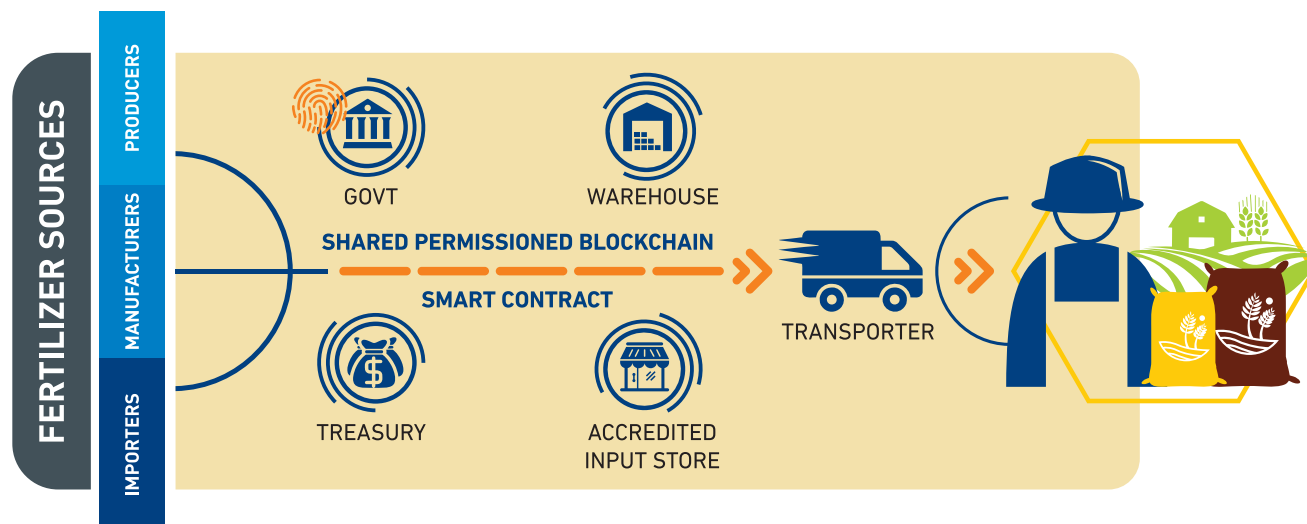
Solution description

Supply chain management was one of the first use cases to benefit from distributed ledgers and AI. We propose to adopt them to aid in the planning and execution of various processes based on actual

demand and supply, driven by the farmers.

A shared, replicated and permissioned Blockchain between various players is proposed, and the primary actors in this ecosystem are shown in figure 13 below.

Figure 13: Primary actors: - Government (Stores and treasury), Transporters, Farmers and accredited fertilizer stores





Scenario 1:

Producers/Importers/Manufacturers tag fertilizer bags and other inputs with RFID/QR code, Date of Manufacture and Date of Dispatch. The details are captured in a smart contract on the Blockchain.

Transport agencies receive the bags/inputs, scan and deliver them. All details are appended to the smart contract on the Blockchain.

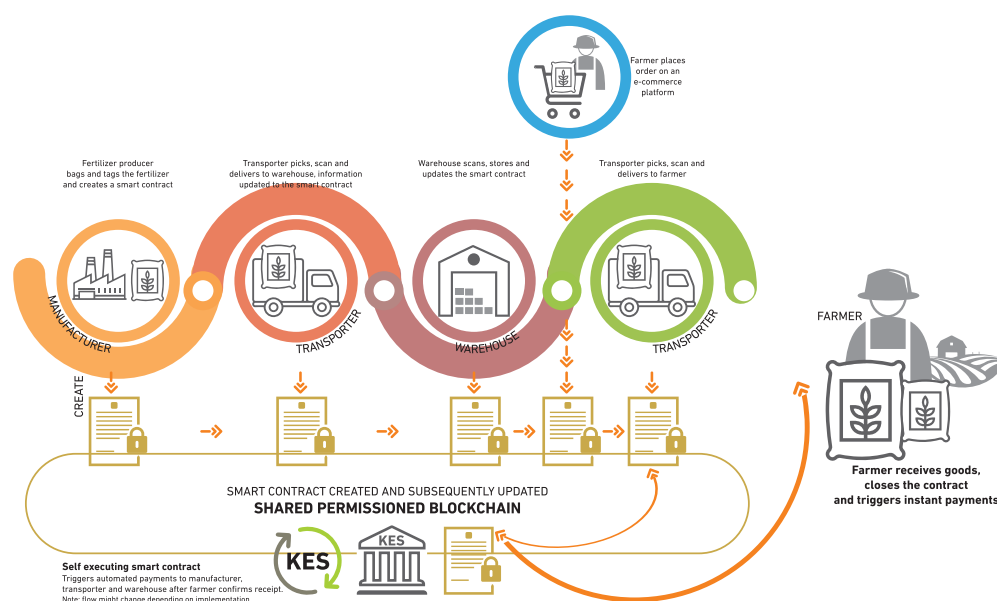
Government stores receive and scan the goods. Captured warehouse conditions are put on the smart contract on the Blockchain.

The farmer goes to a government portal to request fertilizer/inputs, specifying the size of land, type of

crop, when it was planted and other variables. These details and the request are put on the smart contract. The request is sent, and upon receipt of all inputs, these details are again updated on the smart contract. Upon receipt of the inputs, the farmer scans the inputs and payment is triggered to various parties.

The treasury plays a passive role by maintaining proper cash balances for the smart contract to self-execute once various triggers are activated at each touch point. For instance, a transporter is automatically paid when the treasury pays for the fertilizer, storage and manufacturer are paid when the farmer receives all inputs as a smart contract.

Figure 14: Blockchain smart contract for fertilizer distribution





Scenario 2:

By advancing the use case slightly, we come up with an 'AGRIToken' that is issued to farmers based on their requests. It also adds the concept of a 'certified store'. All players obtain a 'token wallet', which is used for transactions in the ecosystem. The 'AGRIToken' can be configured such that it can only be redeemed for specific goods at a set price. The tokens are then

cashed out at the treasury or a designated exchange for a predetermined value. This ensures full traceability and that the farmer gets what they require, by applying the usual 'Bag and Tag' using smart devices (IoT; RFID, QR code or Bluetooth).

The major outcomes of this solution will be increased compliance, improved visibility and guaranteed traceability.

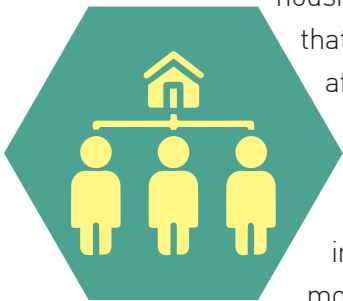
Figure 15: Token-based Blockchain agricultural inputs





Affordable Housing

'Over the next 5 years, we will create 500,000 new home owners through the facilitation of affordable housing, and a home ownership program that will ensure every working family can afford a decent home by injecting low-cost capital into the housing sector. Reforms will be undertaken to lower the cost of construction and improve accessibility to affordable mortgages'



(Uhuru Kenyatta, President of the Republic of Kenya).

Artificial Intelligence

A 2014 McKinsey report identified four approaches that can narrow the housing affordability gap.

