POWERING THE AFRICAN VISION:
BLOCKCHAIN TECHNOLOGY FOR AFRICA'S TRANSFORMATIVE GOVERNANCE

AUDA-NEPAD
AFRICAN UNION DEVELOPMENT AGENCY

About the AU and AUDA-NEPAD

THE AFRICAN UNION (AU)

The African Union (AU) is a continental body consisting of all 55 countries on the African continent. It was established on 26th May 2001 in Addis Ababa, Ethiopia, and launched on 9th July 2002 in South Africa[1] with the aim of replacing the Organisation of African Unity (OAU). The most important decisions of the AU are made by the Assembly of the African Union, a semi-annual meeting of the Heads of State and Governments of its member states. The AU's secretariat, the African Union Commission, is based in Addis Ababa, Ethiopia.

The AU was established following the 9th of September 1999 Sirte Declaration of the Heads of State and Governments of the Organisation of the African Unity (OAU). The AU is based on a common vision of a united and strong Africa and on the need to build a partnership between governments and all segments of civil society, in particular, women, youth and the private sector, in order to strengthen solidarity and cohesion amongst the peoples of Africa. As a continental organisation, it focuses on the promotion of peace, security, and stability. The development work of the AU is guided by the AU Agenda 2063, which is a 50-year plan to harness Africa's comparative advantage to deliver on the vision of "The Africa We Want".

THE AFRICAN UNION DEVELOPMENT AGENCY (AUDA-NEPAD)

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

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

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[1] About the African Union https://au.int/en/overview

AU High-Level Panel on Emerging Technologies Report on Powering the African Vision:
Blockchain Technology for Africa's Transformative Governance

This technology report is the product of the African Union High Level Panel on Emerging Technologies (APET). It is part of a larger effort by the African Union Development Agency (AUDA-NEPAD) to promote knowledge and learning, share ideas, provide open access to its research, and contribute to development policy. The articles featured in the APET Technology Report is considered to have a bearing on the mission of AUDA-NEPAD, and its strategic objectives, as aligned to the AU Agenda 2063, which is a Pan African vision of an integrated, prosperous, and peaceful Africa, driven by its own citizens, representing a dynamic force in the international arena.

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Tributes

Prof Calestous Juma

"For a whole generation, and maybe for future generations of leaders, he was an exceptional teacher and thinker as well as one of the shining lights of Africa in the intellectual sphere." **– Dr Ibrahim Mayaki, AUDA-NEPAD**

"Those who had the pleasure of meeting him—or communicating with him online and off—will testify to his warmth, his love of learning, and his great generosity." **- H. E. Uhuru Kenyatta, President of the Republic of Kenya**

"Calestous was a tireless champion for economic and social development in Africa. His legacy will live on through the fruits of his many years of work as an impassioned scholar, fearless advocate and mentor to students and policymakers around the world." – **Bill and Melinda Gates Foundation**

"We have lost a brilliant mind who was dedicated to innovation, education and Africa's prosperity." **- H.E. Paul Kagame, President of the Republic of Rwanda**

"Gifted with immense wit, charm, courage, humour and modesty—a rare combination, Professor Juma was a trusted advisor to Heads of State and Government throughout the world on critical issues affecting humankind today." **- The Common Market for Eastern and Southern Africa (COMESA)**

Prof Diran Makinde

Many people in Africa and around the world will long remember Prof. Oladiran Martin Makinde as a champion for harnessing Science, Technology and Innovation for better livelihoods of the peoples of Africa; a firm believer that Science, Technology and Innovation can co-evolve with Regulations. But those of us who lived and worked with him nearly every day and will long ache with his passing, know Prof. Diran (as we popularly called him) by many other titles he held: Husband, Father, Brother. Grandfather. Director, Mentor, Advisor and many more.

He was the sunny, joyful person who lit every moment with his infectious smile whether you meet him in the corridors, staff kitchen, boardroom for meetings, but everywhere and always. He had an incredible ability to accommodate and work with people irrespective of their different viewpoints. He cherished life and life cherished him and everyone who met him, everyone who knew him will remember his invincible smile and contagious laugh.

A true gentleman with a great sense of life who lived up to the positive energy he chose to bring to those he interacted and interfaced with every single day. His wisdom and guidance were instrumental in the establishment of ABNE and the success that it continues to achieve to date are the outcomes of the firm building blocks he and others helped to put together 10 years

We have not yet come to terms with the passing away of Prof. Diran. We cannot know for certain as to why he left us this soon. But we remain comforted by the assurance that we will meet again one day. We pray for comfort, fortitude, and peace to all his loved ones.

Prof Oyewusi Ibidapo-Oye

In December 2016, the late Professor Oyewusi Ibidapo-Obe was appointed a member of the African Union High level Panel on Emerging Technologies (APET) by the then Chairperson of the African Union Commission (AUC), H.E. Dr Nkosazana Dlamini Zuma. This began our journey with this eminent expert who we fondly called Prof Oye.

His wit, ambience and welcoming spirit is a feature he brought to APET that would not be soon forgotten.

Prof Oye's characteristic of sacrificing his time and energy for the continent was quite authentic – he did that with charm and joy and always had something to contribute to discussions. He was ever ready to offer to the panel suggestions of continental experts that can contribute knowledge to Africa's development.

We look back at his loving tribute to the late Professor Calestous Juma, and the joy with which he spoke of continuing his legacy – which he adequately fulfilled. Today, we remember someone whose legacy has influenced many far and wide; the youth especially were his heartbeat.

Prof Oye was passionate about sustaining Africa's indigenous knowledge and we at AUDA-NEPAD pledge to carry on with his ideas on effectively harnessing our indigenous knowledge in addressing continental challenges.

Prof Oye! Your life was a blessing, your memory a treasure, you are loved beyond words and missed beyond measure. The day we heard of your death; it was like a dream. Death is appointed unto us all, but we just couldn't accept that it was your time. In the few days to your death, you were actively with us, so it was so hard to take that you would be with us no more.

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Definitions

Blocks - Make up digital pieces of information, store information about transactions, for example, date, time and amount, store information about who is participating in transactions and store information that distinguishes them from other blocks.

Blockchain network - A technical infrastructure that provides ledger and smart contract services to applications. It is an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way.

Distributed ledger – Is a database that is consensually shared and synchronized across multiple sites institutions or geographies. It allows transactions to have public "witnesses." The participant at each node of the network can access the recording shared across that network and can own an identical copy of it.

Participant - Contributor or consumer of blockchain technology.

Node - Replicas of ledgers which one can rely on to keep track of transactions that have occurred on the blockchain.

Personal Identifiable Information (PII) - "is any data that could potentially identify a specific individual. Any information that can be used to distinguish one person from another and can be used for de-anonymising anonymous data can be considered PII."[2]

Global data protection rules (GDPR) - The General Data Protection Regulation (GDPR) is the toughest privacy and security law in the world. Though it was drafted and passed by the European Union (EU), it imposes obligations onto organisations anywhere, so long as they target or collect data related to people in the EU. The regulation was put into effect on May 25, 2018. The GDPR will levy harsh fines against those who violate its privacy and security standards, with penalties reaching into the tens of millions of euros.

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[2] personally identifiable information (PII) https://searchfinancialsecurity.techtarget.com/definition/personally-identifiable-

Executive Summary

Blockchain technology offers the service of moving the value of an asset, product, service, contract from one place to another, directly, faster, and more transparently – by removing the middleman. Blockchain has tremendous potential for simplifying all the bureaucratic procedures and making transactions transparent and more accessible.

Although blockchain as a technology has not reached maturity, (it is still in its infancy), it has proven in the past decade how great an impact it can have on businesses, large and small enterprises, government, and every conceivable industry. Besides the scepticism and mistrust, the technology is expanding to fit a wide variety of needs and offers a way to transfer assets, contracts, and land titles, whilst removing some or all intermediaries. Blockchain has ushered a new wave of the Internet, also called the "Internet of Value" bringing enormous potential waiting to be unleashed, the ground-breaking characteristics it brings is, the establishment of trust inherently built into the application, strangers can transact online without the intervention of intermediaries. This quality of the technology has the potential to disrupt many industries and transform the traditional business models of financial services companies in the future.

This report aims to highlight how blockchain technology can enable the African Union vision, to be **"an integrated, prosperous and peaceful Africa, an Africa driven and managed by its own citizens and representing a dynamic force in the international arena."** To this effect, the report showcases Africa's capabilities, highlights blockchain pioneers on the African content and their investments in emerging technologies and how they have benefited. The various use cases in these countries are a reflection of what the entire continent can achieve by following a similar ambitious path. It also shows that Africa's solutions lie within its borders. This report provides a window of opportunity for the nations in Africa to emulate enabling innovation that will drive their economies more efficiently, as well as a guideline to governments for promulgating enabling policies and regulations that can accelerate the continent's growth through the use of blockchain combined with other technologies. The above opportunities can be realised by ensuring that:

- Policies and regulations enable innovation and the adoption of some of the emerging technologies such as blockchain that would help capture the above opportunities.
- Current blockchain knowledge and skills on the continent are used to test innovative solutions in controlled environments in order to minimise the potential risks that the solutions enabled by this technology may pose.
- Citizens are upskilled to manage and use trusted solutions to set up small enterprises to augment the provision of decentralised services.

Government services are critical for service delivery and core services like identity, refugee, land, voting and health management would be vastly improved through strategic implementation of blockchain technology. Improvement in services at country level would go a long way in the quest to realise **Agenda 2063** and other worthy ideals pursued by the African Union. In chapter 1, the report explores blockchain's potential to significantly transform the fortunes of the African continent in critical aspects, especially public service, and the various economies. This section is structured to present the challenges in 5 main areas, government, agriculture, finance, education, and healthcare. These are some of the vital areas that require transformation so African citizens can benefit in terms of job opportunities, healthcare, good education, availability of credit, financial abundance, lesser costs for cross border payments, easy repatriation of funds and investments.

Chapter 2 speaks to blockchain as a gigantic ledger or a conglomeration of multiple ledgers, where data or transactions are stored on blocks, as shown in Figure 1 below. The blocks are chained together by unique digital identifiers which identify the previous block e.g., 782Z shows on Block 2 and is identified by Block 3, this system allows for tracing concluded transactions in the future. The transactions recorded in these blocks cannot be altered, however, you can add new transactions to the blocks. E.g., if you changed your residential address and would like to inform the bank, the bank will need to add the new address and the old address will always remain as it cannot be deleted. There is no delete or modify function, therefore an audit trail is maintained, and data can be revisited anytime, however, nobody can tamper or modify the data.
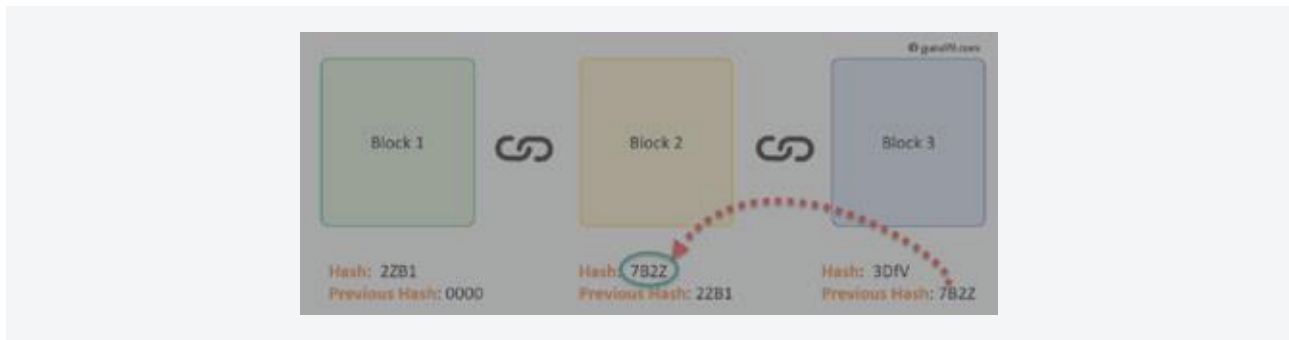
Figure 1 Anatomy of blockchain

Briefly, the unique value of blockchain can be summarised as:

- Trustless: the blockchain system is also called a trustless system since the technology is fool-proof in the way it is conceptualised and built, it is tamper-proof, it works on the principles of validation and verification by consensus, so instead of a clearinghouse, the other nodes (computers) in the blockchain will run a mathematical algorithm to verify the transactions before it is permanently stored on the block;
- Immutability: information cannot be deleted or modified providing an incorruptible historical record that becomes permanent in the system;
- Transparency: ensured while all changes are reflected on the ledger and can be audited by any party that is participating in the network;
- Disintermediation: the blockchain ledger (database) is not maintained by any single person, company, or government, but by all participating network computers distributed around the world. This means that two parties can interact (e.g., move funds) without the need for any central intermediary to authenticate transactions or verify that the records are truthful, you can remove the middleman;
- Substantial cost savings: you don't need to pay intermediaries;
- Greater speed: when transferring money or other assets e.g. cross border payments; and
- Security: blockchain offers enhanced security due to the cryptographic way that information is exchanged, making it ideal for storing highly sensitive, personal data, such as those involving financial transactions, medical health records, or other types of data that require enhanced security.

Chapter 3 looks at some use cases of blockchain and opportunities herein. This document discusses real-life examples of blockchain being in various stages of implementation globally and, especially, in Africa. To date, most use cases will have an impact on financial services. In this area, the technology will change the lives of the unbanked in ways that include the transfer of cross-border remittances and community-based bartering. These changes would reduce the worst levels of poverty prevalent in communities throughout the entire continent.

Cross border payments and settlements are the most meaningful and impactful use case especially in the financial services and Fintech world. Expatriate Africans working internationally spend on average 12% in fees to transfer money back to relatives in Africa. These excessive fees cost the African continent $1.8 billion a year. blockchain will enable instant remittances at fractional costs as compared to traditional systems. Banks are gearing up for this change as they will lose if they do not adopt the technology and transform their businesses.

In the past decade, there has been rapid adoption of blockchain across the globe, surprisingly, many poor nations are at the forefront of expanding this technology in the spheres of economics and governance. In Chapter 4, spotlight on Estonia, Dubai (Developing nations) UK, (Developed nation) and the European Union (which is the equivalent of African Union), J. P. Morgan (the largest financial institution in the world) is showcased here to establish their successful adoption of blockchain globally. This chapter also provides how these emerging technology-based businesses and governance solutions are benefiting these nations. Chapter 5 further elaborates on the blockchain trends in Africa, some success stories, adoption challenges, regulatory hurdles, and exposure to "emerging technologies" as a blockchain ecosystem. It finally espouses what lessons other countries can learn from their wins. In chapters 6 - 8, the report looks at the socio-economic considerations and opportunities for leapfrogging through research and development. Policies, regulations, and standards are critical, particularly for a technology disruptive in nature and these are discussed. The continent also required adequate skills which consequently requires capacity development.

Recommendations

The blockchain revolution is here and will go beyond transforming and disrupting every industry in its path. The financial services industry is greatly disrupted by Fintech companies, which provide basic lending services, micro-lending services and crowdfunding initiatives at a fraction of the charges that banks, and other financial services companies do. blockchain touches every life in mysteriously efficient and cost-effective ways, therefore it is pertinent that the government take cognizance of the inevitable and work in tandem with all stakeholders to create feasible adoption strategies for this wonderful technology. This approach to blockchain solutions, in particular, will consider the full ecosystem of suppliers and customers across the value chain to ensure that the maximum benefit can be gained. Governments, corporates (especially financial technology companies) and educational Institutions should co-create sandbox environments to ensure that solutions developed for Africa or Member States protect citizens. This can be achieved through rigorous testing and understanding of the solutions from multiple perspectives, namely: business (people, process, consensus, incentives, and governance structures), information, data, application, technology, and token economy before they are taken to market.

In the recommendations, chapter 7 elucidates the need for blockchain regulation and how service providers, ICT companies and users of blockchain solutions can comply with the policies to make blockchain more mainstream in its adoption. Regulation favours the citizens and businesses; hence it is vital to the security and safety of the citizens, however too much regulation and too strict policies are detrimental in stifling innovation. New technologies require interoperability standards which can enable greater adoption rate and proliferation. The African Union must collaborate with the technology company's regulators from other jurisdictions and other stakeholders to deliberate on regulations and policies, a quorum will set the proverbial ball in motion.

Africa is diverse in culture, unequal in its economic status and vast in its resources, however, the zeal to progress is palpable. The AU member states need to unite to create consortia of blockchain body of knowledge, list out the various initiatives that are likely to be implemented. No government can achieve a technological revolution on its own. Lessons learnt from various successful countries in Europe are testimony to the fact that public, private partnerships work.

The African Union is encouraged to champion the cause of this blockchain revolution, invite stakeholders across public domain and private sectors to participate in dialogue, forums, and conferences and create testbeds to test solutions. The OECD blockchain Policy Forum 2019[3], has listed out the way forward in the implementation of blockchain technology, it is a viable document that provides guidelines on the public-private partnership engagement models.

Conclusion

This report has identified various use cases that show promise as to how economies would be gradually but surely transformed by blockchain. Specifically, applications in supply chain management and financial sectors are just a few examples of how the alignment of cross-border trading would be enhanced. Therefore, it is conceivable that the implementation of blockchain solutions could be one of the many interventions that could contribute towards the economic unification of different regions and, ultimately, the entire continent.

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[3] The Policy Environment for Blockchain Innovation and Adoption (2019) OECD Global Blockchain Policy Forum Summary Report
https://www.oecd.org/_finance/2019-OECD-Global-Blockchain-Policy-Forum-Summary-Report.pdf

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1

Introduction

Agenda 2063 embodies the Pan African vision for the continent of Africa, which is **"An integrated, prosperous and peaceful Africa, driven by its own citizens, representing a dynamic force in the international arena"**. Agenda 2063 follows a development trajectory which is based on a 50-year timeframe. This is enabled by the current structural transformation happening on the continent such as waning conflicts, economic and social progress, increased globalisation and further, providing a fillip to this development goal, in the context of this report, is the ICT revolution, emerging development and investment opportunities in areas such as agri-business, infrastructure development, health and education as well as the value addition in African

The Agenda 2063 has relevant flagship projects aligned to realise this vision, four of the key 15 projects, worthy of mention, are as follows:

· The Pan-African E-Network;
· Africa Outer Space Strategy;
· An African virtual and E-University; and
· Cyber Security.

The Programme on Infrastructure Development in Africa (PIDA) is a vehicle developed to provide project execution capabilities to the Agenda 2063 flagship initiatives. It is understood that ICT is the enabler of African Union's lofty goals and considering the kind of infrastructure projects, governance, education, trade, logistics, finance, economic reform, and energy, it is pertinent that ICT is further highlighted in its priority action plan.

Smartphones have shown rapid growth within the continent, from 7% in 2007 to 40% in 2015 and steadily rising ahead, which has provoked social, economic, and entrepreneurial inclusions, however at an individual and small business sector level (incomplete sentence). To boost large industry sectors, the African Continent has identified, in its ICT development the importance of establishing Internet exchange points. Currently, there is reasonable dependency and reliance on overseas carriers to exchange intra-continental traffic, which is expensive as well as inefficient. To circumvent this situation the AU Commission started the African Internet Exchange System project to promote local Internet providers to establish a network of regional and national internet exchange points in Africa.

PIDA has developed and is currently executing the digital transformation Agenda which will focus on trust and trade. Priority areas identified in this regard are open data and data centres as the foundation for entrepreneurship and job creation.

1.1 Challenges on the Continent

Despite the African government ICT interventions described above, there are a plethora of challenges at all levels and across industries. These challenges pose risks of adoption as well as opportunities for mitigation through the implementation of emerging technologies such as blockchain.

As seen in Figure 2, the five crucial industries most impacted in terms of revenue and costs are agriculture, financial services, healthcare, public sector, and education. High impact on revenue generation, the efficiency of processes and reduction of processing costs is what makes blockchain technology desirable in these industries.

These five crucial elements of industry are the topics of discussion in this chapter, the challenges faced by these industries are explored, some use cases in these areas developed with blockchain technology are assessed and in the following chapter, the challenges are tied to the plethora of use cases in various areas of businesses that can mitigate these challenges is depicted.
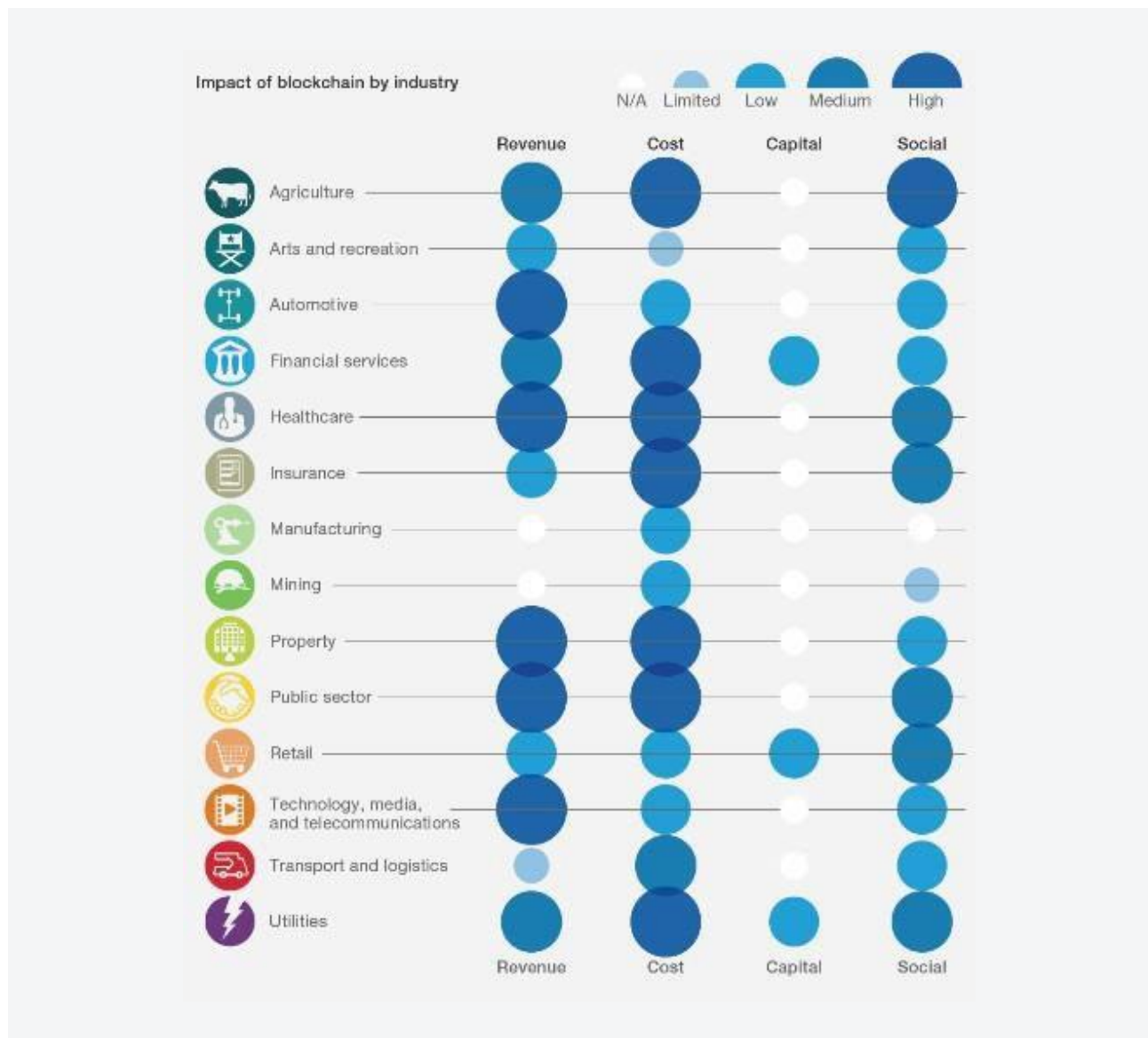
Figure 2 Mckinsey report on impact of blockchain industry-wise

1.1.1 Government Administrative Challenges

The African Nations[4] are not equal in terms of economic and socio-cultural challenges. Governance, policymaking, dependence on other countries for funds to develop infrastructure and essential services such as hospitals, educational institutes all contribute towards the limitations and restrictions in providing authoritative governance. It is further mired by lack of responsibility, terrorism, local conflicts, political instability as well as dissatisfied citizens immigrating due to lack of opportunities within their country. These are some of the macro challenges, however, at an operational level, some of the challenges exist in form of lack of electricity, infrastructure, good transportation etc.

OECD[5] in its report on "Government action in overcoming Africa's challenges" conveys the need for a joint intervention between government, economic stakeholders and citizens and a regional approach towards development. It asserts, that Africa has significant assets for addressing issues and mitigating challenges as long as the government provide the will, a young enterprising population, rapid urbanisation, abundant natural resources, dynamic economies, rich ecosystems, and a solid diaspora of cultural diversity. It is to be noted that Agenda 2063 and its implementation will provide the fillip of leveraging the assets so long as government capacities, transparency, coordination, greater responsibility, and positive action is increased[6].

1.1.2 Manual Voting Challenges

The time away from work when citizens have to manual vote has a direct negative impact on the economy. Further, time is then spent tallying the votes before the final result is known. The manual process sometimes leads to double voting and delayed results, there is the fear of rigging elections by fake and duplicates votes which is rife in African countries, and hence the citizens are not able to exercise their franchise fairly.

In addition to time honesty, accuracy and speed, other pain points include:

· The high costs related to ballot printing, electronic voting machines, maintenance, etc.;
· Increasing threats of cyber-attacks compromising election results;
· Lack of transparency due to a centralized process of election results audit; and
· Voting delays or inefficiencies related to remote/absentee voting.

1.1.3 Healthcare Challenges

In Africa, various constraints are being experienced in the health delivery systems, namely weak health infrastructure, limited tools, inadequate human resource capacity, limited public financing to the health sector as a whole (and not only to disease-specific programmes), poor management and planning and lack of integrated health systems and misapplication of human, technical and financial resources. To improve health in Africa, inequalities to health service access between and within countries should be addressed within the health system. The biggest health challenge is the unavailability of healthcare in the rural and semi-urban areas of African countries.

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[4]   Improving Africa's governance, before it's too late (2011) https://www.un.org/africarenewal/magazine/december-2011/improving-africa%E2%80%99s- governance-it%E2%80%99s-too-late

[5] In Africa, government action is key to overcoming challenges related to growth, jobs and inequalities, according to the new joint report by the African Union Commission and the OECD Development Centre (2018) https://www.oecd.org/dev/africa-government-action-key-to-overcoming-challenges-related-to-growth-jobs-inequalities-according-to-new-joint-report-by-african-union-commission-and-the-oecd-development-centre.htm

[6] Victor Harrison, Commissioner of Economic Affairs of the AUC

1.1.4 Challenges in Agriculture

Some African farmers, like other farmers in developing countries, suffer from poor governance, malpractices and a layered supply chain of produce to the consumer, inundated with middlemen who provide no real value. Some of the real-world problems faced by small holding farmers if they are not part of a conglomerate or cooperative farming community include:

Land acquisition & titles: Farmers buy smallholding farms from other farmers who do not have clear title deeds, or the land is under litigation. There is either no paperwork, fake papers or one-sided contracts which are detrimental to the interest of the purchasing farmer.

Government Subsidies & Lack of Funds: Government subsidies inputs such as seeds and fertilisers but the quality are questionable, the subsidies do not go directly in the farmers› pockets. Lack of Funds to buy equipment, storage facility, and good quality seeds results in damage to crops, failure to harvest in time. Farmers cannot avail loans from banks as their crops cannot be insured due to high level of risk, this leads to farmers taking loans from loan sharks at a high-interest rate when they are unable to pay, the loan shark usurp their land.

Supply chain & Intermediaries: There is a complete lack of transparency in the supply chain, the farmers lack awareness of market demands and pricing and the intermediaries dictate the pricing. This leads to the farmer getting paid poorly for his crop, while the intermediaries make the most of it.

Climate & Weather Conditions: Weather is not always the farmer›s friend, especially in Africa drought is a yearly occurrence in many parts of the continent. Inadequate or poor distribution of rainfall, erratic weather conditions, drought, floods all take a toll on the farm produce and in turn on the farmer's livelihood. Additionally, lack of irrigation facilities complicates the matter further.

1.1.5 Financial

As seen in the above agricultural example and many others the basic problem in the African financial world is a lack of trust. The poor farmers, microbusinesses and SME do not have credible identities, they have no collateral against which loan can be acquired. Those who do have some sort of collateral lack the education to manage the acquired funds, to use them for the right purpose and to make provisions to pay back the loan.

1.1.6 Educational

The continent currently needs the digitisation of student information in verifiable formats that can be used by required organisations or students in job applications and higher education. There is a need to also safeguard students against loss of certifications through fires or natural disasters etc.

2

Blockchain Technology

2.1 Introduction to Blockchain

"The blockchain is an incorruptible digital ledger of economic transactions that can be programmed to record not just financial transactions but virtually everything of value".[7] Indeed this is a revolution to reckon with. Blockchain technology is a formidable yet leaning towards the mainstream in 2020. Historically it was meant to facilitate financial transactions, move digital assets in a transparent, secure, and tamper-proof way. This technology has proven its might to transform industries worldwide regardless of its initial application in the financial world; it is now applicable across all businesses and industries, supply chain, logistics, identity management across various industries such as education, agriculture, recruitment etc.

2.2 A Brief History

As depicted in Figure 3 below, blockchain technology was introduced to the world by Satoshi Nakamoto (a person or group of people, identity unknown) who created the bitcoin cryptocurrency on the underlying technology a blockchain platform, after releasing the bitcoin white paper in 2009. In the past twelve years, this blockchain platform has not only supported the trading of bitcoin cryptocurrency but unleashed to the world the power of the underlying Blockchain technology, in terms of being able to digitally transfer value in the form of crypto assets.

In **2013**, Vitalik Buterin released the ethereum white paper which proposed the creation of a blockchain platform that enabled anyone to create applications that facilitate the transfer of information and value between individuals on a public or private decentralised application platform. He also introduced "Smart Contracts" programmable software where real-world contracts could be drafted and executed. In 2015, the Linux foundation unveiled the open-source hyper ledger blockchain platforms which aim to improve the performance and reliability of current systems to support global business transactions. From here on, many versions of blockchain platforms have been created as people tried to improve the blockchain protocols and applications written to date.

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[7] Don & Alex Tapscott, authors Blockchain Revolution
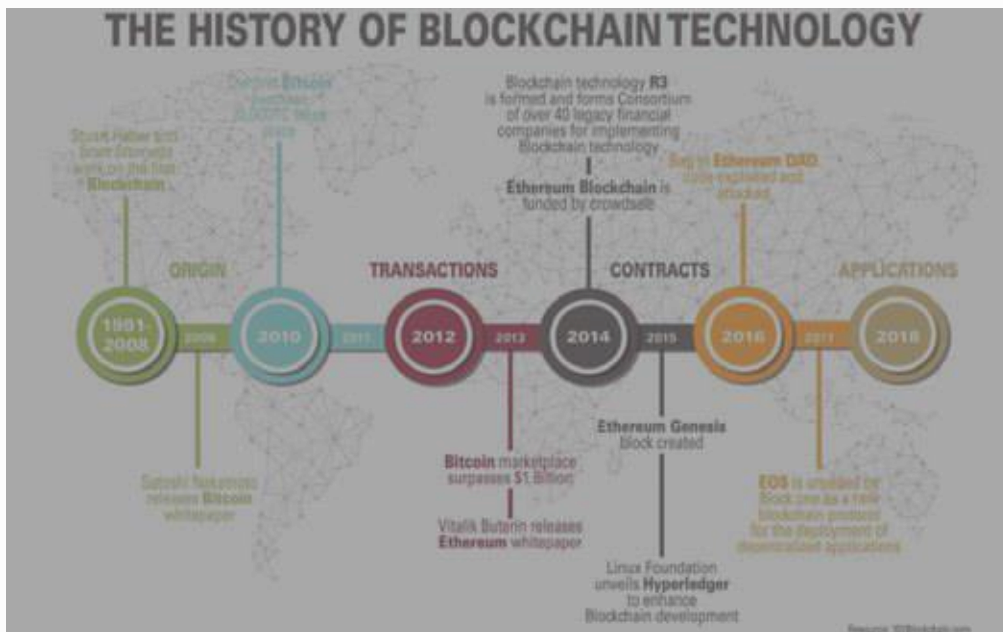
Figure 3 Timeline depicting the history of blockchain technology

Blockchain is the new wave of technology, also sometimes called the 4th industrial revolution that is analogous to the internet. Just as nobody could fathom e-Commerce becoming a reality with the Internet, in future, Blockchain technology will be known by the applications that are built on top of it. Similar to Google, Amazon, and Uber, today we mention the e-commerce applications and not the internet. Just like the internet is the underlying technology on which businesses were built to transact, so also blockchain will be the underlying technology on which decentralised applications will be built.