- 1) **Unlocking Land Supply:** Land is typically the largest expense; thus, securing it at appropriate locations can be the most effective way to reduce costs. AI could be used to ensure predictive population planning to ensure that correct locations are selected.
- 2) **Reducing construction costs:** Construction costs can be reduced by incorporating new technology (possibly robotics) into building efficiency. Other areas could include standardised design and industrial approaches, such as offsite manufactured components. AI could potentially help in these areas, and even improve procurement methods and

processes.

- 3) **Improved operations and maintenance:** A relatively large component of housing cost is operations and maintenance. AI could be used to predict maintenance issues and consolidated purchasing.
- 4) **Lowering finance costs:** Using AI to better analyse credit risk rather than the blanket approach of applying interest, which would enable access to less expensive credit to finance affordable housing construction and purchase.

Another potential application of AI is property management to ensure that the correct individuals/families are allocated housing. Using data analytics, AI could potentially undertake financial accounting and appraisals to enable better decision making.

Blockchain

As illustrated by the above examples, Blockchain technology can be used to create land registries that are expected to benefit both the administration and citizens. Kenya's recently digitised land registration services make it well placed and ready to implement a Blockchain-enabled system.¹²⁰

¹²⁰ Onyango, Protus, Ministry of Lands Re-open Activities at Nairobi Registry, The Standard, 2018



Universal Health Coverage

‘Over the next 5 years, we will target 100% Universal Health Coverage for all households by ensuring that 13 million Kenyans and their dependents are beneficiaries of the NHIF Scheme. This will be achieved through a complete reconfiguration of the NHIF and reform of the laws governing private insurance companies’



(Uhuru Kenyatta, President of the Republic of Kenya).

Artificial Intelligence

Healthcare has long been considered a promising domain in relation to AI. AI- based applications could improve health outcomes and quality of life for the citizens of Kenya in the coming years, but only if they gain the trust of doctors, nurses and patients and if the correct regulations are in place.

AI is already improving healthcare access in Kenya. Babyl Rwanda is a healthcare provider that partnered with Rwanda’s national healthcare scheme to provide affordable healthcare. Babyl Rwanda currently uses AI to triage, provide medical advice, book appointments and deliver prescriptions to patients through mobile apps. Currently, the app does not include AI diagnoses; however, it does allow for digital consultation with doctors. Babyl Rwanda’s long-term plan includes AI diagnoses as an offering, which could also be beneficial to Kenya. ¹²¹

The primary applications of AI in healthcare include clinical decision support, patient monitoring and coaching, automated devices to assist surgery or patient care and management of healthcare systems. As in other domains, data are a key enabler. There is need for an immense exercise to collect useful data from personal monitoring devices, electronic health records, etc. In Kenya, one of the first steps would be to digitise all patient/medical records to realise easier access to and updating of records to generate the required datasets.

Accurate data collection and verified data would enable NHIF to deliver healthcare effectively. Some of the areas where AI can help NHIF include:

- Patient monitoring/tracking: ensuring right treatments, and potentially using AI to translate medical terminology into plain language so the patient can better understand the procedures and requirements.
- Drug monitoring/tracking to ensure correct usage of drugs, not only for fraud prevention but to analyse costs and improve resources utilisation.
- Costs controls such that the premium costs are monitored carefully.
- Predictive care: to ensure certain treatments are provided at home and thus not strain critical resources in hospitals.





- Remote care: using remote diagnostics to ensure wider reach of care by potentially using robotics in surgery.
- Improving quality of life for the elderly in the country.
- Effective use of limited doctors by, for example, using AI to augment radiologists to reduce turnaround time for feedback and further improve the efficiency of medical care.
- Using predictive models for treatments, disease control, monitoring, etc.

Blockchain

Blockchain technology can enable customers to trace the supply chain of medication, which would help tackle the issue of counterfeit medication. It is estimated that counterfeit medication kills approximately 100,000 people each year in Africa.¹²² An example of this is The MediLedger Project, which brought together

leading pharmaceutical manufacturers to track and trace prescription medicines. Following the project, the conclusions drawn are that Blockchain technology enables the tracing of products back to their originating manufacturers and the confirmation of the authenticity of a drug with each transaction.¹²³ the government of Kenya can make great strides towards achieving universal healthcare, by using AI to analyse the vast amounts of data generated by patients, doctors, healthcare experts, hospitals and administrators. Blockchain technology can then be used to secure transactions and ensure traceability in the healthcare sector. Part of achieving better health includes incentives for citizens to eat healthy foods, especially indigenous varieties that will encourage food security and healthy living. Figure 16 shows how a health living token will function.

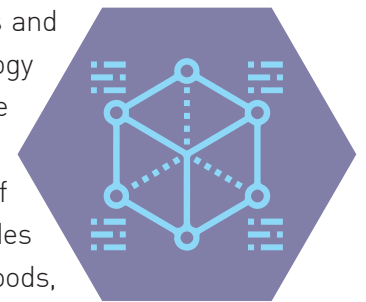
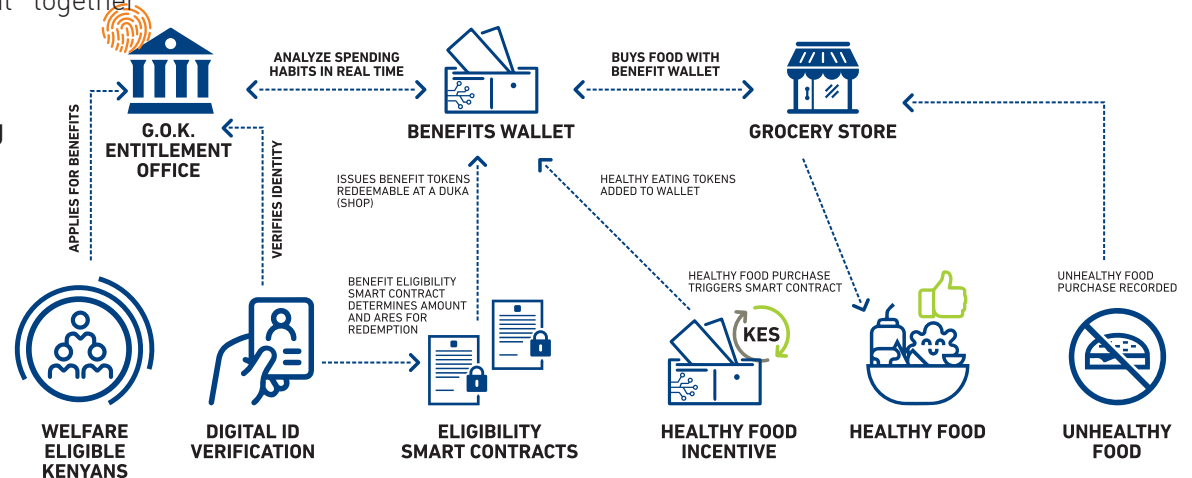


Figure 16:
Healthy Living
Incentives

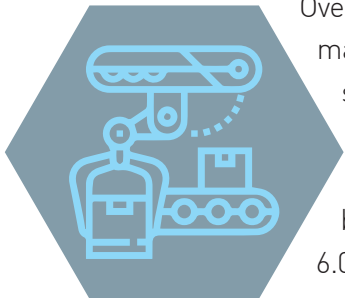


122WHO: Report on the situation of counterfeit medicines, 2010

123Chronicle: The MediLedger Project 2017 Progress Report, 2018



Enhancing Manufacturing



'Over the next 5 years, we will grow the manufacturing sector and raise its share of the national cake from 9% to 15% by reducing power tariffs charged to manufacturers by 50% between the hours of 10.00pm to 6.00am. This is in line with our 24-Hour economy policy'

(Uhuru Kenyatta, President of the Republic of Kenya).