2.3 Blockchain Technology Overview

Blockchain technology is a shift in paradigm from the plethora of technology architectures we have dealt with so far in the business and commercial environment. Blockchain technology has disrupted some of the crucial age-old business paradigms, e.g., banking, and financial services industry. The new business model eliminates the middleman, such as the clearinghouse and the correspondent bank, reduces time from days in making cross-border and international payments to minutes. It also reduces the costs of payments and settlements. When technology disrupts it is here to stay.

2.3.1 Some Disruptions Worth Remembering

The motor car replaced the horse cart and disrupted the transportation industry for good. Similarly, before the advent of the internet and email, people wrote physical letters for communication, technology disrupted the mode of communication, so much so that the postman's job became redundant and luckily for him, another disruptor came along, the courier service, which changed the way parcels were transported, which offered him the opportunity to transport parcels.
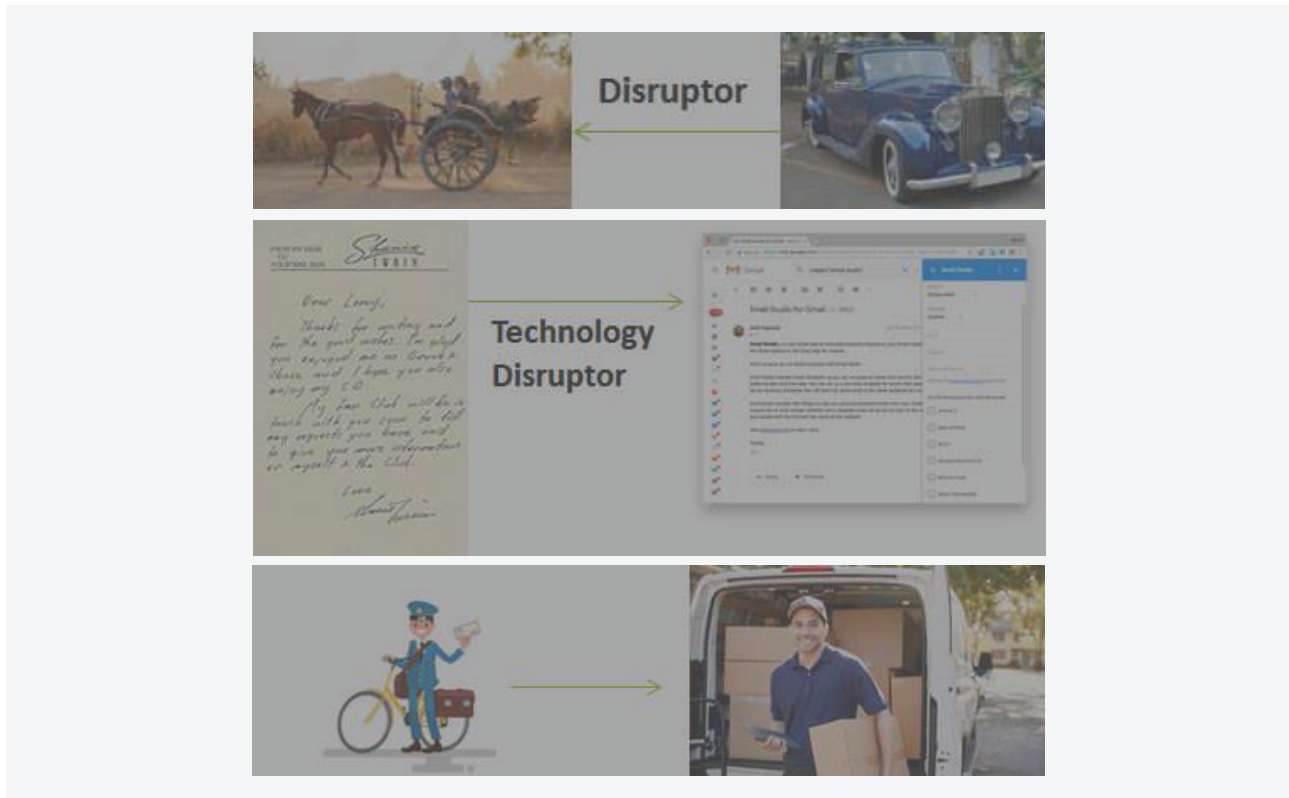
Figure 4 Some disruptions worth remembering

Blockchain technology is disrupting all industries and their business models, financial services, agriculture, supply chain & logistics, education, government, governance, risk, and compliance, healthcare, and many more through the following five trends, which are depicting this disruption, are:

· Digital Identity
· Track and Trace
· Auditing
· Peer to Peer (Direct transactions, eliminating the middleman)
· Cross border payments and settlements

2.3.2 Why is it Called Blockchain?

The blockchain ledger on any node consists of transaction data stored in blocks as shown in Figure 5. Blockchain is a combination of the following two concepts:

Block: A block contains a piece of data e.g., a financial transaction or a land registry record. A block also stores an identification code also called a hash; of the data it contains. Think of the hash as a cryptographic string that uniquely identifies the data (like a fingerprint). If the data is changed, the hash is automatically recalculated (changed).

Chain: Each block follows another preceding block, and it is interconnected through a sequence of identifiers or pointers that point towards the previous data block. This chain allows for integrity to be maintained between blocks and if there is foul play it can be rendered invalid so further tampering can be avoided.

2.3.3 How does Blockchain Work?

Blockchain is a decentralised system with no central authority like a clearinghouse or a correspondent bank as in the traditional centralized banking system. The blockchain's working can be understood with the help of a banking example: In an international funds transfer situation, when a person does transfer to another person across the border, the transaction is first validated at the clearinghouse, then forex department sends the funds to their correspondent bank who in turn transfers it to the correspondent bank of the beneficiary and finally it reaches the actual beneficiary's bank. The whole process involves a few days and a lot of charges.

On the contrary, a blockchain system is peer to peer and money is transferred instantaneously (in minutes) with minimal charges. So long as both beneficiary and sender are on the same Blockchain and have access to their respective e-wallets. As shown in Figure 5 below, here is an example of how blockchain executes transactions. A bank transaction of remittance is used. So, when a sender in South Africa, requests a transaction on the network through his blockchain app to send 100 USD to his peer in Ghana, that request is broadcast across the network, certain nodes (computers) validate the transaction using a consensus algorithm. When the transaction is validated, it is added to a block along with other simultaneously occurring transactions and the ledger is updated with the beneficiary receiving money in his wallet. Finally, the block is added to the blockchain, and it is available permanently as a record.
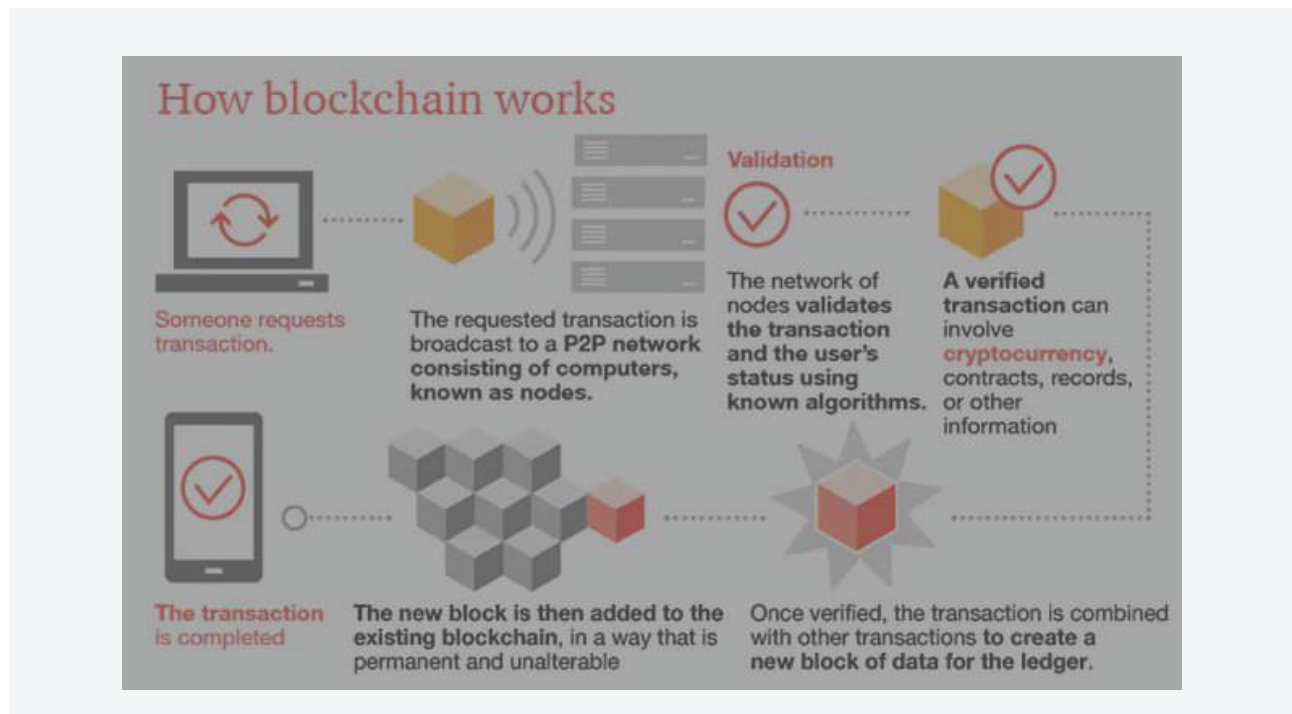
Figure 5 How blockchain works- Source: Courtesy PWC

2.4 Understanding Blockchain Technology

Technical topics are hard to fathom and harder to simplify without losing their meaning. This section is a sincere endeavour to make it easy to understand. In blockchain technology architecture, the ecosystem is first explained for better understanding of its placeholder in the technology domain, so-called, a bigger picture, followed by a simplified understanding of its internal working.

2.4.1 Understanding Blockchain Architecture

A detailed explanation with examples will follow on understanding the blockchain, how does blockchain work? Why is it different from traditional database technology? Why is it called Blockchain? The section begins with the high level (Bigger Picture) first, then drills down into the nitty-gritty details.

2.4.1.1 The Traditional Database Architecture

In Figure 6 below, the traditional database (client-server) architecture is shown as centralised, in which you have a central server connected to a number of computers. Data and some critical applications reside on the central server, when a user makes changes, example: A bank teller updates the general ledger when you withdraw or deposit cash, the update happens in the database on the server, so that central server is kept secure, only some people are allowed access to it and fewer people have access to the database on it. When you visit a branch and request for sending funds overseas, it requires a central authority to authenticate that you are the rightful owner of the account and have the required funds, you have requested to remit cross border.

2.4.1.2 The Blockchain Architecture

Contrary to the centralised architecture, blockchain technology uses decentralszed and distributed architecture. This means the Blockchain network is a collection of various computers and other devices to each other. In the same banking example, you can remit funds using a blockchain application directly to your relative across the border (PEER2PEER). You use an application with an e-wallet and so does your relative have an e-wallet. Your funds will be remitted in a few minutes to your relative, the can be minimal depending on who is hosting that application you are currently using.   No more waiting for a week, no charges and also more secure than bank remittances, fewer chances of fraud.
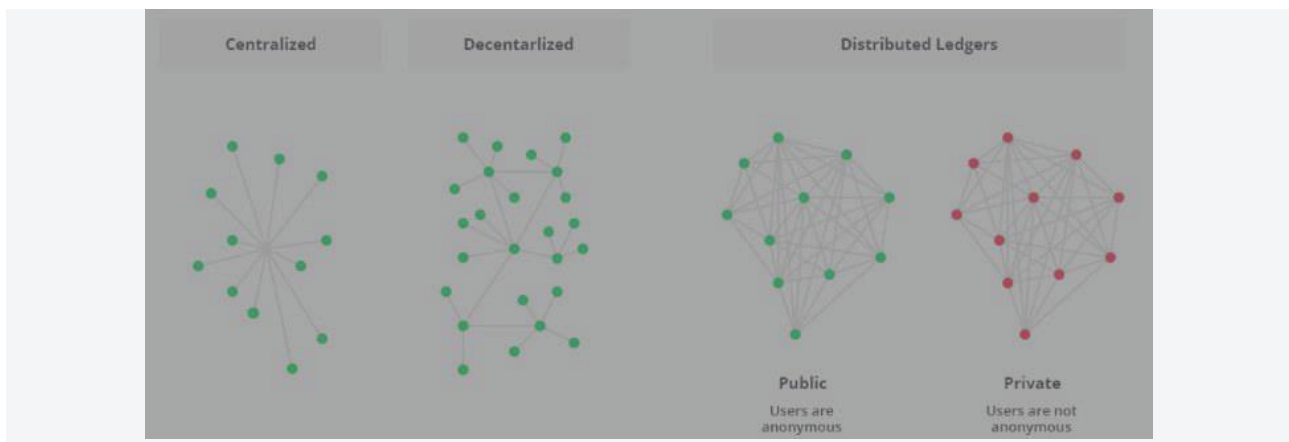
Figure 6 Traditional database of client-server

2.4.2 Concept of Data and Storage in Blockchain

Blockchain is a database or ledger of records for each transaction conducted on the platform. Any computer hat is added on the blockchain network is called the node and all transactions created on the Blockchain platform are shared to all of the nodes in the network, which means each node has a copy of the ledger. The data is stored in blocks, as shown in the following Figure 7 below:
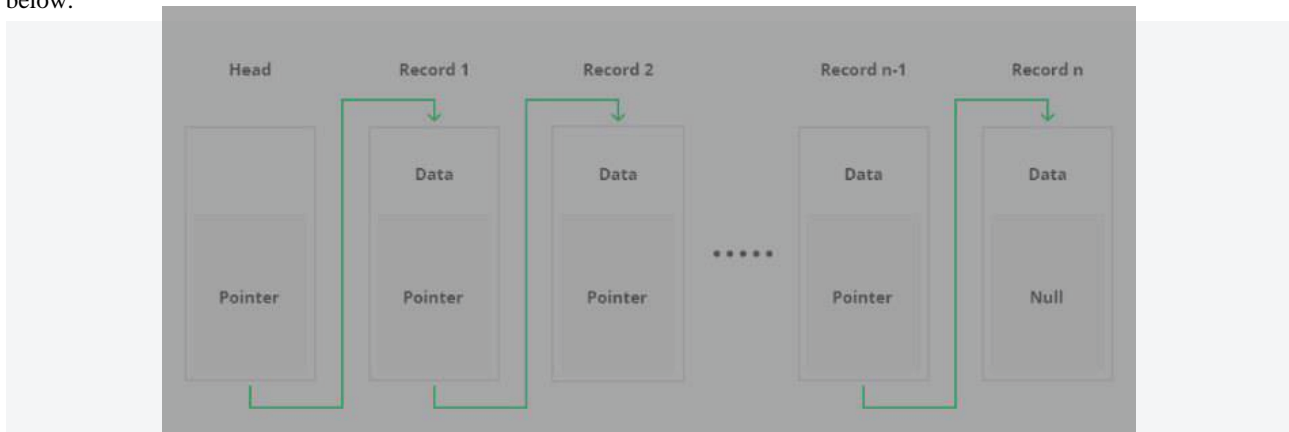
Figure 7 Blockchain ledger working

[8]The first block is the genesis block or the head block the subsequent blocks have a key or digital fingerprint of the previous block as shown in the grey area called Pointer, this is done to be able to reference the sequence of a transaction and find the root of where it began. Records of transactions are stored on these blocks as data in a compressed form.

A significant characteristic of this kind of data system is that you can only write to the database you cannot modify and delete the data once written, this makes it tamper-proof and difficult to manipulate. Example: If you go to the bank and would like to change your physical address, the old address will still be there and the new address will appear as a new address in your record. Even if you wish to delete the old address it is not possible with the blockchain system. This is a perfect solution for farmers and land ownership. It is a well-known fact that corrupt officials in the land registry office can manipulate the database and delete the farmer's name from the land he owns. So, in a nutshell, you can write a record, to modify a record, you create a new one and the old one stays for future reference. The record contains the date and time stamp of when it was created, which is an audit trail for all records and since the record is shared to all the nodes in the blockchain network it is extremely difficult to manipulate.

2.4.3 More on Distributed/Decentralised

When a computer connects to the blockchain as a participant (node) (as opposed to as a user of the blockchain application), a copy of the blockchain programme and data gets downloaded onto the computer and the computer is synchronized with the latest data and automated rules of the blockchain.