Artificial Intelligence

AI has the potential to significantly improve production capabilities and efficiency through optimization of processes and quality, as well as the minimization of yield loss/waste (from erroneous product defects) and time loss (from the slower pace and downtime associated with humans).¹²⁴

While AI technologies are likely to have a profound future impact on employment and workplace trends globally, it is still difficult to accurately assess current impacts, both positive and negative. To be successful, AI innovations must overcome understandable human fears. AI will likely replace tasks rather than jobs in the short term and will also create new kinds of jobs.

However, new jobs that will emerge are more difficult to predetermine compared to identifying existing jobs that will likely be lost. Changes in employment typically happen gradually, often without sharp transition, which is a trend that is likely to continue as AI slowly moves into the workplace. A spectrum of effects will emerge, ranging from small amounts of

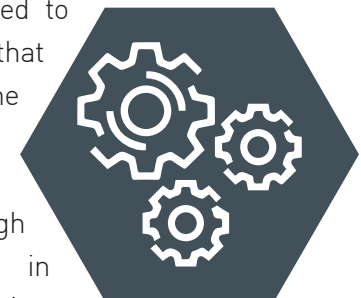
replacement or augmentation to complete replacement.

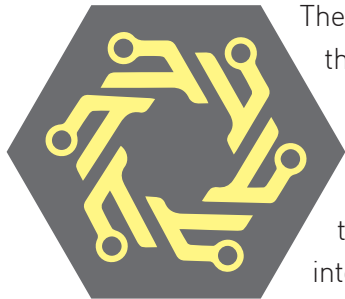
AI will create jobs, especially in some sectors, by making certain tasks more important and will create new categories of employment by enabling new modes of interaction.

In the Kenyan context, enhancing manufacturing via AI as a tool has the potential to increase productivity and up skills-labour with augmentation. AI also has the potential to create jobs in the field of digitising existing data such that future AI can be used effectively.

Blockchain

Blockchain technology can be used to improve supply chain systems that include various activities in the manufacturing industry, such as payments, labelling and transport. These systems often carry high transactional costs and errors in manual paperwork. Wipro, a business process services consulting company, has developed a range of Blockchain applications for supply chains that address the registering, certifying and tracking of goods that move from one party to another. Kenya's manufacturing industry could harness similar Blockchain technology.





There is need for a supply chain security act that would initiate the creation of a regulatory framework in the manufacturing industry. This framework needs to outline the steps towards building an electronic, interoperable system that identifies and traces manufacturing outputs (and inputs) as they are distributed in Kenya. This will enhance the government's ability to protect consumers from exposure to counterfeit, stolen, contaminated or otherwise harmful products/inputs.. The system will also improve detection and removal of potentially dangerous products/inputs from the supply chain to protect Kenyan consumers. This act should consider the key role of authority organizations, such as the Anti Counterfeit Agency. In addition, the act should have sufficient capacity to mobilise manufacturers to use a network that can help to make legitimate goods move faster in the supply chain and flag and report counterfeit goods.

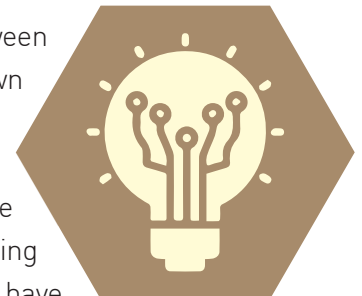
The import documentation process would be one key area where the network of government agencies will need to create permissioned networks. They can do this by using appropriate technology that can interoperate with manufacturer's systems in a secure manner, or by working with a middle layer of companies that provide this service to both government and industry. Note that interoperable systems are not about partner relationships, they are about network relationships and ecosystem creation. The government is a key node in the network with manufacturers and can play its part to invest in

distributed ledger technology and act as an ecosystem player and enabler. Technology that does not respect data privacy and masks business intelligence will not work for the private sector.

Using Blockchain technology to ensure transaction immutability and traceability, together with complimentary data and applying AI to strengthen the manufacturing industry will enable the government to deliver on the agenda for Enhanced Manufacturing.

Strategy Component 9: Public Policy Recommendations

There is always a disconnect between making policy on matters that are known and those that are unknown. Regardless, public interest can be promoted by making decisions that are grounded on facts while anticipating unknowns.. Emerging technologies have always presented such difficulties when it comes to making decisions, even as the urge to try new things is overbearing. In our view, public policy should always be dynamic in a technologically evolving world in order to exploit the benefits of new technologies.



Emerging technologies have always presented such difficulties when it comes to making decisions, even as the urge to try new things is overbearing.



The Kenyan Parliament developed guidelines for dynamic policy making that is referred to as evidence-based policy making. Evidence-informed decision making attempts to ensure decisions are well informed by the best available research. It is characterised by systematic and transparent access to, and appraisal of, evidence as an input into the policy-making process (Oxman, Lavis, Lewin & Fretheim, 2009). If this model is adopted across Government, there will be no need to develop any new policy making procedures.

Appendix 1 contains a broad-based policy proposal derived from evidence gathered in the process of developing this report. We acknowledge that the policy proposal, although broad, will require review from time to time.

Strategy Component 10: Implementation Roadmap

The implementation strategy will consist of quick wins out of this report. The key areas targeted for Blockchain and AI implementation include: the Ministry of Lands, which has already been digitised and thus is ready for digital transformation; public service delivery, particularly the Huduma Centres; and financial inclusion programs leveraging the advanced mobile money that has enabled greater inclusivity in the country.

Regarding the implementation of DLTs, it is anticipated that different Ministries, Departments and Agencies (MDA) will be at different levels of readiness. To allow each entity to determine its DLT governance and system structures, a middleware layer will be implemented to facilitate interoperability between the MDAs.

The agency handling identity management will be key to successful DLT implementations. Regardless of whether this agency has implemented eGov 1.0, 2.0 or 3.0, it should be able to provide reliable identity services to the entire ecosystem.





Financial Inclusion

In 2015, Kenya began implementing a variety of innovative financial solutions to drive the financial inclusion agenda. In 2006, Kenya enacted microfinance banking legislation and in 2007 mobile phone financial services were implemented. Shariah compliant financial services have been available since 2005, and the roll-out of the popular and wide spread agency banking began in 2010.

The next phase (Figure 17) of financial inclusion will be driven by big data derivatives, Fintech, Blockchain technologies and the overall democratization of finance.

Figure 17: Financial Inclusion Roadmap

FINANCIAL INCLUSION	Description		Means of Verification
	<p>Objective: is to get the unbanked and underbanked to have better access to financial services, The availability of financial services that meet the specific needs of users without discrimination.</p> <p>Financial inclusion means that individuals and businesses have access to useful, and affordable and transparent financial products and services that meet their needs-transactions, payments, savings, credit and insurance-delivered in a responsible and sustainable way.</p> <p>Financial access facilitates day-to-day living, and helps families and businesses plan for everything from long-term goals to unexpected emergencies. As accountholders, people are more likely to use other financial services, such as credit and insurance, to start and expand businesses, invest in education or health, manage risk, and weather financial shocks, which can improve the overall quality of their lives.</p> <p>Financial inclusion has been identified as an enabler for 7 of the 17 Sustainable Development Goals. It is envisaged that financial inclusion will lead to access to credit which will enable economic development for the Republic of Kenya.</p>		<ul style="list-style-type: none"> Ministry of Finance Data CBK Quarterly or Annual Data
	Indicators		Risks & Mitigations
	<ul style="list-style-type: none"> Percentage of Kenyan with an account at a formal financial institution Number or percentage of SMEs with accounts 	<ul style="list-style-type: none"> Number or percentage of SMEs with outstanding loan 	<ul style="list-style-type: none"> Restricted Access to Agents <ul style="list-style-type: none"> Mitigation: Agents ability to transact on interoperable platforms (Open Access) Security <ul style="list-style-type: none"> Mitigation: ensuring policy for data protection/privacy in place
	Priority		
	Short Term Initiate Process to provide bank accounts for all citizens (special accounts for really poor)	Medium Term Link said bank accounts to national system where all payments made are linked, therefore enabling easier/faster transfer for funds digitally.	Long Term Moving away from cash transactions to Digital transactions and with interoperability at all levels (Full open access)
	Recommendation		
	<ul style="list-style-type: none"> Use of Digital ID for opening bank accounts Increase Citizens' financial literacy and capability so they understand different financial services and products. Establish robust financial consumer protection frameworks, and adapt relevant regulatory and supervisory authorities, including by utilizing technology to improve supervision 		



Reduction of Transaction Costs

Transaction fraud occurs primarily in the financial services industry. This is a global phenomenon; therefore, deliberate and coordinated efforts are required from both private and public sectors. Given the use of ICT in financial intermediation, most transaction fraud is perpetrated through cyberspace, and tends to exploit weak internal controls, technology and operational governance.

With the implementation of Blockchain technology and AI with embedded cybersecurity defences, it is anticipated that the incidents of transaction fraud will be dramatically reduced.

Figure 18: Reduction of Transaction Cost Roadmap

Reduction of Transaction Fraud	Description		Means of Verification	
	To reduce transactional fraud to lower the economic cost of public and private enterprises. Identify fraud indicators and widely conduct awareness campaigns. Create a digital locker (securely store official documents e.g. credit report, birth certificates etc., that can be used to complement the digital ID) for every citizen Regulatory requirement for issuers to provide tools to merchants to prevent fraud The aim of reducing transactional cost is to reduce fraud and increase customer confidence. This will in the long run reduce crime while at the same time facilitate adoption of digital currency for efficient online business. A fully digitized economy will be more efficient, better service delivery and could facilitate greater expansion of the economy. Lower transactional fraud could facilitate lower transaction cost that is a critical cog in realizing financial inclusivity where citizens can afford to access cheaper services.		<ul style="list-style-type: none"> Central Bank Data Statistics of fraud incidences Statistics from Computer Incident and Response Team Publication of all fraud incidences 	
	Indicators		Risks & Mitigations	
	<ul style="list-style-type: none"> Digital fraud reduction measured in number of digital fraud incidences and amount of money 2020 - Internal ← 5% External ← 5% 		Reporting <ul style="list-style-type: none"> Mitigation: Incident must be reported as soon as it is detected. Lack of experts in fraud detection <ul style="list-style-type: none"> Mitigation: Capacity building in fraud detection and regular upgrades to understand emerging issues Lack of awareness on fraud incidences <ul style="list-style-type: none"> Mitigation: awareness campaign across the country 	
	Priority			
	Short Term Baseline data to ensure starting point for fraud detection to be put in place	Medium Term Initiate the process of building capacity in fraud detection experts and leveraging AI for pattern recognition	Long Term Quicker fraud detection and transparent mechanism for reporting and prevention	
	Recommendation			
	<ul style="list-style-type: none"> A new legislation to compel financial institutions to report fraud incidences <ul style="list-style-type: none"> Mandatory reporting of any fraud incidence Mandatory customer awareness campaigns on fraud detection CBK to start leveraging Artificial Intelligence and Machine Learning to verify institutional reporting 			



Overall Public Service Delivery

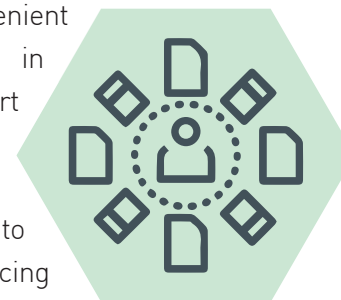


DLT can improve transparency, accountability, governance and delivery of public services. Huduma Centres were established to enhance access to and delivery of government services to all Kenyans. Huduma Centres were intended to be full-service centres wherein citizens can access multiple government agencies' services at a single location. Upon adoption of DLT, Huduma Centres will be able to issue identity cards, birth certificates and police abstracts, among other services. In addition, citizens will be able to register businesses and register with the NHIF. For these services to be delivered efficiently, the government will be required to manage data across different departments and sources, including paper-based records, while protecting trusted records. Various government agencies' technology platforms must be integrated to provide convenient access to information and simplify interactions with citizens.

A secured DLT, such as a Blockchain, will provide a common platform that would simplify management of sensitive data while maintaining data integrity and security (Figure 19). The platform must be able to verify identity, share information and facilitate payments. A digital identity can be used to verify eligibility for public services, prevent issuance of duplicate or falsified documents and reduce fraudulent claims for public benefits. The technology makes it difficult for a compromised party to tamper with records because all agencies in the network are required to verify modifications.

Using Blockchain technology, we can deploy smart contracts to automate paper-based transactions. Manual paper-based processes often require interaction with different government agencies. For example, ID replacements require police abstracts and import processing involves various port entry agencies. Digitised documents, such as police abstracts, import declarations, customs inspection documents, etc, can be shared with the appropriate departments and the transactions are then automatically processed through smart contracts that execute upon meeting requirements.

Further, citizens can be assured that payments for public services are traceable. The use of a digital currency can facilitate convenient payments and transparency in transactional processes. Smart contracts can be used to disburse payments to the various agencies without requiring an intermediary to allocate payments, thereby reducing opportunities for misappropriation of funds.



Further, citizens can be assured that payments for public services are traceable. The use of a digital currency can facilitate convenient payments and transparency in transactional processes.



Figure 19: Public Service Delivery Roadmap

Overall Public Service Delivery	Description		Means of Verification	
	<ul style="list-style-type: none"> To leverage distributed ledger technologies in enhancing public service delivery throughout the country Build DLT solutions in all Huduma centers with transparent service level agreements to the citizens Leverage DLT solutions for faster efficient processing of import documents by entry point agencies (KEBS, KRA, KPA, Police, Anti-counterfeit). Enhance ease of doing business by leveraging DLT technologies Leverage DLT technologies to create the single source of truth for all government issued documents and services 		<ul style="list-style-type: none"> Statistics from Huduma centers on issued documents and services rendered Statistics from the government registries represented at Huduma 	
			Risks & Mitigations	
			<p>Lack of capacity</p> <ul style="list-style-type: none"> Mitigation: Capacity building countrywide <p>Lack of resources</p> <ul style="list-style-type: none"> Mitigation: Encourage Public Private Partnerships (PPP) <p>Data security</p> <ul style="list-style-type: none"> Mitigation: Build secure infrastructure Mitigation: Cybersecurity awareness and training Mitigation: Computer crimes and cyber security bill 	
	Indicators			
	<ul style="list-style-type: none"> Performance contracting matrices Continuous customer surveys to ensure SLA are met Improved ease of doing business index (current index:80) 	<ul style="list-style-type: none"> improved ease of doing business index (current index: 80) 		
	Priority			
	Short Term Proposed for execution within the first six months	Medium Term Real time reporting of performance/statistic - via public website na dmechanisms for improvement put in place	Long Term Moving vast majority of services online (over 90%) to ensure all service transactions are captured at national and county level.	
Recommendation				
<ul style="list-style-type: none"> Implement digital identity Enable a digital fiat (surrogate) currency 				



Land Titling

The challenges faced by the Ministry of Lands can be resolved by adopting Blockchain technology. Specifically, issuing the same title deed to multiple people is a classic case of the 'double-spend' phenomenon that was resolved by the first Blockchain use case– the Bitcoin Network.