Blockchains are decentralised (figure 8) in nature meaning that no single person or group holds the authority of the overall network. While everybody in the network has a copy of the programme and data, no one can modify it on his or her own. This unique property of blockchain allows **transparency** and **security** while giving power to users.
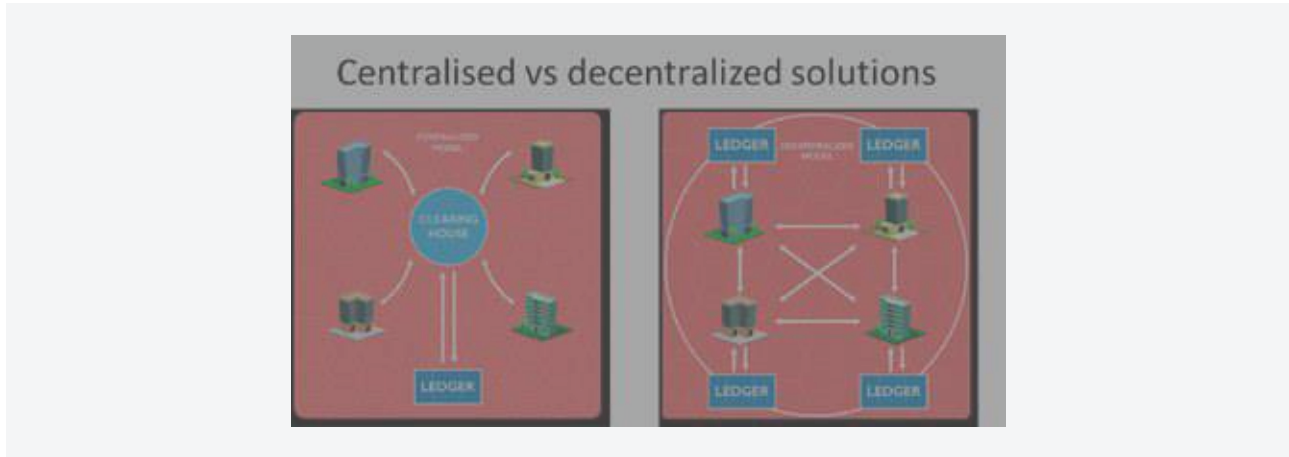
Figure 8 Depiction of centralised vs decentralised

2.5 Features of Blockchain Systems

A piece of technology becomes successful when more and more people use it for useful purposes, such as email, or internet. e-mail- enabled electronic communication was instant, and it disrupted the postal services. Similarly, internet-enabled e-commerce created a parallel universe of commercial activity, from books to hairpins to cars and houses. It also boosted the supply chain activity to create door-to-door delivery systems for the purchased goods. Case in point is Amazon, Google, and UberEats etc. Blockchain is the future or one such disruptive technology which will change the way business is conducted. It will change age- old traditional practices, processes, and ways of working, into a super-fast, efficient, and cost-effective mechanism of conducting the very same business. This is evident from the superior features and functionality provided by blockchain, some of the key features are as follows:

2.5.1 Immutability

The immutability property of a blockchain refers to the fact that any data, once written on the blockchain cannot be changed. An attempt to change the data of one block requires a change to the entire blockchain following it as each block stores the hash of its preceding block. This is a complex process.

On public blockchains, more than 50% of the participants (nodes) must agree with the required change for the remaining nodes to be updated with the latest longest version of the Blockchain. This is impractical on public Blockchain because public blockchain has thousands or even millions of nodes run by unrelated people. Collusion is, therefore, more likely to happen on a blockchain network in which most participants know each other.

For this reason, the data stored in a blockchain is not susceptible to alterations or hacker attacks due to immutability. The inability to change a transaction on a blockchain requires the correction of mistakes to be rectified in a new transaction after mistakes are discovered.

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[8] Source: Courtesy MLDEV.COM

2.5.2 Transparency

The use of blockchain started with cryptocurrency networks such as Bitcoin, therefore financial integrity was of paramount importance to build a trustless system. By its design, transparency and integrity are built into the blockchain. As mentioned earlier in the document, participants of the blockchain network must conform to the rules of the solution according to the permission they have been granted. Automated rules result in any suspicious transactions being rejected.

As each transaction occurs, it is encoded into a block of digital data and uniquely signed. Records added to the blockchain remain linked in a unique chronological chain that will not allow for the insertion of additional blocks between existing blocks. Blocks cannot be lost, changed, or deleted without the consent of the majority of participants. It is therefore highly transparent and incorruptible; providing a clear audit trail of every record added.

2.5.3 Security

Blockchain security is multi-layered, in a blockchain solution, security can be implemented at various levels as shown in Figure 9:
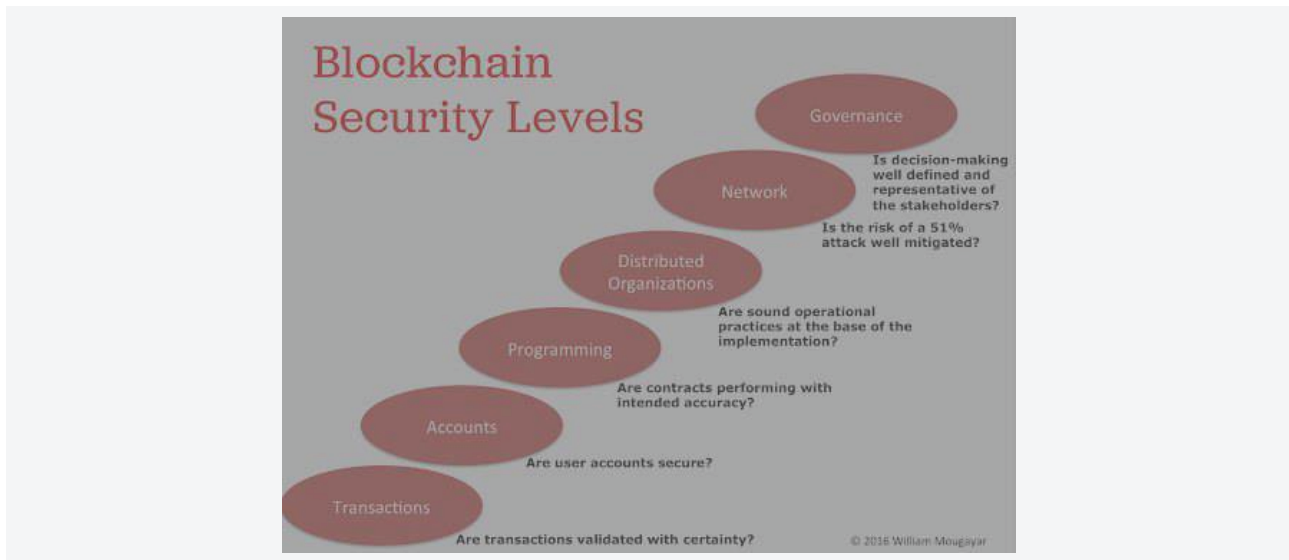
Figure 9 Blockchain security levels

Blockchain security comprises many elements; however, three main features that make blockchain a very secure and robust technology are the concepts of consensus, cryptography, and immutability. Consensus refers to the ability of the nodes (computers) within a distributed blockchain network to agree on the true state of the network and on the validity of transactions. This process uses mathematical algorithms that are tamper-proof and are set to establish the validity of the transactions before they are posted to the blocks. Immutability, we have mentioned earlier, on the other hand, refers to the ability of blockchain to prevent alteration of transactions that have already been confirmed. Cryptography is inbuilt in the blockchain system, each transaction in the block is coded with a unique identifier, such as a private key, a password, or a fingerprint (Hash) which cannot be altered. These three aspects provide a framework for data security in a blockchain network making blockchain security formidable and trustworthy.

2.5.4 Auditability

According to Kevin Black (Digital Audit Leader - Deloitte), some publications have hinted that blockchain technology might eliminate the need for a financial statement audit by a CPA auditor altogether. If all transactions are captured in an immutable blockchain, then what is left for a CPA auditor to audit? The blockchain network creates an audit trail since data is tamper-proof and cannot be altered, it is deemed reliable, and an audit involves an assessment that recorded transactions are supported by evidence that is relevant, reliable, objective, accurate, and verifiable. The acceptance of a transaction into a reliable blockchain may constitute sufficient appropriate audit evidence for certain financial statement assertions; the reason for this is also there is no scope for manipulation, human error or mischief like in traditional database systems.

2.5.5 Provenance and Traceability

In today's world more consumers expect transparency in food safety; they expect to know where the food they purchase originates from and how it reaches them. This said, there is a need for provenance (origin) and real-time traceability of products within global food supply chains. Blockchain has been increasingly gaining market traction in supply chains—for example, in proofing product provenance and implementing track-and-trace of products through the supply chain.

Today products have to traverse an increasingly complex supply-chain before they reach the end customers. Given the increased number of participants, the number of handovers involved, and a multitude of transaction recording systems, it is difficult to establish product provenance and product quality traceability for assurance or audit purposes.

While most product categories are under pressure to deliver on the above, the need to do this for perishable and/or temperature-sensitive products (like food, pharma, etc.) is the highest. By integrating blockchain with IoT (Internet of Things) solutions, product provenance and quality traceability for food and pharma products can be established.

Figure 10 below shows provenance (product origin) to reaching the retail or ordering online of the finished product, e.g., pre-packed mango smoothie, the mangoes are produced in India, harvested, processed in a plant to make pulp, packaged and filled in labelled bottles, thereafter, shipped to the destination in freezer trucks which control temperature, until they reach the final destination, a retail store or a consumer's hands. This entire supply chain can be traced and tracked using a blockchain system.

Figure 10 Inner workings of blockchain in tack and trace Source: Courtesy Sensiwise

2.5.6 Consensus-Mechanism

Consensus mechanism or protocol is a process within the blockchain network that enables the designated network nodes to validate transactions using complex mathematical algorithms which are inbuilt into the system. The validation process in this decentralised network eliminates the need for a central authority or a point of control to validate the transaction. Example: in a banking scenario for all international remittances, the clearinghouse and correspondent banks validate transactions. These are central entities and therefore charge fees and delay the process. In the decentralised blockchain system, the decentralised network and cryptographic consensus enable effective and efficient ecosystem collaboration.

2.6 When to use Blockchain technology?

Blockchain has the following inherent features that make the technology very significant in making efficient and automating certain processes:

·   Immutable (records cannot be deleted or changed only rewritten to a new block);
·   Unhackable (inherent cryptographic security, no central authority so difficult to hack);
·   Transparent (trustless), does not require a centralized authority to validate transactions like the clearinghouse hence transactions are peer to peer in a distributed environment; and
·   Auditable (audit trails are maintained forever, records can be traced to their origin or provenance).

Based on the above features, many proofs of concepts, use cases and production case studies have been researched, developed, and implemented by industries and are currently in the process of commercialisation.

2.6.1 Track and Trace

Every transaction stored in the blocks are eternally available, therefore based on a unique identifier, if a record is accessed you can query the entire history of the record since its origin. This helps in preventing fraud, establishing ownership of titles, managing identities and medical records, will show a patient's medical history from every hospital he has visited. E.g. in a flower exports market, if tulips are being exported from the Netherlands to the USA, the supply chain goes through a chain of transporters until goods are delivered to their destination. The transporter is contracted to maintain a constant temperature of 14 degrees, in his vehicle, to ensure that the tulips survive. The use of blockchain smart contracts can monitor the temperature and provide action, such as providing a penalty if products go fraught due to temperature changes.

2.6.2 Eliminating the Middleman

Blockchain enables peer to peer transactions in a distributed, highly secure, auditable environment, this enables direct interactions and transactions between buyers and sellers without intermediaries. This technology is taking the sharing economy to another vantage point. The last decade saw a proliferation of aggregator platforms (intermediaries) such as Uber and AirBnB, bringing consumers and suppliers together for a fee. Blockchain is about to change that by disintermediation so consumers and suppliers can directly transact with each other without the middleman. E.g., one of the largest travel and tourism companies the TUI Group has invested in a decentralised platform for travel bookings which will disrupt the travel industry.

2.6.3 Availability

In blockchain, there is no single-point-of-failure since it follows a decentralised architecture. As a result, in comparison to centralised systems, it provides for higher availability. In centralised systems, if the system goes down, the availability is completely lost for all the parties. Whereas in a blockchain system, the node may go down, but the system is available to other nodes and any transaction recorded on the system will be available from every node on the blockchain. When your business always requires the availability of the system, e.g., to register a title deed in the deeds office. Any node can be used to register the deed if the entire system is not down and some nodes are functioning in the office, or in the blockchain network which could be functioning outside the office. Blockchain solutions can be successfully built using the intrinsic features as mentioned above.

2.6.4 Trust

Blockchain is a good candidate for trustless systems where the middleman can be dispensed. E.g. the music and film industry is mired by copyright protection issues as well as monetary compensation issues. The artists and musicians get paid very little compared to the intermediaries hence, Imogen Heap, singer-songwriter uses a blockchain platform to upload all her music and fans purchase online directly. This is possible since there are no middlemen involved and every party can see the data in the blockchain, it provides more trust between the participating parties. In a centralised architecture, your traditional database systems, E.g. when you use net banking, you have to trust your bank that they will send the funds to your friend whose transfer you have initiated. If your bank defaults, you can't really do anything.

2.7 When not to use Blockchain?

2.7.1 Blockchain Requires an Ecosystem, it cannot Function in Isolation

Blockchain is a good candidate for processing transactions across multiple organisations, across multiple stakeholders who work together to achieve a common goal. That means that blockchain is the best solution for any process where you require disintermediation, have zero trust, and need cryptographic security. Similarly, when it comes to smart contracts for automating decision-making, it works best where external stakeholders are involved, be it customers, suppliers, partners etc. otherwise for internal use of an organisation, artificial intelligence is sufficient with traditional systems.

2.7.2 Blockchain is Inefficient for Heavy Customisation

Blockchain is not efficient when multiple transactions are taking place with constantly changing variables. E.g. if multiple parties are transacting over a platform with constantly changing data for each transaction, will require multiple smart contracts for each type of transaction and that can be daunting.

2.7.3 Blockchain, Scalability and Performance

Compared to relational databases, which are known for their performance, blockchain technology is still in its infancy and currently undergoing significant research, development, and improvisation in terms of scalability and performance. Blockchain has a decisive advantage over relational databases in terms of robustness, transparency, and security. E.g. VISA and Mastercard can process 5000 to 7000 transactions per second. Whereas blockchain can process only 7 transactions per second. Substantial increase in the speed of transaction is currently being experimented but the trade-off is its robustness, or a certain amount of centralisation required. EOS is a blockchain network where transaction speed of about 3994 transactions per second has been established however, at the cost of its decentralised feature.

2.8 Blockchain vs Distributed Ledger Technology (DLT)

Distributed Ledger Technology (DLT) as it is popularly called is a broader technology architecture that enables peer to peer (direct) transactions such as transfer of assets of any kind in a secure and transparent way. Blockchain uses the underpinning DLT technology therefore it embodies most of the features of DLT. DLT on the other hand is a broader definition of a peer to peer closed, permissioned network of computers that are connected and can facilitate transactions with each other. Blockchain is to DLT as Kleenex is to face tissue or PostIT is to sticky notes. In the following table, the blockchain platform – ethereum is compared to CORDA, which is a DLT platform, we compare the key differences and how they impact their application in the business (commercial domain).

Table 21: Comparison of features between blockchain and DLT

Blockchain vs DLT – Comparison of two Platforms

Features	Ethereum (Blockchain)	CORDA (DLT)
1. Consensus	At network level across all participants	Pluggable at transaction level
2. Permissions	Open Permissionless can be Set to Permissioned	Closed Permissioned
3. Blocks	Transactions stored on Blocks	Transactions sent to participants in any form
4. Privacy	Secure as everyone has a copy	More secure, limited stakeholder have access to records
5. Scalability	Due to consensus mechanism Transactions are slow less scalable	Scalability is higher due to Minimal consensus protocol
6. Crypto-currency	Ether	No Crypto-currencies Involved
7. Tokens	Empower token creation	No Token Capability

The reasons businesses and government are implementing "blockchain" technology and not a general "DLT" can be answered using three key features:

2.8.1 Permissions

The public blockchain has issues of energy consumption, latency, scalability issues due to the architecture and the consensus mechanism. This can be mitigated by the use of a hybrid blockchain architecture which means the platform will have a private permissioned blockchain (DLT Identical) and where required a public open permissionless blockchain.

2.8.2 Tokenization

Tokens are a store of value, historically traditional tokens were airline tickets, concert entrance, stamp on hand, money etc. In the digital world, tokens are also a store of value and are an integral part of the blockchain ecosystem. Tokens enable the exchange of goods and service and provide a secure platform to engage with customers in commercial activity.