The double-spend phenomenon describes a situation where one attempts to issue the same digital asset to several people simultaneously with clear intention to defraud. Blockchain technology was designed to ensure that this is not possible. Adopting Blockchain technology would prevent the same digitised title being issued to multiple parties simultaneously.

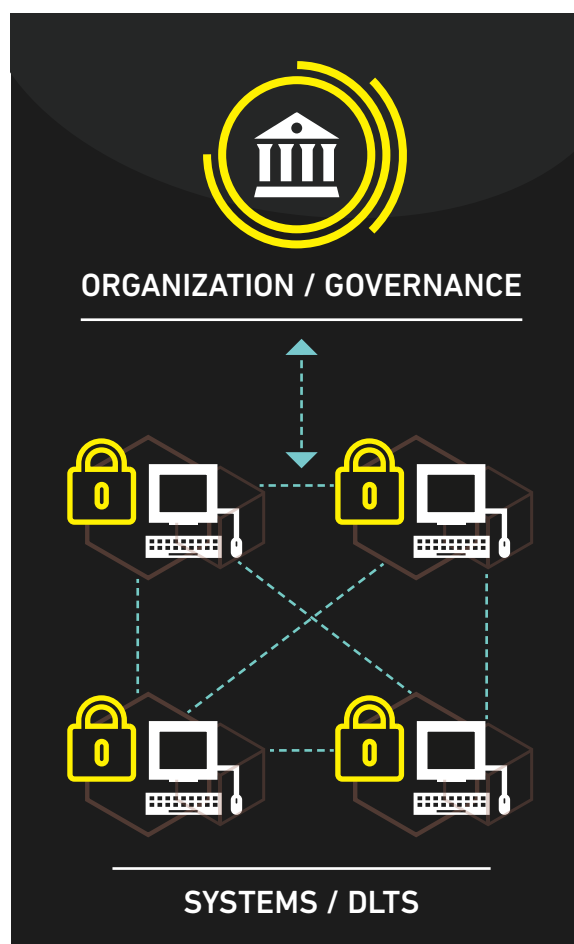
The Minister of Lands also faces significant problems regarding data integrity. Valid title deeds maybe illegally modified to represent different ownership, location or land size.

Blockchain are designed to be immutable, which means that modifications of land transactions are only authorised after multiple parties in the network accept the change through prescribed consensus mechanisms.

The Minister of Lands' current client-server systems cannot provide the immutability property that is the hallmark of Blockchain technologies. Adopting Blockchain technology would put an end to the

notorious practice of manipulating lands records and restore confidence in the accuracy and integrity of land titles. In addition, Blockchain technology would improve transparency, thereby increasing investor confidence in land related transactions.

Figure 20: Typical Implementation





As shown in Figure 20, the Organization (Ministry of Lands) would be responsible for the governance of the DLT. It would determine which participants would form the networked nodes that would run the validation software as well as the consensus mechanism.

Typically, the network of participants would include stakeholders with specific roles and mandates within the ministry and across the sector. For example, the National Lands Commission, the Law Society of Kenya, the County Government and the Lands Survey

department would be good candidates to run the consensus and validation software for land transactions.

It should be noted that once each of these stakeholder nodes have independently reviewed and validated the land transaction, it is recorded in the Blockchain's DL; therefore, no stakeholder can unilaterally change a record. Consequently, illegal or unauthorised changes to land records would be eliminated.

Figure 21: Land Titling Roadmap

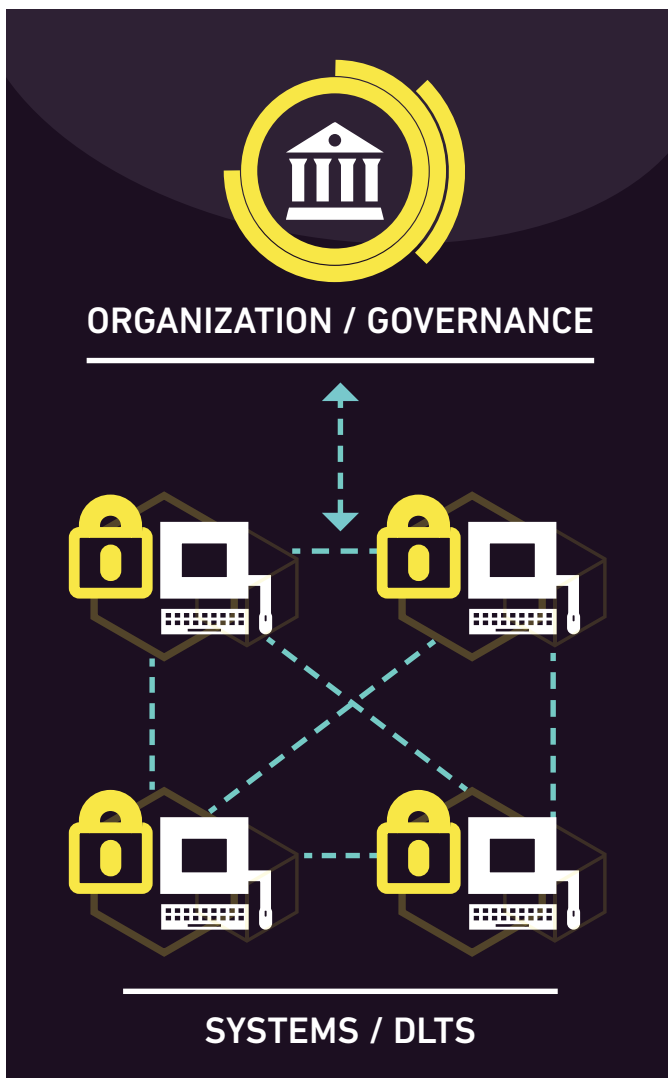
Land Titling	Description		Means of Verification	
	To close loopholes in unauthorized duplications of land titles, To close loopholes in unauthorized transfers of land titles, To enable real-time online searches of land titles Actions: <ul style="list-style-type: none"> Leverage land digital data to introduce, DLT and create immutability and increased transparency of land transactions (auditability). Leverage existing national spatial data infrastructure to develop a geospatial blockchain in healthcare, housing and education 		<ul style="list-style-type: none"> Ministry of Lands, statistical data. Collection of revenue Transfer of title KPIs 	
	Indicators		Risks & Mitigations	
	<ul style="list-style-type: none"> Performance contracting matrices Continuous customer surveys to ensure SLA are met Improved ease of doing business index (current index:80) 		<ul style="list-style-type: none"> Unauthorized duplication/transactions of land titles to be mitigated by appropriate cybersecurity measures. DLT solutions - track and trace 	
	<ul style="list-style-type: none"> improved ease of doing business index (current index: 80) 			
	Priority			
	Short Term Initiate the process for digitizing land records and ownership.	Medium Term eTransaction of land transfer with standardized contracts for sale/acquisition	Long Term Fully digital and transparent transaction for land ownership with target lead time (of less than 60 days) for close of transaction (once agreed upon by buyer and seller)	
	Recommendation			
<ul style="list-style-type: none"> Digitization of land titles, Public awareness campaigns & Training for Land Officials and Land Practitioners Review and amendment of the land titling regimes under Land Registration Act, the Land Act and the Community Land Act with a view to formulate guidelines for electronic land titling. Further recommendations expected from the Taskforce on Electronic Land Transactions, Registration, Conveyancing and Other Related Activities that was appointed on 13th July 2018 vide Gazette Notice No. 7859 				



The Sharing Economy

Recently, mobile broadband Internet in conjunction with data analytics, the IoT and AI have given rise to new business models that have produced unique digital entrepreneurs. Notable examples include

Typical implementation



Uber, the largest taxi company that does not own any taxis; AirBnB, the largest hospitality company that does not own any hotel chains; and Facebook, the largest media company that does not hire journalists or reporters.