Examples:

A farmer in Kenya signs up for a policy with a local insurer. The policy enables a contractual pay-out in case of drought conditions (Index-based Insurance). The conditions are set in the smart contract on a blockchain platform. The farmer signs up, pays his premium, and is offered tokens for the value of his pay-out. In case the drought conditions are met, the farmer exchanges his tokens for money. Either he can do it at once or as he desires.

Crowdfunding is a new business model to collect venture capital for business expansion, sometimes also known as ICO (Initial Coin Offering), investors interested in a venture will receive tokens for cash transferred to the venture's digital wallet. The token enables the investor premium interest on his funds. Just like stocks in a stock market. Since blockchain is a technology of choice for banks to support online lending and settlements/payments as it allows secure and transparent trusted payments. Therefore, Tokenisation is an important aspect of the blockchain ecosystem, and it is here to stay. DLTs do not offer tokens hence blockchain is an apt choice in terms of distributed ledger system.

2.8.3 Cryptocurrencies

The financial services industry is currently embracing blockchain as a preferred technology for payments and settlements. Cryptocurrencies or assets are a token of a store of value, they represent the actual fiat money. Bitcoin, Ethers etc. can be transferred digitally through e-wallets on a Blockchain platform, thereby facilitating peer to peer transactions without a clearinghouse or correspondent banks. This saves banks and users transaction costs and time. DLTs were designed for business applications not necessarily for financial transactions, for which Blockchain offers a proven value in commercial terms.

2.9 Decentralized Finance (DeFi)

Blockchain technology has ushered in many lateral sub-technologies which are currently spreading like wildfire and taking the world by storm. One such technology is called Decentralized Finance[9] or DeFi. Simply put DeFi is financial software built on a blockchain such as ethereum, it uses digital asset, financial smart contracts, protocols, and decentralised applications (DApps). The advantage of DeFi is the transparency and speed of financial transaction such as lending (loan disbursements), investing (crowdfunding) all this is independent of banks. It is a retail system which is currently offering the potential to transform and democratise access to financial services worldwide. The objective of the DeFI systems is to give the user complete and total control of their assets. Anyone can store, invest, buy, sell, trade, and take custody of their assets in a secure blockchain driven environment. The transaction costs are relatively lower, considering there are no intermediaries involved in the handling of assets.

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[9] Decentralized Finance (DeFi) Webinar with Blue Swan (2020) https://berchain.com/2020/05/decentralized-finance-defi-webinar-with-blue-

Figure 11 DeFi ecosystem - companies offering services[10]

In a DeFi ecosystem, you have various stakeholders who contribute towards a robust decentralised financial system offering diverse services, sometimes on their own and sometimes in conjunction or collaboration with others. E.g. infrastructure providers, credit/lending, KYC Platform, Insurance, capital markets, investment marketplaces, custodial services, and payments. Figure 11 shows various start-ups and other mature companies who are involved in DeFI systems.

2.10 Blockchain Cryptocurrency Exchanges and Trading

Interest in cryptocurrency, a form of digital currency, is growing steadily in Africa. Some economists say it is a disruptive innovation that will blossom on the continent[11]. Cryptocurrency is not bound by geography because it is internet-based; its transactions are stored in a database called blockchain, which is a group of connected computers that record transactions in a ledger in real-time. So, what is the difference between, fiat currency, Visa or Mastercard? The difference between cryptocurrency and, say, Visa or Mastercard, is that a cryptocurrency is not regulated by government, you do not need brokers to intermediate a transaction, the investor relies on the internet, which means the transactions can happen anywhere in the world. The big cryptocurrency global brands include bitcoin, Litecoin, XRP, ETH, dash, lisk and monero, but bitcoin leads the pack in Africa.

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[10] Image credit https://www.theblockcrypto.com/

[11] Crypto Usage and Trading Surging in Africa, Exchange CEO Says (2020) https://cointelegraph.com/news/crypto-usage-and-trading-surging-in-africa-exchange-ceo-says

The reason for the resounding success of crypto and spurring its growth on the continent is perhaps the lack of regulation; however, there is no guarantee that governments will not change that in the future. The Nigerian central bank indicated recently, currently tackling the country's 12% inflation rate, the Nigerian apex bank announced that it could not control or regulate bitcoin, "just the same way no one is going to control or regulate the internet. We don't own it."

The political instability, high inflation rates and a fear of the collapse of the banking industry or arbitrary appropriation of money by the government, the unbanked Africans could be attracted to cryptocurrency. "Bitcoin transactions help to eliminate the procedural bottlenecks that plague traditional banking and financial services," Mr Darko explains. Crypto usage and trading have made its way over to Africa, gaining prevalence all over the continent, according to Chris Maurice, CEO of Yellow Card — a crypto exchange based in Lagos, Nigeria. The crypto has soared in the continent, and specifically in Nigeria, South Africa, Ghana, and Kenya,» there is a good chance of expansion to the rest of the continent, but South Africa–based Luno Exchange, established in 2013 and now boasting 1.5 million customers in over 40 countries worldwide, is the first to be based in Africa.

Cryptocurrency exchanges are good for trading currencies as well as they can be used as a tool to affect cross border payments. Retailers and industries can accept bitcoins and other tokens or cryptocurrencies for buying and selling goods and services. The third most important use case of cryptocurrency is Fintech, banks and insurance can use the crypto as collateral for lending instruments.

The adoption of cryptocurrencies is notably arguable, the reason is at 22% (the world average is 48%[12]), and Africa has the lowest rate of Internet usage of any region, according to a 2017 report by the International Communications Union, which may undercut optimistic projections of cryptocurrency and blockchain technology on the continent. Also, poor power supply in many countries continues to impede internet access on which cryptocurrency largely depends.

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[12] Africa could be the next frontier for cryptocurrency (2020) https://www.un.org/africarenewal/magazine/april-2018-july-2018/africa-could-be-next-frontier-cryptocurrency

3

Blockchain Applications & Opportunities

In the first chapter, various challenges within the African governance context were elucidated, especially in five crucial areas of government, agriculture, finance, education, and healthcare. Blockchain offers key applications that cut across all the above-mentioned business areas, as well as provides opportunities to build customised applications that complement the key areas of businesses. The following sections elucidate some use cases, listed according to the five key applications i.e. identity management, digital asset storage and access, track and trace, cross border payments and smart contracts. Each use case signifies the importance of these for a specific industry or business and how each of these use cases can be applied in other industries and businesses to mitigate the challenges described in the previous chapter.

3.1 Blockchain Applications

Blockchain is a distributed ledger that records transactions, allowing entities who are total strangers to establish trust, while transacting without any central authority. The Blockchain ledger is immutable, auditable, secure, unhackable and transparent. Enterprises are developing and using proof of concepts (POCs) in asset tracking, payments and settlements, smart contracts, trading, voting, shared record-keeping, digital tokens, claims, provenance, copyright protection and loyalty rewards programmes. According to Garter (a research firm),[13] their survey in 2020 shows that 60% of CIOs in its report, across various industry sectors, expect some adoption of Blockchain in the next three years.

Figure 12 Gartner›s hype cycle for blockchain in 2020

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[13] Gartner sees blockchain as top tech trend for 2020 (2020) https://www.ledgerinsights.com/gartner-sees-blockchain-as-top-tech-trend-for-2020/

Currently, there are industry verticals building proof of concepts and real-life solutions in Blockchain of which 46% are related to financial services, whereas the remaining 54% include manufacturing, insurance, healthcare, transportation, utilities, retail, and government. Of which a staggering majority are in utilities and supply chain (manufacturing & logistics)

The spread of use cases are as follows:

· Asset tracking: Transportation and government;
· Record keeping: Utilities, healthcare, and insurance; and
· Provenance: Retail and securities trading.

3.1.1 Digital Identity

The mechanisms of blockchain enable the digitisation of identity which looks promising in terms of streamlining administration for citizens as well as public and private sector organisations. Some blockchain solutions that address this are Sovrin, Uport and Civic. The magnitude of the identity challenge is recognised by public sector actors around the world—a world in which one-fifth of the world's population lives without a legal or officially recognised identity. This automatically excludes them from participating in public services and the economy at large.

On the internet, it is not easy to know if the person on the other side who is they say they are. The use of an improved digital identity has been enabled by blockchain whereby people own and manage their own data and consent to sharing their data with other people or organisations.

The digital identity facility offered by blockchain (figure 13) establishes trust between data owners, such as farmers, patients, citizens, students etc. when they interact with trusted entities like governments, hospitals, universities etc. where their credentials can be easily verified by the receiving party, e.g., verifying if the patient has any allergies (hospitals) when a patient goes to an unknown doctor of another city. Another example would be a person goes for a job interview and the interviewer verifies his degree certificates and other credentials (preventing fraud). This access to identities and data owners will lead to efficiencies, quicker responses and prevent fraudulent transactions, however, it will need regulation to be reviewed in terms of the use of digital credentials.
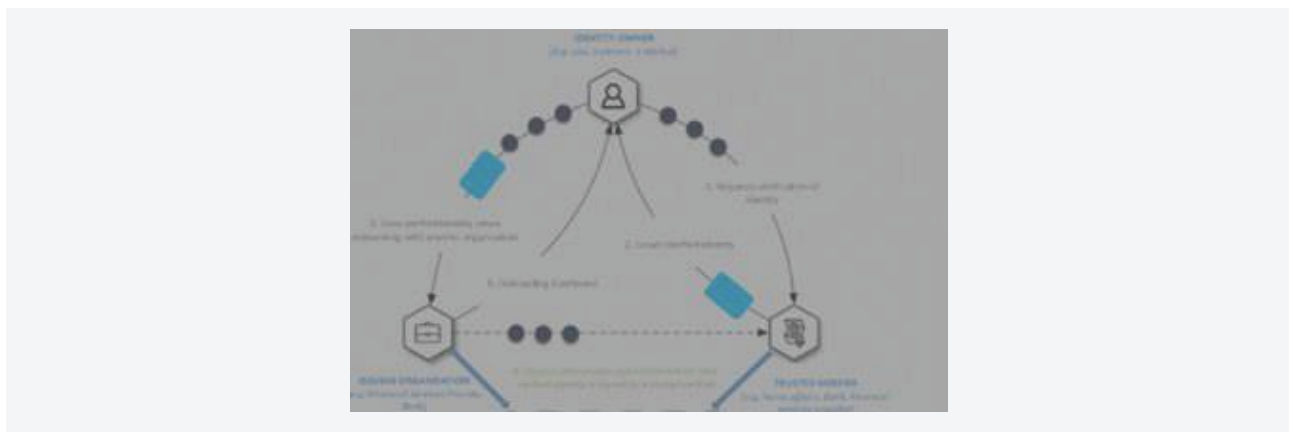
Figure 13 Concept of blockchain-based identity

"The world wide web consortium is standardising the format of issuing and verifying digital credentials. This is how blockchain is enabling the use of trusted digital identity information to improve the management of national identity records whilst maintaining privacy. The figure below depicts how blockchain-based digital identity system helps in shortening the process of onboarding a customer, e.g. when a person tries to open a bank account with a new bank, the person signs a request to verify his identity. Once the bank officer verifies his identity, he can immediately complete the transaction (of onboarding) without the need for an ID document, similarly, if a patient is travelling across borders and needs emergency medical attention his identity on the blockchain will also show his medical records with allergies, medical conditions that are vital in administering medicines by the unknown doctor in a foreign country, preventing mishaps.

3.1.2 Secure Storage and Access

Blockchain technology offers security, transparency, and immutability (incorruptible) data storage and access capability. Digital Identities, as seen in the previous section, are a possibility due to the Blockchain secure data storage and access function. Compared to traditional centralized cloud servers like Amazon or Google Drive, blockchain-based decentralised cloud storage has a number of compelling advantages[14].

a. **Security:** Blockchain creates a secure transmission of data. Files are encrypted with private keys, which make it impossible for anyone without the key to access the file. Files are also divided into pieces to be kept on multiple nodes so that there is no single point of failure. If a centralized server breaks down, you'll probably lose access to your data.

b. **Immutability:** Since there is no central authority, no one can take away your file, restrict access or make amendments to it for the sake of censorship. The file's private key (hash) is kept in the ledger;

c. **Lower price:** While centralised cloud storage products like Amazon S3, Google One and Dropbox offer 1 GB of space for
$0.023, $0.02, and $0.005 per month, respectively, their competitors using blockchain have prices as low as $0.002.

d. **Rewards for storing:** Several decentralised cloud projects use Blockchain and native cryptocurrencies to incentivise users. Those who have spare storage space — unused hard drives, disks, data centres — can rent it for a reward. Blockchain cloud storage platforms connect users willing to share their storage space with the ones who need it, making it a win-win situation.

3.1.3 Track & Trace

Blockchain is a perfect solution for the process of monitoring logistics, be it transportation, goods in transit, optimum temperature conditions and to prevent theft and pilferage which is common in these processes.

Logistics is of paramount importance within a supply chain, it orchestrates the clockwork movement of goods to its desired destination. These processes are usually owned by third party companies, seldom by the manufacturer himself. There are two facets to logistics in a manufacturing environment, 1) inward bound, where raw material is sourced and delivered to the manufacturer. 2) outward bound where the finished goods are transported and delivered to the distributors and retailers.
Logistics is the best candidate for blockchain implementation. Firstly, there are multiple parties involved in the process of a manufacturing supply chain and there is ample room for fraud because of using paper-based logistics documents. Delays in logistics are due to paperwork and finally, tracking of goods and their condition is difficult as evidenced by counterfeiting, pilferage and contractual disputes which are all common occurrences in these events.

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[14] How Can Blockchain Improve Data Storage? (2020) https://cointelegraph.com/news/how-can-blockchain-improve-data-storage

Manufacturing Industry Supply Chain

Figure 14 Manufacturing industry supply chain

3.1.3.1 Applications that Enable Traceability of Records Linked to Digital Identities

Once digital identity is solved, paired with traceability, it will enable the reduction of fraud in various sectors through diverse use cases such as land registries, voting, education certificates, cash equity trading and fractional investing/ownership. These use cases can be implemented today using a different combination of technologies and centralised solutions with centralised record keeping. Digitising identity combined with these use case will greatly streamline administration processes resulting in more affordable services.

3.1.3.1.1 LAND

Land titles ownership, legitimacy and determining the validity is the biggest challenge as seen in agriculture example in the previous chapter. The farmers are often at a disadvantage due to lack of knowledge and blind trust in loan sharks. These being the reason, banks are not willing to loan or provide micro-credit; neither the insurance companies are ready to insure the credit for weather conditions and high risk of failure to pay by the farmer. Blockchain brings a huge relief by authenticating the title deeds in the farmer's name through the digital identity application, the banks and insurance are now coming forward to provide funds and insurance to smallholding farmers.
Bitland[15] is a Ghanaian NGO leading the charge in the use of blockchain to restore confidence to Land title owners in Ghana.

3.1.3.1.2 VOTING

Blockchain brings the much-needed cost and speed efficiency while preventing fraud, election rigging and other untoward political conundrum that follows due to trust issues post-elections. The high costs related to ballot printing, electronic voting machines, maintenance, etc. is greatly reduced due to the electronic platform;

Blockchain's ability to create transparency makes it a good fit for implementing a legitimate voting system. Citizens can cast votes the same way they initiate other secure transactions and validate that their votes were cast or even verify the election results. Potential solutions are currently working to blend secure digital identity management, anonymous vote-casting, individualised ballot processes and ballot casting confirmation verifiable by (and only by) the voter.

3.1.4 Cross Border Payments

Remittances, funds transfer and cross border payments[16] comprise the highest number of charges for the consumer and revenue for the financial services like banks. They are an important source of revenue among other sources. The Global Payments Report[17] revealed revenues from global payments amounted to $1.9 trillion, while transaction fee growth, luckily (for the consumer) stagnated as a result of competitive and regulatory pressures.
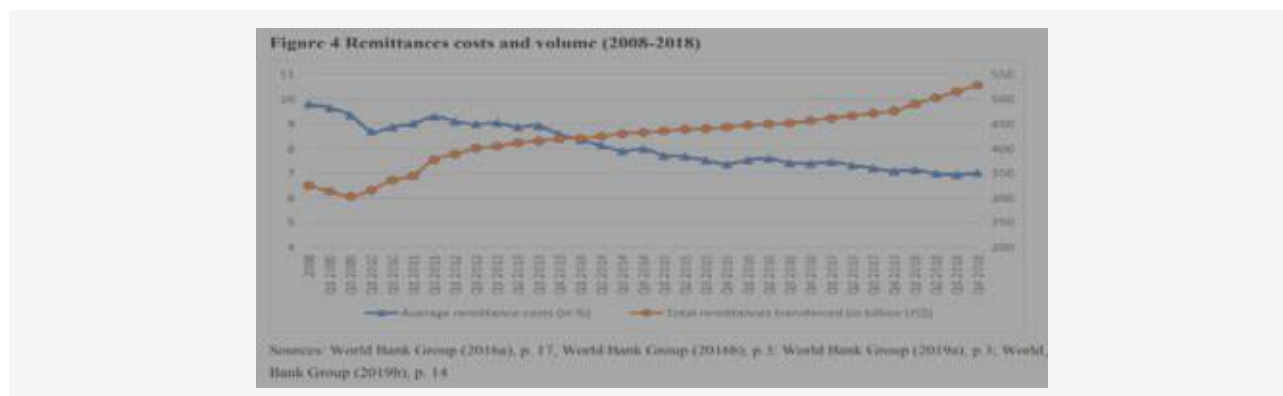
Figure 15 Average remittance volume in billion US$[18]

Source: World Bank Group (2016a), p. 17, World Bank Group (2016b), p.3; World Bank Group (2019a), p.3; World Bank Group (2019b), p. 14. The figure above shows the average remittance costs and the total remittances in billion USD. The report also asserts that, in contrast, the most expensive region to send money in 2016 –through 2018 was Sub-Saharan Africa, with an average cost of almost 10 per cent (World Bank Group 2016b, p. 1).

As per the World Bank (Report 2019b, p14), "Average remittance costs (in %) Total remittances transferred (in Billion US$), the poorest countries in Africa tend to display the highest cost of remittance; and secondly, the transfer costs of intra-regional or intra-continental remittances within Africa and some domestic remittance transfers are even higher than those of remittances sent from outside the continent to Sub-Saharan Africa (IFAD 2009, p. 3)".

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[15] http://landing.bitland.world/

[16] 6 Ways Blockchain will Disrupt Cross-Border Payments (2020) https://techmeru.com/blockchain-disrupt-cross-border-payments/

[17] Global Payments Report 2019: Amid sustained growth, accelerating challenges demand bold actions (2019) https://www.mckinsey.com/~/media/mckinsey/industries/financial%20services/our%20insights/tracking%20the%20sources%20of%20robust%20payments%20growth%20mckinsey%20global%20payments%20map/global-payments-report-2019-amid-sustained-growth-vf.ashx

[18] Migrant Remittances: Alternative Money Transfer Channels (2020) https://www.ipe-berlin.org/fileadmin/institut-ipe/Dokumente/Working_Papers/_i pe_working_paper_127.pdf

What is the reason? Firstly, the African continent is a smaller market size compared to the global market in terms of the global market with **$ 43 billion** of a total $ 667 billion transfers in the 2019 forecast (World Bank Group 2018, p.4). A second issue is the unreachable remittances to remote, rural areas which require a local remittance channel to fulfil the transactions, as outreaching remittances to clients in remote areas comes at some costs and finally, there are regulations for currency exchange and administrative costs which also add to the remittance costs involving the exchange of currencies.

3.1.5 Smart Contracts

Blockchain provides "smart contracts" to manage the multiple stakeholders enhancing information flow expeditiously. Track and trace through provenance (original location) is possible and can be fully automated using smart contract rules and conditions so the entire transportation chain can be tracked in real-time. No more delays in shipments and no more disputes in contracts. When sensitive goods are transported across county borders in a temperature-controlled environment, there is no way to track if the logistics company is taking care of the conditions as stipulated in the contract, however, with blockchain and integration of an IoT device such as the cooling data in the van/truck, if conditions are altered due to breakdowns, it can be easily automatically recorded thereby penalties can be imposed on the logistics supplier if goods get damaged.

Smart contracts[18] are software programmes that are stored on a Blockchain, the programme has terms and conditions based on which the outcome within the contract is executed. The smart contracts have changed the dynamics of blockchain adding unprecedented value to the business community, by automating mundane tasks, paperwork and fast-tracking the decision-making process. Smart contracts do away with intermediaries and also incorporate other devices to help in the decision-making process. Following are two examples of smart contracts on blockchain, these are working solutions. They can be referenced and understood for further deployment in other countries. What is the reason, smart contracts are popular and go hand in hand with blockchain technology? Here are some interesting facts which are being revisited:

- **Speed and accuracy:** Smart contracts are digital and automated, they eliminate paperwork, save time, since no data entry or writing is required, no reconciliation or corrections required;
- **Trust:** Smart contracts automatically execute transactions following predetermined rules, and the encrypted records of those transactions are shared across participants. Thus, nobody has to question whether information has been altered for personal benefit;
- **Security:** Blockchain transaction records are encrypted, and that makes them very hard to hack. Because each individual record is connected to previous and subsequent records on a distributed ledger, the whole chain would need to be altered to change a single record;
- **Savings:** Smart contracts remove the need for intermediaries because participants can trust the visible data and the technology to properly execute the transaction. There is no need for an extra person to validate and verify the terms of an agreement because it is built into the code;

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[19] Smart Contracts: The Blockchain Technology That Will Replace Lawyers https://blockgeeks.com/guides/smart-

Figure 16 Comparative chart[20] between traditional and smart contracts

3.2 Blockchain Use Cases

3.2.1 IBM Use Case

IBM Blockchain World Wire[21] provides banks with a Blockchain platform developed using their own technology such as Hyperledger Fabric, to simultaneously clear and settle near-real-time payments transactions across borders. IBM's blockchain-based real-time global payments network has begun rollout, with several banks also committing to issue their own stable coins on the platform.

Marie Wieck, GM, IBM Blockchain, says: "By creating a network where financial institutions support multiple digital assets, we   expect to spur innovation and improve financial inclusion worldwide."
Currently, the network supports settlement in Stellar Lumens and a US dollar stable coin. It has already enabled payment locations in **72 countries,** with **47 currencies** and **44 banking endpoints.**

According to IBM, it has signed letters of intent from six international banks ready to issue their own stable coins, subject to regulatory approval. The banks include Banco Bradesco, Bank Busan, and Rizal Commercial Banking Corporation, adding Euro, Indonesian Rupiah, Philippine Peso, Korean Won and Brazilian Real coins. Their current focus is on innovation that adds value for their customers, and "World Wire" presents an opportunity to transform and enhance the payment infrastructure.

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[20] 10 Use Cases of Smart Contracts https://www.devteam.space/blog/10-uses-for-smart-contracts/

[21] IBM gets banks onboard for blockchain-based payment system (2019) https://www.finextra.com/newsarticle/33548/ibm-gets-banks-onboard-for-blockchain-based-payment-system#:~:text=First 20 year IBM, time payments%20transactions across borders &text=It has already ena bled payment, currencies and banking endpoints.

3.2.2 Walmart Use Case

Walmart is the world's largest retailer, operating over 11,200 stores under 55 banners in 27 countries and e-Commerce websites in 10 countries. They employ approximately 2.2 million associates. According to Frank Yiannas, VP of Food Safety for Walmart, the proverbial Achilles heel for each retailer is "food safety". Walmart imports material from all around the world and exports finished goods, perishables, and prepared food through their supply chain worldwide. Every item of food has a shelf life and expiry dates, so food sourced from the farms and delivered to the consumer across the food chain is subjected to external elements such as temperature, weather conditions, handling conditions, hygiene etc. that determine how safe the food is for consumption.

IBM along with Walmart has developed and implemented a blockchain-based "food safety" solution for Walmart. This solution uses IBM;s own products hyperledger fabric, smart Contracts and Watson IoT, the artificial intelligence product to create a holistic solution recording every event in the logistics supply chain. E.g. from sourcing of mangoes from the farms in South America to the freshly cut mango on to the consumer's plate, the entire supply chain is recorded, the seed quality, fertilizers and pesticides used by the farmer, the date on which mangoes were picked, the transportation, refrigeration, customs, cross-border communication, warehouse receivables, processing, weather and temperature conditions, packaging and finally, delivery to the stores. For a detailed account please view https://www.youtube.com/watch?v=MMOF0G_2H0A

3.2.3 J. P. Morgan Use Case

In 2017, JP Morgan partnered with the Royal Bank of Canada in developing an Interbank Information Network (INN) through b Blockchain project that will create a conjointly accessible ledger across banks. Currently, the network of banks has over 400 (those who have signed a letter of intent to join), and they are now able to resolve problems that delayed cross-border payments, such as missing data and compliance checks. As more banks join the network, payment delays will reduce dramatically.

3.2.4 The Mediledger Project Use Case (Patient Identity Management & Tracking)

The Mediledger Project was started by Pfizer along with other pharmaceutical companies, in the United States of America, it is focused on providing "track and trace" capability to players in the pharmaceutical supply chain. Initial pilots have proven that a blockchain-based solution will enable compliance with the Drug Supply Chain Security Act (DSCSA) while improving operations and reducing the supply of counterfeit drugs.

The Mediledger Project uses blockchain technology to provide a solution to remove inefficiencies in the current healthcare and pharmaceutical systems; it is an open and decentralised network for the pharmaceutical supply chain that provides the following benefits:

· All patient's electronic health records are stored on the blockchain allowing the history of the patient's health to be shared with any hospital, clinic, or pharmacy with the consent of the patient as and when required, putting patient health first (identity management);
· Data is immutable and transactions are auditable showing compliance with improved security;

·   Barcoded drugs once passed through this supply chain, can be traced to their origin with its entire history enabling any counterfeit drugs to be identified easily and discarded;

·   Smart contracts enable electronic recording of all rules, terms, and conditions to protect patient privacy and payment contractual terms. The data is wholly in the company's control and they can share only what they want to share and who they want to share it with. For more details view: https://www.youtube.com/watch?v=Cxkjntn6F10.

3.2.5 Storage Use Cases

3.2.5.1 School/University Certificates and Transcripts Storage and Access

Blockchain can be used by any educational institution be they national or international, formal, or informal. As the educational system becomes more diversified, democratised, decentralised, and disintermediated, we need to ensure that reputation, trust in certification, and proof of learning is maintained. Blockchain has the potential to provide a massive open, online, secure database for educational systems. For instance, as of mid-October 2017, a hundred plus students at the Massachusetts Institute of Technology (MIT) will have a copy of their diploma stored on blockchain.

When students go to other universities for admission for other courses, they need to submit their certificates, qualifications and transcripts, the process of attesting certificates to prove authenticity and make it available to educational authorities is time-consuming and costly. Without a trusted system for verifying identity and certificates there is a possibility of fraud and sometimes results in acceptance of false information by the universities or organisations employing individuals.

The identity use case explained in the previous section, introduces us to the idea of digitising information that can be verified and reused by organisations. Blockchain facilitates educational institutions to issue digital qualifications and transcripts to students, into their identity wallets which may be reused when transferring universities or applying for jobs. The identity use case introduces data economy benefits to financial institutions who can now be paid when the digital transcripts and qualifications issued are reused by organizstions. Students will also be able to sell their data when participating in student surveys or when needing to share their education data.

The blockchain capability of data storage and access can be extended to recognise on the job knowledge and skills gained through a peer to peer issuing of digital references which could stimulate a market for the provision of goods and services.
The bursary and recruitment processes within organisations will now be able to make use of information issued for qualifications and transcripts by educational institutions without them having to contact multiple institutions during their recruitment process to verify the potential employee's certifications and credits.

Blockchain technology provides the opportunity for educational institutions to include this topic in their curriculum. In Russia, many universities have included cryptocurrency and blockchain in their curriculum. In Africa, the University of Cape Town started an MPhil degree specializing in financial technology and includes a final project that uses blockchain technology.

3.2.5.2 Certificates Verification

Blockchain, as an immutable, decentralised ledger of information can be used to store the digital signatures of academic certificates. Therefore, anyone with access to the distributed ledger can verify the authenticity of an academic certificate in real-time, and free from third-party interference.[22]

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[22] Note: Blockchain technology will have to be deployed along with digital information systems since it will only store the digital signatures of the records, which prove their validity.

If the digital copies (PDF's, Word, etc.) of academic documents were stored in the blockchain, the process would be expensive and inefficient. Instead, anyone who wants to verify the legitimacy of a digital record can simply vet the digital certificate against the signature held in the blockchain.

The blockchain solution will act as a central repository for academic certificates from institutions. Therefore, the main actors in this blockchain will be:

· Academic qualification agencies;
· Academic institutions;
· Professional bodies and associations;
· Accreditation agencies; and
· Other relevant stakeholders.

On the other hand, the end-users will be public and private organizations, hiring agencies, public institutions and many more.

3.2.6 Healthcare Use Case (Medical Health Records Management)

Blockchain will revolutionise patient health records by eliminating most of the weaknesses of even electronic records as we know them today. Electronic Health Records (EHRs) on blockchain will be accessible from multi-institutional sites, enable instantaneous update of information, improve the quality of research data, and render the records secure and interoperable.

Costs of healthcare are expected to be much reduced because the technology will reduce fraud and inefficiency associated with duplication of records and services, primarily because of the current silo-based systems. Further, smart contracts will speed up payment systems and enhance efficiencies of administration. Blockchain will enhance patient centricity, render life-long records portable across borders and enable patients to derive new income streams in the form of incentives when they adhere to medical treatment and when participating in clinical trials and other research.

The healthcare industry is mired with a bevy of issues, especially in developing countries. Regular management of chronic conditions, lack of patient medical health records for proper diagnosis and treatment, especially historical data of treatments, allergies etc., are not available resulting in the medical faux pas, wrong diagnosis, and treatment and even loss of life.

Digital Rajasthan is an initiative by the Rajasthan State in India which has pioneered fully automated, digital governance processes. Above all, they have used blockchain technology to create medical records so that patients can seek medical assistance within the state in any district hospital or clinic. Their history records are available to the medical doctors through the blockchain system. The entire state has captured essential services such as fleet management (ambulances, fire brigade, and refuse trucks), citizen services and agricultural services on their digital platform. Farming communities have their title deeds and ownership documents captured on blockchain facilitating ownership provenance[23].

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[23] Medicalchain Explainer Video - Blockchain Technology for Electronic Health Records (2017)

3.2.7 AXA Index-based Insurance Program

Travel insurance is popular and necessary in today's unprecedented times. This is more than necessary considering flight delays, causing business disruption and sometimes loss of income and loss in terms of the cost of journey. AXA[24] is an American insurer which has created a blockchain and smart contract platform that uses an index as a condition to navigate flight delays. The conditions are recorded on the smart contract and executed automatically when the flight is delayed by more than 2 hours. This system is integrated with the flight data system to access flight departure information and to calculate the delay. Pay-out is instant, directly from the claims department into the account of the traveler with no questions asked and no delay.

Figure 17 Flight delay insurance - AXA source:

The examples above follow a determined pattern or process within the blockchain system, the terms of the policy are defined between the counterparties, as shown in the figure below: the terms are hardcoded in the smart contract, e.g., percentages, conditions, terms of engagement, once the smart contract is signed off it stays permanently, it cannot be changed.

The next step is when an event stipulated within the contract occurs, the insurance policy is executed, and value is transferred automatically, without manual intervention, inspections, assessments etc. by the claims department. Pay-out is completed instantly and efficiently, through a settlement mechanism in the blockchain system.