These digital entrepreneurs have found a business niche by connecting customers to a service or asset using easily available digital platforms made possible by the convergence of the contemporary digital technologies.

In the case of Uber, prospective passengers use the Uber platform to connect to the nearest taxi driver. The passenger does not need to own a car and the taxi driver is not limited to a fixed geographical base to find passengers.

In addition, the taxi is likely to be more active because it is available to a wider group of passengers who book and deploy it in small chunks of time and distance over the course of the day. This is the essence of the sharing economy and similar models can be found in different sectors of the economy.

The central pillar in the current model of the sharing economy is the middleman or owner of the platforms.

Whether it is Uber, AirBnB, Facebook or YouTube, the middleman owns the platform that connects the customer to the service or asset and determines what commissions to charge for the service.

In most cases, the middleman is not local. Such middlemen tend to be associated with the advanced



economies in the North. They often do not pay taxes to the local economies in the South. Furthermore, due to first-mover advantages, the poorer economies in the South are unable to replicate the ecosystem required to compete with more established digital entrepreneurs.

However, Blockchain technology can be deployed to disrupt the existing middlemen in the sharing economy. The customer and the service provider can meet on a neutral platform that is owned by all participating stakeholders rather than a central authority.

For example, the Uber platform could be re-designed and implemented via a Blockchain system such that customers, taxi service providers, smart-contract developers, validating nodes and other stakeholders all become part-owners of the overall value created by the network.

Essentially, the sharing economy is expected to transition to the next level, where the middleman is not extracting maximum value at the expense of the other participants. Instead, depending on the specific use case or design, the created value will be distributed more equitably.

Here, to provide public transportation under the shared economy model, the Organization (Ministry of Transport or Nairobi County Government) would be responsible for the governance of the implemented DLT.

The Organization would determine which participants would form part of the networked nodes that would run the validation software as well as the consensus mechanism. Typically, the network of participating nodes would include stakeholders with specific roles and mandates within the ministry or county and across the transport sector.





Figure 22: The Sharing Economy Roadmap

SHARING ECONOMY	Description		Means of Verification	
	<p>To create a secure environment for sharing assets between private individuals (Land, Equipment and services), either free or for a fee, through emerging technologies (GPS, IoT, National Spatial Data Infrastructure). Identify assets and services that can be shared</p> <ul style="list-style-type: none"> • Sensitize the public through awareness campaigns. • Develop an asset bank of assets for sharing • Create an enabling regulatory environment <p>The aim is to make use of idle assets both in public and private by encouraging optimal utilization of resources. Fro example, services like radiology should be centralized such that only technicians will be at the county hospitals and the images sent via internet to the central for analysis and report writing. At the moment radiologists are posted to different hospitals where in most cases the X-ray machines are not working. Both the doctor and the echnician end up idle when there is so much to be done in report writing. Machanisms for land sharing also need to be established.</p> <p>The Ministry of ICT's Ajira project makes use of underutilized government facilities to run innovation hubs.</p>		<p>Big Data analytics</p> <ul style="list-style-type: none"> • Performance contracting reports • National Economic Survey reports • Other reports 	
			Risks & Mitigations	
			<p>Existing legislations on land that may reverse ownership of some assets</p> <ul style="list-style-type: none"> • Mitigation: Change some laws especially land law to enable sharing economy to take root in Kenya. <p>Resistance to change current behavior towards sharing</p> <ul style="list-style-type: none"> • Mitigation: Policy guideline and giving incentives to those takling the risk to move forwards. <p>Education on emerging issues</p> <ul style="list-style-type: none"> • Mitigation: awareness campaign across the country 	
	Indicators			
	<p>Number of shared assets/service</p> <ul style="list-style-type: none"> • 2013 - C • 2020 - 1,000 			
	Priority			
	<p>Short Term</p> <p>Create baseline data for data in respective sectors to ensure alignment of starting point</p>		<p>Medium Term</p> <p>Initiate the process of regulation change when assets are digitized and thus enabling long term ambition.</p>	<p>Long Term</p> <p>Ensuring Transparent Ownership of Assets - fully digitized and enabling efficient transaction of said assets.</p>
Recommendation				
<p>A new legislation to outline</p> <ul style="list-style-type: none"> • Land use laws • Government policy on sharing resources • Policy to gather and analyze data on performance targets 				



CONCLUSION

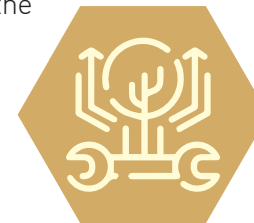


Within the stipulated timeframe, this taskforce has envisaged how emerging technologies can be implemented in Kenya in a manner that impacts positively on the national economy and development. Kenya has an impressive history of being at the forefront of ICT development in Africa and has shown its willingness to embrace innovation. Through various discussions with multiple private sector participants and regulators, the taskforce has come up with recommendations that are not only aligned to industry trends but also best practices globally. These recommendations will ensure successful and beneficial implementation of Vision 2030 and the Big Four Agenda. This will in turn allow the government, as it has done in the past, to create improved economic growth and social inclusion for the citizens of Kenya, in addition to truly placing Kenya on the map within the context of the Fourth Industrial Revolution.

As we have highlighted in this report, emerging technologies can support and develop all of the Big Four Agenda points, and none have the potential to be as disruptive and transformative as Blockchain and Artificial Intelligence (AI). We also note that these emerging technologies complement each other rather than compete, and are expected to be extremely beneficial to the Government and to have tremendous positive impact for citizens.

Furthermore, with the two key considerations, i.e., (i) supportive ecosystem and (ii) effective regulation to balance citizen protection and private sector innovation, the Government of Kenya will have to

implement protections necessary to ensure economic development and successful implementation of the Big Four Agenda. We have highlighted the potential implementation strategy for the Government to execute, potential use cases that government can implement and the ecosystem that must be in place (National Digital Infrastructure) to fully realise the emerging technologies. We have further analysed the value propositions of each emerging technology while considering global best practices from an implementation perspective and, more importantly, from a regulatory perspective. Finally, we have presented the potential risks these technologies pose for both government and citizens.



We believe that the implementation of the recommendations set forth will position Kenya favourably within the emerging technology space. The implementation will also help the Government deliver on its promise of food security, universal healthcare, enhanced manufacturing and affordable housing. This will truly strengthen Kenya's position not only on the African continent but globally, as stated in the national motto 'Let us all pull together'. By adopting these recommendations, Kenya will demonstrate to the rest of the world that the effective use of emerging technologies is instrumental to fostering economic development.