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[24] AXA goes blockchain with fizzy (2017) https://www.axa.com/en/magazine/axa-goes-blockchain-with-
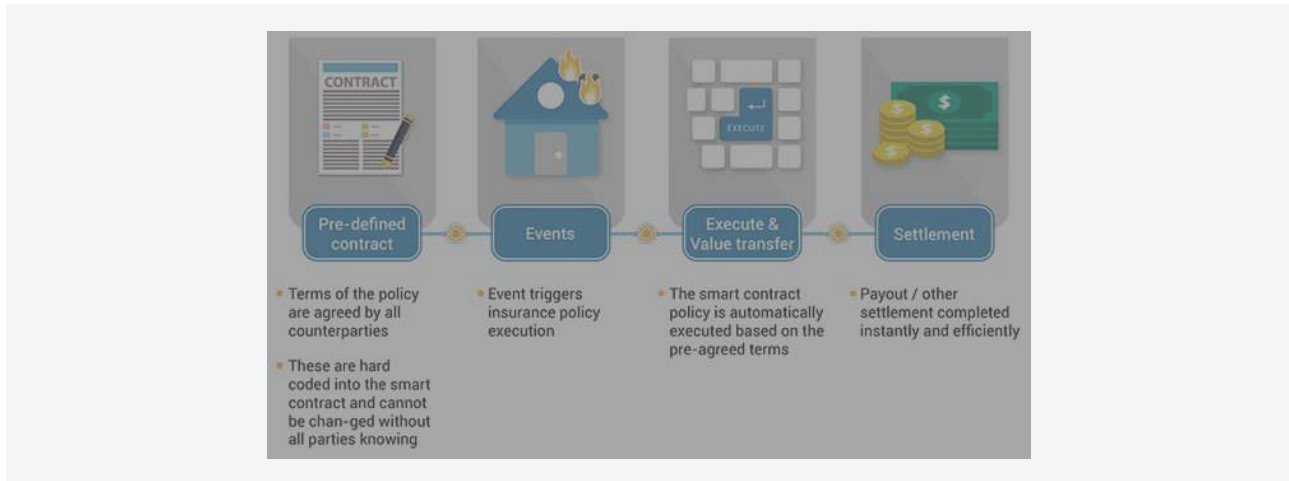
Figure 18 Smart contract execution process[25]

3.2.8 Kenya Transit Corridor – Qualifications Storage for Nurses

"Nurse in hand" is a pilot project on the eastern corridor of Kenya that aims to save lives on the road and ensure that accurate statistics related to road accidents are reported. The additional benefits of this use case are that it has the potential to provide rural communities along the route with skills to assist at accident scenes in their area. Proof of skills is required when requesting manpower from the communities. Proof of skills can be obtained and verified using the above-mentioned solution for issuing and verifying information. These skills now become tradable services within the community.

Figure 19 Nurse in Hand Kenya

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[25] 10 Use Cases of Smart Contracts https://www.devteam.space/blog/10-uses-for-smart-contracts/

3.2.9 Kenya Livestock Index-based Insurance Programme
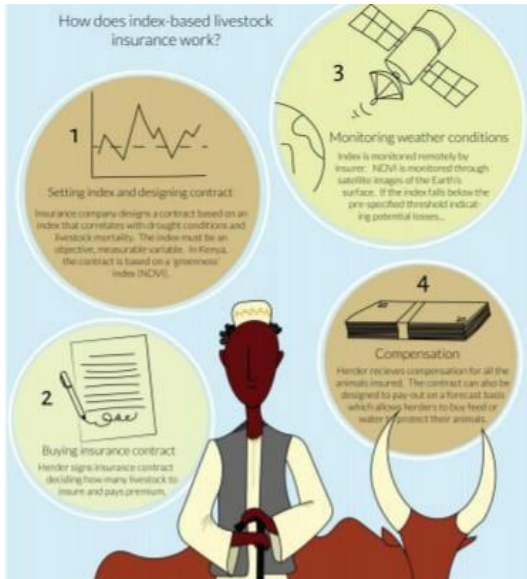
Figure 20: Kenya Index Based Livestock Insurance Programme

Some counties in Kenya are prone to drought conditions, due to which the herders/pastoralists are in frequent agony of their livestock dying due to lack of food and water. The pastoralist communities are the most marginalised and have been the victim of neglect. In October 2015 the Kenyan government acted and formed the Kenya Livestock Insurance Program (KLIP/IBLI) also called Index-based Livestock Insurance.

Approximately 75 percent of livestock deaths in Kenya caused by severe drought, repeatedly leaving herders, their families, and entire communities destitute. Although initially piloted in two counties in the north of Kenya. The scheme was launched in conjunction with the World Bank, Swiss Re Insurance and the Kenyan government, there are several local insurance companies and technology start-ups also involved in the current expansion of the programme countrywide.

This smart contract is executed based on the conditions signed by the government and the farmers. The conditions are based on satellite data that is integrated on a real-time basis with threshold points. Greenness index is the range of green colour that the satellite images relay and the smart contract monitors, Green is no drought and Yellow is drought conditions.

No sooner the threshold is reached as the grass turns yellow, an immediate pay-out is affected to the farmer's e-wallet, enabling him to purchase fodder and water to keep his livestock alive.

The Kenyan government is wholly supporting this programme; the premiums come at no charge to herders registered under the "Hunger Safety Net" programme and cover five animals per household. They can also choose to insure additional animals at their own expense. In addition to the Kenyan government, KLIP[26] has been implemented with the help of local insurance companies. The scheme is also supported by the World Bank, The International Livestock Research Institute, and Swiss Rebank.

3.2.10 South African Reserve Bank Use Case

The South African Reserve Bank, along with the Payments Association of South Africa and top banks, circulated Africa's first-ever private ethereum-based smart contract among several of the country›s financial institutions in an attempt to test the technology for potential future implementation in its financial system. They are also participating in a regional consortium of leading banks, including ABSA, Standard Bank, Nedbank, and others, to develop a blockchain- based solution for loan syndication and securitisation.

South Africa also boasts a blockchain-curious and active financial sector looking to improve existing company operations through process re-engineering and cost reduction. Rand Merchant Bank has launched a blockchain initiative to develop blockchain solutions for its business, while Absa Bank, Barclays Africa and Standard Bank have joined the R3 Consortium to collaborate with other international financial institutions in the development of blockchain systems for the banking sector.

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[26] Livestock insurance gains ground in Africa (2017) https://spore.cta.int/en/finance/all/article/livestock-insurance-gains-ground-in-africa-sid01a2cc171-3fc1-49de-86bf-a3fdd29176e5

3.2.11 Other Digital Identity Management Use Cases

The Sovrin identity is a solution that is live in Canada where the government decided to move their organisation book to the blockchain, and the banks now allow people to use their identity wallets to login to their bank accounts without the use of a username and password.

The South African Financial Blockchain Consortium (SAFBC) started an identity workstream in 2017 when their members identified that digital identity was a perfect use case for blockchain technology. Last year, global teams of people have progressed this use case and the development of standards as well as ecosystems, like the one above, to test the solution.

Some concerns regarding identity security and recovery have been raised. From a security perspective, the mobile app of the user should ideally be protected using biometric authentication as Personal Identifiable Information (PII) is either stored on the person›s device or in their personally owned cloud storage. The data storage component of this use case provides an opportunity for government to provide infrastructure for storing and backing up data. This will be required to safeguard African citizens against the US Patriot Act which allows the American government full access to one's information.

The recovery of identity is important for refugees lost devices and documents as the recovery solution will ensure that one's digital identity history is not lost. For example, refugees who had a credit history in their previous country can then reuse their credit score in a different country. This is not the case today as one has to build up a credit history from scratch while moving

The economic opportunities created by digitising identity are:

·   Governments can earn an infrastructure fee for cloud storage of PII;
·   People can use their data as a commodity and be paid for sharing information for surveys and research purposes; and
·   Organisations and other entities can issue people with verified information and earn an income when the verified
    information is reused by other entities.

Strengthened data collection and analysis in Africa can inform evidence-based economic policy development that can be powered by the blockchain, for instance, birth certificates and IDs "create" our identities, but millions of people especially, women and children across Africa don't have them, which limits their entry into society at large and to economic participation. The solution needs to be checked against current regulation and policies e.g., the Protection of Personal Information Act (PoPI, South Africa), General Data Protection Regulation (GDPR, European Union) and other legislation had to be introduced to protect people's information, the USA Patriot Act to be noted depending on where information is housed and the Safe Harbour Act to be considered in the case of UK.

3.3 Conclusion

Africa is a greenfield for technology adoption and trials because Africans are ready to try new technologies to better their lives. The penetration of mobile phones in Africa is a strategic driver for this adoption. In this chapter some use case, the actual implementation of the blockchain technologies in various industries were explored. Digital identity management is applicable across a wide variety of industries and its significance is to establish your identity and ownership of assets, similarly, the track and trace blockchain-based system present enormous opportunity to trace back a product to its origin and evaluate every stage of its production. When applied to food it can establish authenticity and safety, when applied in pharmaceutical supply chain, it determines the safety of medicines we consume.

Blockchain technology is here to stay and explode into various businesses; it will change the lives of ordinary people with its approach and design of honesty and integrity, enabled by the cryptographic architecture. Africans have the opportunity to involve in the business of blockchain, skill up, be part of the development landscape and build solutions to prosper themselves and their countries.

4

Global Trends in Blockchain Technologies

The world is making a beeline for blockchain technology, according to Deloitte[27]. The year 2017 and 2018 were at the height of the blockchain hype cycle as enterprises experimented with the technology and created a proof of concepts. The hype is slowing down and 2019-2020 have seen the emergence of enterprise-ready solutions that are currently being deployed with certainty. Therefore, according to Deloitte, the blockchain technology is real, "In 2020, we can see that the prevailing question among executives is no longer, "Will the technology work?" but rather, "How can we make this technology work for us?"

This section provides a brief about how some nations in the world have rapidly adopted blockchain technology and its ecosystem, and in the process saved billions of taxpayer dollars and brought about the desired efficiency. We have listed two of the developing nations i.e., Estonia and UAE (DUBAI) with their success stories and to gain perspective on how a larger entity such as African Union can learn from its European counterpart, the European Union, in terms of legislation, regulatory framework, cooperation, action on adoption and deployment of viable, union-wide blockchain solutions.

The year 2020 started with the worst economic and human health crisis due to the coronavirus pandemic. The disease COVID-19 has put a spotlight on existing challenges, issues, and gaps in global supply chains. Especially, when various international bodies are helping with provisioning of PPE (Personal Protective Equipment) for healthcare workers and supplies like ventilators, masks, visors etc. There have been touts and fraudsters making quick bucks selling fake and substandard equipment. To address this issue, the World Economic Forum with the help of an Estonian IT company along with 100+ other Blockchain start-ups and IT giants created a toolkit for the responsible deployment of blockchain in supply chains. According to Ms Nadia Hewett[28](Blockchain & Digital currency project lead) of the World Economic Forum USA, "There are many lessons to learn from the current pandemic and this toolkit is a starting point for improving long-term pandemic preparedness and accelerating an economic recovery by public- private cooperation."

It must be mentioned that in addition to the World Economic Forum, the other contributors to the Toolkit include the Fourth Industrial Revolution (FIR) Network Fellows from Hitachi, Deloitte and Saudi Aramco as the leaders and among many others who contributed to its development in over 50 countries were FIR UAE, the Port of Los Angeles, Latham & Watkins, Cardiff Business School, University of Berkeley, Tech Mahindra, Maersk Angola, World Bank, Inter-American Development Bank and the World Food Programme. The full list of contributors is available on the World Economic Forum website.

According to Deloitte, in their blockchain-Trends 2020 Report, their survey shows, on average enterprises are making investments of over $5 Million in Blockchain solutions. In the USA alone 86% of corporate enterprises are investing in building blockchain technology teams. The rest of the world is not far behind trailing at 70%. Some of the key use cases being deployed are data access and sharing, data validation and customer identity protection. These are the underpinning characteristics that

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[27] Blockchain Trends for 2020 (2020) https://www2.deloitte.com/content/dam/Deloitte/ie/Documents/Consulting/Blockchain-Trends-2020-report.pdf
[28] New World Economic Forum toolkit: Deploying blockchain in supply chains (2020) https://e-estonia.com/new-world-economic-forum-toolkit-_deploying-blockchain-in-supply-chains/

are being exploited for the purpose of creating robust and secure ecosystems for general solutions such as supply chain, KYC (know your customer), payments and settlements, automation of conditional contract execution so on and so forth, the following figure will provide clarity on the current trends in blockchain technology.

Figure 21 Global trends in blockchain technology deployment - Source: Deloitte

The magic of blockchain technology resides in its inherent capability to mitigate challenges across all kinds of enterprises across industries, which traditional IT solutions and systems were unable to handle. Blockchain thus brings in disruptive technology which can do much more than just mitigate challenges. Some of the challenges as depicted in Figure 21 above show that blockchain can easily deal with are:

· **Data & big data management:** Every enterprise today has a plethora of data assets, sometimes structured, sometimes unstructured and most of the time all kinds of data, graphic, textual, video, spreadsheets, financial, media files, compressed, high resolutions so on and so forth. Data is critical and managing this data to make it meaningful, to gain insights of the business operations, for decision making purpose is of paramount importance, however, it is also one of the critical challenges;
· **Centralised processes:** It is costly to create a central authority and manage it with people, technology, and processes. Other challenges enterprises deal with centralised systems are, that they are time-consuming, validation is through human intervention and assessment of the volume of documents;
· **Functional processes have low visibility:** The centralised systems were function orientated and fully controlled by the enterprise e.g., a bank teller had to give you a bank passbook with your balances, even today, a lot of businesses rely on information provided by office staff rather than generate their own information due to low visibility;
· **Asset & value transfer is slow:** Bank charges are very high and remittance to international beneficiaries can take up to 4-5 days. Similarly, in an import/export scenario, the goods flowing from exporter to importer and money flowing from importer to exporter can take weeks to months due to heavy paperwork and change of hands, also the charges are very high; and
· **Security:** During this pandemic, cyber-attacks have grown exponentially, securing, and protecting your data and mitigating vulnerability is the biggest challenge in the past decade.

Blockchain has proven to be successful in mitigating the above challenges to a large extent. There are countries that have successfully digitalised their governance and services using blockchain. The next section illuminates short success stories of Estonia, UAE (Dubai) and the UK (United Kingdom). The first two are developing countries and the UK provides a

different perspective on how a first world country is handling the blockchain revolution. This is followed by an exploration of the European Union's efforts and involvement in the blockchain revolution, their stance on regulation of the blockchain technology in general and cryptocurrency platforms and exchanges in particular.

4.1 Continental bodies

4.1.1 The European Union (EU)

The European Union consists of 27 member countries, many of the countries from Eastern Europe are poor and overall, there is a disparity in economic levels amongst the member nations. Despite their economic circumstances, many countries have progressed in leaps and bounds especially with the help of emerging technologies. Malta and Estonia have taken remarkable strides in digitising governance and businesses. By opening their doors to foreign direct investments through legalising Cryptocurrencies and inviting companies and start-ups from all over the world to participate on their digital infrastructure, has served the countries well and boosted their economy in the bargain.

European Union (EU) realises the importance of blockchain and have seen the proof of how it can uplift the economy of the member countries. Through cooperation and inclusiveness, The European Commission aims at positioning Europe at the forefront of blockchain innovation and uptake. To make this into a reality, the EU relies on the following main initiatives to enable globally and regionally inclusive governance, reinforce cooperation and investments in deploying blockchain/DLT based applications, support international standard-setting, and facilitate dialogue between industry stakeholders and regulators, especially to build a meaningful regulatory framework.

4.1.1.1 The European Blockchain Partnership

The European Blockchain Partnership was created in April 2018, this is at a political level wherein all EU member states and members of the European Economic Area (Norway and Liechtenstein), the signatories of this partnership will work together, creating potential blockchain solutions for the benefit of citizens, society, and economy. As part of this commitment, the partnership is building a European Blockchain Services Infrastructure (EBSI) which will deliver EU-wide cross-border public services using Blockchain technology. In 2020, EBSI will deploy a network of distributed Blockchain nodes across Europe, supporting applications focused on selected use cases. To this effect following initiatives have been undertaken by the European Commission:

4.1.1.2 European Blockchain Service Infrastructure

In December 2019, the European Commission began inviting member nations for a cooperative consultation process to solicit blockchain solutions which will evolve into the European Blockchain Service Infrastructure.

4.1.1.3 Public-Private Cooperation

The European Commission officially launched on 3rd April 2019; the International Association for Trusted Blockchain Applications (INATBA) is a multi-stakeholder organisation based in Brussels. It brings together suppliers and users of Distributed Ledger Technologies with representatives of governmental organisations and standard-setting bodies from all over the world. They share the common vision of promoting transparent governance, interoperability, legal certainty, and trust in services enabled by blockchain and DLT.

On 11-13 November 2019, the EU Commission also co-organised the "CONVERGENCE" Global Blockchain Congress in cooperation with INATBA, the EU Blockchain Observatory & Forum and Alastria.

In February 2018 the European Commission, in collaboration with the European Parliament, launched the European Blockchain Observatory and Forum. The observatory and forum act as a stakeholder's engagement platform, an initiative to accelerate blockchain innovation and uptake, by featuring, knowledge sharing, community engagement, project mapping, working groups on use cases and the regulatory framework, production of thematic reports and delivery of training. It hosts lively debates, organises workshops and produces reports with the help of many European and international stakeholders.

The European Commission has launched a call for tenders for the renewal of the European Blockchain Observatory and Forum. The European Commission currently sees two areas related to blockchain which could benefit from improved legal certainty:

· Smart contracts: The European Commission will study whether the current legal framework is sufficiently clear to ensure the enforceability of smart contracts and clarify jurisdiction in case of legal disputes;
· Tokenisation: The European Commission will study whether the current legal framework is appropriate for issuing and trading tokens (i.e. crypto assets) when they are not considered as financial instruments but as escrow accounts;
· A 'Study on Blockchain, Legal, Governance and Interoperability Aspects' has been launched to examine legal and regulatory aspects and socio-economic impacts of Blockchain-inspired technologies; and
· Promoting interoperability standards.