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APPENDIX

1. POLICY AND REGULATORY FRAMEWORK

1.1 Introduction

Disruptive technological advancements, such as 5G, AI, Big Data, Distributed Ledger Technology and the IoT, have created a variety of new scenarios to which existing legal and regulatory regimes should be applied. All technology players, including owners, service providers and end-users, are likely to face complex concerns related to access, ownership, ethics, neutrality, inclusiveness, privacy, liability, security, competition, accountability, standards, biases, transparency, participation and skills development, among others.

In our view, the core policy and regulatory framework challenges required to support emerging disruptive technologies relate to data protection, access to information, cybercrimes and cybersecurity, as well as agile ICT sector legislation. Currently, Kenya lacks a policy and legal framework for data protection. This is a significant regulatory gap because 5G, AI, Big Data, DLT, IoT and other related technologies are intensively data-driven.

1.2 Situational Analysis and Issues to be Addressed

1.2.1 Artificial Intelligence (AI)

The appropriate policy and regulatory approach could foster the development and adoption of AI by various sectors. The risks associated with evolving applications of AI and machine learning, including data standards, privacy considerations, ethical issues, criminal and civil liability, are all properly the subject of regulation.

As AI evolves, it can greatly benefit society by powering the information economy, fostering better informed decisions and helping unlock answers to questions that are currently unanswerable. Therefore, it is beneficial to better understand AI and foster the development of AI in a manner that maximises its benefit to society.

1.2.2 Big Data

Big data analytics finds patterns, correlations, trends and other insights to help private and public sector actors to better understand the information within data and identify which data can improve the effectiveness of their decisions. From a policy and regulatory perspective, big data analytics raises new questions concerning privacy, protection of personal data, cyber security, consumer protection, data ownership, intellectual property protection and contract law issues related to terms and conditions of use/service, among others.

As computing power increases, larger amounts of data can be processed faster and patterns in large datasets that are not easily discerned by manual analysis can be identified. One can immediately see opportunities to use such high-powered computing systems in diverse sectors of our economy and governance systems, such as Education, Elections, Agriculture and Environmental Protection, Supply Chain and Procurement, Financial Markets, Telecommunications, Land Operations, E-Government



Services, Public Transportation, Healthcare, Media and Entertainment.

1.2.3 Distributed Ledger Technology (DLT)

In December 2015, the Government through the Central Bank of Kenya issued a public notice and a circular to all licensed financial institutions regarding bitcoin and other virtual currencies. Effective governance and regulation should be extended to ensure the successful implementation of DLT.

Successful implementation of DLT will require a combination of governance to protect the participants and stakeholders, and regulation to ensure the system is resilient to systemic risk or criminal activity. The challenge is to strike a balance between safeguarding the interests of participants in the system and the broader interests of society, while avoiding stifling innovation through institution of excessively rigid structures. Moreover, a bifurcation has occurred within DLT, where many applications support virtual currencies while others support secure distributed business ledgers. It is conceivable that legislation will be required in the former case but not the latter.

1.2.4 Fifth Generation Technology (5G)

A policy and regulatory framework that prioritises and supports the timely and sufficient availability of spectrum for 5G is required, both in the short term and beyond. With regard to 5G infrastructure, the regulator must aim to reduce barriers to deploying infrastructure. Moreover, infrastructure sharing arrangements ought to be allowed to develop organically and commercially over time – if they are viable – rather than introducing rules that could slow down the pace of deployment.

With regard to the economics of 5G for the mobile industry, the investment required to deploy 5G networks and deliver mobile connectivity for all use cases should be supported by a long-term policy and regulatory environment that encourages innovation, provides greater predictability and ensures effective competition among companies in the ecosystem.

1.2.5 Internet of Things (IoT)

The growing expansion of the IoT demands a modernised digital infrastructure and regulation of data ownership. The key stakeholders in IoT initiatives would be the citizenry, the government and industry. Participation with, and collaboration by, each of the stakeholders at an appropriate stage is essential.

It is recalled that in June 2018, the Government through the Communications Authority of Kenya issued Guidelines on the Use of IoT Devices, machine-to-machine-based devices as well as devices with embedded universal integrated circuit cards. Moving forward, policies to promote IoT and selection of essential economic sectors will be required.



1.3 Analysis of the Existing Policy and Legal Framework

The Computer Misuse and Cybercrimes Act 2018, established the National Computer and Cybercrimes Co-ordination Committee whose functions include advising the Government on aspects touching on matters relating to distributed ledgers, critical infrastructure, mobile money and trust accounts. The Kenya Information and Communications Act, 1998, established the Communications Authority (CA) of Kenya as the regulatory authority for the ICT industry in Kenya with responsibilities in telecommunications, e-commerce, cyber security, broadcasting and postal/courier services. The CA is also responsible for managing the country's numbering and frequency spectrum resources as well as protecting the interests of users of ICT services. The CA is equally charged with the management of the country's numbering resources and the approval of ICT devices. In the case of DLT applications related to cryptocurrencies, the relevant regulatory framework exists under the National Payment Systems Act, 2011, and the National Payment Systems Regulations, 2014.

The draft National ICT and Innovation Policy concentrates on four thematic areas:

- a) Mobile first, which will ensure that every Kenyan can access the Internet inexpensively and has reasonable access to locally produced devices;
- b) Market, increase the size of the digital economy to 10% of GDP by 2030;
- c) Skills and Innovation, which outlines a careful plan designed to jumpstart a self-supporting ecosystem that will produce world-class research, technology products and industries;
- d) Service delivery, which requires that all government services are available online, that every Kenyan has online access and that government services are delivered quickly when and where they are needed. The policy also anticipates that ICT will be integrated in the implementation of the Big Four Agenda to facilitate efficient and effective processes and data sharing to achieve the program objectives.

The current government policy is that all Ministries, Departments and Agencies must move to all digital systems of communication, document generation, document storage and archiving. This policy mandates that all MDAs will digitise all historical records and make such records available to the National Archives in an acceptable electronic format.

1.4 Objectives and Strategies

1.4.1 Affordable Housing

In line with the Government's overall development objectives, the National Land Policy is designed to secure land rights and provide sustainable growth, investment and reduction of poverty. It recommends that Government shall: a) modernise the land delivery infrastructure through computerization and the use of other electronically linked systems, b) create human resource capacity to operate the modernised infrastructure, and c) remove constraints that prevent the realization of an optimal cadastre.



The National Housing Policy is intended to arrest deteriorating housing conditions countrywide and to bridge the shortfall in housing stock arising from demand that far surpasses supply, particularly in urban areas.

A regulatory framework will be developed for the use of DLT to register and identify beneficiaries of interest in an immutable history of transactional records. This distributed registry will provide a single source of truth of ownership and the ownership history of any given property. For example, buyers will be assured that the land being bought is the correct plot and that the seller is unequivocally the owner, thereby reducing the potential for disputes as well as the costs and time involved for any given transaction.

The relevant provision of land laws shall be amended to ensure that Blockchain are used to record annual estimates by the commission and that audits, accounts and annual reports also use digital ledgers for uniformity.

1.4.2 Universal Health Coverage

The National Health Policy 2014-2030 focuses on ensuring equity, people centeredness, a participatory multi-sectoral approach, efficiency and social accountability in the delivery of healthcare services. A study conducted in 2009 on leading risk factors and factors that contribute to mortality and morbidity, identified that risks to good health include unsafe sex, unsafe water, poor sanitation and hygiene, suboptimal breast feeding, underweight babies and mothers, indoor air pollution, alcohol use, vitamin A deficiency, high blood glucose and zinc deficiency. Other health indicators include literacy levels of women, nutrition, access to safe water, adequate sanitation, proper housing, roads and infrastructure, among others.

A framework will be developed for the use of DLT for patient data, data on nutrition and registration of births and deaths. Similarly, guidelines on the use of AI in the analysis of radiological images, diagnosis and monitoring of massive amounts of health data will be developed. It is noted that AI systems are already able to offer clinical decision support in diagnosis and recommend treatment options.

AI could be used to glean new insights from existing data, such as electronic health records and laboratory tests. AI can be used to help doctors analyse tissue samples to determine the likelihood that breast and other types of cancers will spread, thereby enabling better treatment recommendations.



1.4.3 Enhancing Manufacturing

To reduce illicit and counterfeit trade, it is proposed that a special database be created, possibly using DLT, where legitimate businesses can incorporate their original products and identification marks such that counterfeit versions are more easily identified and counterfeiters can be charged with an offence under the Anti-Counterfeit Act.

1.4.4 Reduction of Transactional Fraud

The insurance sector in Kenya is mandated to provide insurance coverage for the various risks that might be anticipated during our daily lives. Various insurance and re-insurance companies undertake to provide coverage for both natural and legal persons across the country. Compensation will be much faster once the information related to the insurance contract is entered into a special database. Differing significantly from the long process clients currently endure pursuant to the existing Insurance Act, such a database would allow previous claims under the same contract terms to be compared, thereby determining the appropriate compensation more effectively and efficiently. The finance sector is very critical to the insurance sub-sector as well as other sectors; therefore, transaction time should be reduced as much as possible.

1.4.5 Financial Inclusion

It is noteworthy that the National Payments Systems Act provides that: 'The Central Bank may, by notice in the Gazette, designate a payment system for the purposes of this Act'. This provision may be relied upon to license and regulate cryptocurrency and other alternative payment systems. The Central Bank E-Money Regulations require E-money issuers to utilise systems capable of providing an accurate and fully accessible audit trail of all e-money transactions. It is possible that DLT could be applied to manage this audit trail to ensure that the transaction records are accurate, accessible and secure.

Similarly, under the Banking Act, the Central Bank is required to collect such data and other information as may be necessary to enable it to maintain supervision and surveillance of the affairs of institutions or their duly authorised agencies and the protection of their depositors and, for this purpose, may require institutions or their duly authorised agencies to submit statistical and other returns on a periodic basis in addition to any other returns required by law. The use of DLT would control this system of periodic data collection; thus, an amendment to incorporate it in this section of the Banking Act would be required.



1.4.6 Overall public service delivery

Appropriate policies and regulation of disruptive technologies could help the public sector achieve efficiencies, including promoting cost savings and streamlining operations.

Government ministries have adopted some reforms in supply chain management, such as E-government. E-government involves digitalizing all government operations from procurement to payments. This process could be enhanced by the use of distributed ledgers. Distributed ledgers would not only enhance ease of payment, enable the harmonization of all documents, records and other procurement procedures but would also ensure minimal mistakes in record keeping, accountability and transparency. Competent e-procurement should be consistent with internationally accepted conventions. In some cases, adhering to internationally accepted conventions may require the use of distributed ledgers in procurement. Some countries have already adopted DLT, including the United States of America, Canada, Australia and some countries in the European Union.

1.5 Conclusion

The policy and regulatory framework for emerging technologies should support the realisation of new business models, including creating better testing and trial options, while considering important socio-economic or protection-related factors in Kenya. This framework should help private and public sectors keep up with technological progress by avoiding set requirements regarding the use of specific technologies or solutions as a prerequisite for complying with the intention of the law.

The Government will work with its agencies to identify use cases for all emerging technologies to entrench them in public systems and services and thereby enhance service delivery to Kenyans.

To foster innovation, the regulatory framework must have a clear overall purpose rather than focusing on process requirements. Where possible, new regulations should avoid detailed requirements and specific descriptions that make it difficult to apply new technologies and business models. Where possible, the Government should also ensure that new policies and regulations consider interactions with other regulatory areas that could impact the use of new technologies and business models.



TERMS OF REFERENCE

GAZETTE NOTICE NO. 2095
THE KENYA INFORMATION AND COMMUNICATIONS ACT
(No. 2 of 1998)

APPOINTMENT

IT IS notified for the general information of the public that the Cabinet Secretary for Information, Communication and Technology has appointed a Taskforce for the exploration and analysis of upcoming digital technologies that demonstrate great potential to transform Kenya's economy including disruptive technologies that are currently shaping the global economy such as distributed ledger technologies (Blockchain and hashgraph), artificial intelligence (AI.), 5G wireless technology, and the internet of things.

The Taskforce shall comprise of-

Bitange Ndemo (Prof.) - (Chairperson);

Stephen Chege

Julian Rotich

Charity Wayua (Dr.)

John Walubengo

John Gitau

Elizabeth A. Ondula

Fred Michuki

Michael Onyango

Lesley Mbogo

Martin Murungi

Daniel Obam

Sachin Kamath

Mahmoud Noor



1. The terms of reference of the Taskforce shall be to

- a) to critically review distributed ledgers and artificial intelligence technologies;
- b) to contextualize how the application of distributed ledgers and artificial intelligence technologies can and will deliver the Government's Big Four Agenda of affordable housing, universal healthcare, manufacturing and agriculture agro processing;
- c) to develop a roadmap on how distributed ledgers and artificial intelligence technologies can promote and enhance Government services including
 - i) overall public service delivery;
 - ii) job-creation through the Ajira Digital Programme;
 - iii) cybersecurity;
 - iv) single digital identity;
 - v) financial inclusion;
 - vi) reduction of transactional fraud;
 - vii) land titling;
 - viii) democracy;
 - ix) election process; and
 - x) the sharing economy;
- d) to prepare an implementation strategy with key performance indicators and clear delivery timelines; and
- e) to prepare and present a comprehensive report on all aspects of this assignment to the Cabinet Secretary.

2. In the performance of its mandate, the Taskforce shall

- a. hold such number of meetings in such places and at such times as the Taskforce shall, in consultation with the Cabinet Secretary, consider necessary for the proper discharge of its mandate;
- b. shall review official reports, policies, legislation or any document related to its mandate; shall hold consultative meetings with sector stakeholders and members of the public;
- c. may carry out or cause to be carried Out such studies or research as may inform the Taskforce on its mandate; and



- d. may co-opt such other persons who possess the appropriate competencies as are necessary for the performance of its mandate.
3. The term of office of the Taskforce shall be three months from the date of the publication of this notice.
4. The Taskforce shall prepare and submit to the Cabinet Secretary a work plan and a progress report at the end of the third week after its appointment and its final report at the end of three (3) months after its appointment.
5. The Taskforce shall regulate its own procedure.
6. The Cabinet Secretary may appoint a secretariat to offer support services to the Taskforce.
7. The Secretariat of the Taskforce shall be based at the headquarters of the Ministry of Information, Communication and Technology, 10th Floor, Boardroom, Telposta Towers, Kenyatta Avenue, Nairobi.

Dated the 28th February, 2018

JOE MUCHERU,

Cabinet Secretary for Information, Communication and Technology.