Interoperable blockchains are needed for global deployment. The European Commission is thus supporting and is engaged in work on international standardisation, for DLT and blockchain through a liaison with ISO TC 307 on blockchain and Distributed Ledger Technologies.

4.2 Countries

4.2.1 Estonia

Estonia is the world's first country to deploy blockchain technology as far back as 2012, it was a succession registry kept by their Ministry of Justice. Over the years Estonia is a fully digitalised country and blockchain is the cornerstone of all its systems. According to Kaspar Korjus[29] (2017), "Blockchain has the power to transform almost every aspect of our lives — improving democracy and providing greater opportunities.
— but it may only be possible to unleash its' full potential with the support and co-operation of governments."

The technology chosen for Estonian systems is KSI blockchain, also used by NATO and the U.S. Department of Defence, blockchain pioneers from anywhere in the world are invited to become e-residents through their blockchain-enabled e-residency platform, first of its kind to attract foreign direct investment into Estonia and also promote entrepreneurship, so these residents can build the future through Estonian digital infrastructure, even without stepping foot in Estonia."

"Estonia is now a Blockchain nation," said President Toomas Hendrik Ilves — who was instrumental in establishing Estonia as an advanced digital nation — explained how Estonia is keen to support more blockchain entrepreneurs.

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[26] Kaspar Korjus is the former Managing Director of E-Residency and Government of Estonia initiative drawing foreign investments from start-ups, he is also an official blogger on the official E-Residency Blog https://medium.com/e-residency-blog/welcome-to-the-blockchain-nation-_5d9b46c06fd4

"Our digital society is underpinned by blockchain technology and our secure digital identities provide a significant advantage to blockchain companies that need to verify online identities. Through e-residency, Estonia is ready to support Blockchain products and services for e-residents; the programme wishes them every success and is ready to provide support where we can add value."

The Estonian government has provided remarkable support to its citizen with quick decisions and legislative framework that more flexible that bureaucratic. According to Kaspar Korjus (2017)[30] [31], there are two critical aspects that were prime drivers for blockchain technology applications in Estonia.

4.2.1.1 A Smart Policy Framework

In the development of blockchain technology, a smart policy framework could both encourage entrepreneurial activity and provide greater consumer protection. For example, Estonia has the technology to monitor who is accessing their data, (Citizen Health Records) conduct e-voting or digitally sign documents. This is, however, only possible with a good policy framework to ensure improper access of data is punished, e-votes are counted, and digitally signed agreements are legally binding.— like legalising ride-sharing apps or letting 'cute delivery bots' roam the streets. Through close co-operation between the public and private sector, Estonia has emerged as a leading start-up hub. With many firsts under its wings, Skype was invented in Estonia, one of the world's largest Blockchain companies, Guard time, started here as well as a number of other start-ups that are using blockchain in increasingly creative ways to disrupt traditional industries.

4.2.2   Dubai (UAE)

Dr Aisha Bint Butti Bin Bishr, Director General of Smart Dubai, said that Dubai's ambition goes beyond simply bringing advanced technologies and automating tasks. "Government, private and public sectors are leveraging this technology to create seamless transactions. By 2021, the Dubai government will achieve its paperless strategy. We are in the early days and we will continue to leverage the emerging technologies. Our focus is not on the technologies, but on the impact, these technologies can create. The emirate is looking to establish itself as a full-fledged smart city of the future, build a robust, integrated and interconnected ecosystem where advanced technologies are utilised to serve the people and ensure their well-being"[32].

The DUBAI Blockchain Strategy[33] was established in October 2016, it is an initiative between Dubai government, private and public sectors that are leveraging this technology to create seamless transactions. By 2021, the goal of the Dubai government is to achieve its paperless strategy. Dubai government is invested in leveraging emerging technologies, the focus is on the impact of these technologies on the lives of citizens and businesses and how the power of Blockchain can be harnessed to create inherent efficiencies.

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[30] Korjus, Kaspar. «Estonia Could Offer 'Estcoins' to E-Residents: The Proposal to Issue Crypto Tokens Would Make the Republic of Estonia the First Country with an Initial Coin Offering (Ico).» In EResidency Blog. Tallinn, 2017.

[31] Kaspar Korjus to E-Residency Blog, August 22, 2017, 2017, https://medium.com/e-residency-blog/estonia-could-offer-estcoinsto-e-residents-a3a5a5d3c894.

[32] Dubai Government has 24 use cases on blockchain platform in last three years https://www.techradar.com/news/dubai-government-has-24-use-cases-on-blockchain-platform-in-last-three-years

[33] The Dubai Blockchain Strategy https://www.smartdubai.ae/initiatives/blockchain

The strategy aims to 100% digitise all government services and offer these services to the residents and visitors of Dubai via one mobile platform. Currently, Dubai has deployed solutions and has successful use cases in finance, education, real estate, tourism, commerce, health, transport, and security. Blockchain plays a significant role in eliminating the use of paper and moves from manual to fully digitised transactions.

According to Dubai's Paperless Strategy, there are three core pillars that underpin this strategy: government efficiency, industry creation and international leadership. It envisages creating an open platform to share the technology with other cities worldwide. Dubai aims to be the first city fully powered by blockchain. Processing the likes of visa applications, bill payments and license renewals that currently generate more than 100 million documents annually – by 2020, all these will be transacted digitally on the blockchain. Going paperless will save US$1.5 billion (AED 5.5 billion) in administrative costs each year, reduce C02 emissions by 114 MTons and free up 25.1 million hours of economic activity.

4.2.3   The United Kingdom (UK)

The United Kingdom (UK) has invested substantial funds in the promotion of emerging technologies in general and blockchain in particular. Following are few of the initiatives undertaken by the UK government:

4.2.3.1 Innovate UK

In 2018, the UK government's "innovation agency" pledged a total of £19 million to fund innovative ideas for new products, processes and services in the fields of "emerging and enabling" technology, including distributed ledgers or blockchain, and health and life sciences. The condition for this investment was that these projects must have potential to create significant economic impact, cost savings, business growth, productivity, or an export opportunity for at least one small & medium-sized enterprise (SME).

4.2.3.2 Isle of Man Global Hub

The Digital Isle of Man, an advisory body, launched a global hub for the development of blockchain initiatives. The global hub set up a blockchain office to guide blockchain businesses through current and future regulatory landscapes, an Isle of Man Sandbox, was created which is a "testbed" for testing proof of concepts and innovative new blockchain projects.

The key role of this office is to facilitate a dialogue between the business and local and international regulators and to help blockchain platforms design and future-proof their concepts in-line with regulation. It will also provide guidance and marketing support and encourage collaboration. Several initiatives were launched under the aegis of the Innovate UK, one such innovation was the Blockchain-as –a-service (BaaS) this platform is used for paying welfare checks and student loans currently, however, it may be extended in the future for other services in the public interest.

The UK government have set up a crypto assets task force comprising the Treasury, the Bank of England, and the financial conduct authority (FCA) with the intention of exploring risks versus potential benefits of crypto assets and other applications of blockchain in the financial services sector and assess the regulatory requirements if needed.

4.2.3.3 Some Blockchain Services Currently Live in the UK

4.2.3.3.1 IDENTITY AND E-SIGNATURE

Cygnetise was founded in May 2016 and, to this day, is one of the few blockchain utility applications that are live and is adopted by dozens of entities across 12 jurisdictions. Cygnetise is a decentralised application that makes the process of managing authorised signatory lists efficient and secure. By using this technology, organisations including PwC, Ogier, Vistra and others, can significantly mitigate the risk of fraud and save over 90 per cent of the time and cost of administration.

4.2.3.3.2 DISTLYTICS-INSURANCE POLICY SOLUTION

Distlytics – as a blocksure techUK member, Distlytics has worked with blocksure to develop a Blockchain-based platform as the foundation for a policy administration system in the insurance sector. The company was founded in 2016 and is currently live and being used by Covea Insurance. The key reasons for using a blockchain-based platform were the connectivity, segregation, and security that it provides parties that require trust.

· Reduces expense in an insurer's internal operating model;
· Disintermediation (brokers);
· Easy KYC and AML testing;
· Underwriting using smart contract;
· Smart claims that pay-out automatically; and
· Improves cash management.

4.2.3.3.3 Gradbase

Gradbase, as the name suggests is a GDPR-compliant blockchain platform which allows users to store their qualifications and certificates. Anyone anywhere can instantly and effortlessly check academic and professional qualifications. E.g., in a job recruitment environment if the interviewer desires to check the interviewee qualification it is instantaneous and prevents fakes and fraudulent documents as these are sought directly from the universities and schools. Gradbase has partnered with several UK, EU, and UAE universities, professional institutions, and recruitment companies to build an ecosystem that will enable worldwide social mobility and bring fairness and efficiency back to the job market.

4.3 Corporations

4.3.1 J. P Morgan

J.P. Morgan[34] is a global leader in financial services, offering solutions to the world›s most important corporations, governments, and institutions in more than 100 countries. JP Morgan has pioneered blockchain technology solutions and applications within their enterprise these solutions are for facilitating transactions in the financial services domain. Through concerted efforts, their competency centre, called the "Blockchain[35] Centre of Excellence" has created Distributed Ledger Technology applications in-house and pilot solutions across lines of business within J.P. Morgan.

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[34] About Us https://www.jpmorgan.com/global/about
[35] The Blockchain Center of Excellence https://www.jpmorgan.com/global/technology/blockchain

The centre of excellence runs a programme and employs leading technologists, and researchers who create enterprise-grade blockchain tools, such as JPM Coin, Interbank Information Network® (IIN) and Quorum®, to drive industry standards and deliver value to clients. The programme also manages strategic relationships and investments with key vendors and consortia, including Enterprise Ethereum Alliance, The Initiative for Cryptocurrencies & Contracts, Global Blockchain Business Council and Hyperledger, a Linux Foundation Project.

4.3.2 A Closer look at J. P. Morgan's Blockchain Solutions:

4.3.2.1 JPCoin

The key driver behind this effort was a need to facilitate instantaneous payments between institutional clients which may reduce typical settlement time. JPCoin is a currency of value currently pegged against the US Dollar.   In future, it may be extended to major currencies based on market demand.

4.3.2.2 Interbank Information Network (IIN®)

This is a Blockchain-based solution, created to facilitate cross border payments currently 412 banks are participating in the IIN with the intention to facilitate payments to beneficiaries with least friction enabling beneficiaries to receive payments faster and with fewer steps This platform is scalable, peer-to-peer network powered by blockchain technology. IIN serves to address the longstanding challenges of interbank information–sharing. The correspondent banks can share information in real-time and complete the payment transaction in fewer days. "The more banks that join the network, the more dramatic the reduction in payment delays," said John Hunter, Head of Global Clearing for Treasury Services at JP Morgan. "As the network scales, our clients› payments will be processed faster with less operational expense."

4.3.2.3 Quorum

This is a blockchain platform built on the ethereum protocol, the characteristics of this platform are it is a permissioned network, therefore, it is designed to process transactions privately and without the interference of privacy and performance challenges which are posed by public blockchains. This is the base on which their solutions such as IIN are built.

4.3.2.4 Dromaius

This blockchain solution is created to mitigate the challenges around transactions within capital markets. The blockchain-based platform is designed to "streamline operations, help with cost savings and overall make the experience of transacting or issuing a financial instrument like this more seamless and simplified," according to Christine Moy, Executive Director and Head of J.P. Morgan's Blockchain Centre of Excellence.

4.4 Conclusion

This chapter provided a sneak peek into the blockchain investments and efforts in developing and developed countries, the support of governments of Estonia, Dubai, UK, and European Union into Blockchain and its ecosystems in creating real-life business solutions that are robust and based on trust and security. The narrative exhibited the overarching benefits derived by these nations. This section provides a live example of the largest financial services company in the world adopting Blockchain for changing its business model with the intention of creating efficiencies, cost-saving, and saving time.

The past few years mature solutions have been developed by every conceivable industry across the globe, be it the financial services or fintech, supply chain, logistics, education, or agriculture, Blockchain has reached beyond the hype cycle, real- world solutions are being showcased and are ready to deploy. Globally, there is a drive to legitimise blockchain transactions and regulatory bodies are working closely with independent private companies, in a public-private partnership model to make informed decisions related to regulation and compliance of blockchain as a mainstream technology. After a decade of success in the cryptocurrency trading arena, blockchain technology is unleashing its potential value on the businesses, industries, and governance domains. The next section contextualises Africa's strides in the implementation of blockchain solutions in various industries and how the continent is deriving benefit from this technology. There is a need to spread awareness to all other countries on the Continent so they can reap the benefits of blockchain.

5

The Relevance of Blockchain to Africa's Development

The African continent and all its member states are mired by a number of challenges that span across various sectors and industries. With the arrival of blockchain technology, many opportunities have presented themselves which will disrupt the industries, at the same time create many avenues of revenue, establish new industries and change people's lives. This chapter has sections around current challenges in Africa and the opportunities that blockchain brings to mitigate these challenges.
This chapter contextualises the dynamics of African Industry and its people, Government interventions to better the lives of people, current challenges and how blockchain as a technology can assist the continent in flourishing economically by building an ecosystem of trust and fair play.

Many of the economically better nations in Africa have made strides in adopting blockchain as technology in various industries. blockchain has been a game-changer in building better communities. What lessons can be learnt and how can other countries be assisted by them in replicating their success stories.

The next section elucidates government's intervention for a Pan African engagement of ICT initiatives on the continent, this is followed by Industry-wide challenges and each challenge is followed by what blockchain solutions can be applied to mitigate this challenge.

5.1 African Blockchain Opportunities

One role of Member States of the African Union is to safeguard their citizens as well as to provide basic infrastructure and services to their people, whilst enabling their citizens to create their own economic security. These roles are defined in aspirations 1 and 2 of the AU's Agenda 2063. The continent, through its strategy, aspires to improve the provision and access to quality basic services to its citizens, with the support of available and emerging technologies.

The African Continent houses 15% of the world's population (1.2 Billion), which is expected to double by the year 2050 in 26 of the 54 African countries. According to Rossini Zumwalt, the CPO of Emergent Payments, Africa is ready for the next e-commerce and digital revolution as well as alternate payments such as e-wallets, mobile money, or crypto-exchanges market. Some interesting research with respect to these facts is as follows:

· 35% of the continent's 1.2 billion population are connected to the internet as compared to 54% which is the global average;
· 280 million people have mobile wallets, which is three times more than the banked population, this mass adoption has democratised the financial services sector;
· Consumer spending is forecasted to exceed one trillion USD annually;
· The average age of the retail consumer, who is digitally savvy and educated is under 20 years; and
· By 2025 Africa's annual revenue will exceed 75 billion USD of which retail sales will account for 10%.

Africa, therefore, is a formidable market, with a large population that are techno-savvy, willing to adopt and drive, to better their lives, creating immense opportunities in rapid development space. There is no better time than now for emerging technologies such as blockchain, IoT, AI and data science to create their indelible mark in addressing the challenges of the African businesses. There are success stories of businesses in Africa to rejoice and learn from, there are beneficiaries and benefactors that are paving the way for future development and glory on the continent. Some case studies categorised by the industry are presented herewith.

The Science, Technology, and Innovation Strategy for Africa (STISA-2024) focuses on wealth creation, protection of our space, food security, disease prevention and hunger eradication; using technology;

Blockchain technology is applicable to the management and security of citizens' data (identities, criminal history, etc.). Blockchain platforms have the potential to limit internal government corruption, track tender processes and bring about transparency in the public sector which will, in turn, increase the confidence of foreign investment and the payment of services delivered to member states.

5.1.1 Agriculture

5.1.1.1 CASE STUDY: Kenya Agriculture Blockchain

The agricultural industry in Kenya uses blockchain technology for efficiency, cost reduction and to create profitable ventures. The agricultural industry is connected to an ecosystem (consisting of transaction partners, data sources, smart contracts etc.) of various stakeholder's primary parties, such as insurance (index based), deeds office (land titles registration), farmers, cooperatives, Government departments, (subsidy disbursements) fertiliser corporations etc. The data sources can be many such as spatial data, meteorological data, drone images etc. The smart contracts are terms, conditions and agreements between the parties that are engaged in transactions with outcomes based on logical reasoning. These devices require no external manual intervention to execute. The smart contracts enable pay-outs instantly and execute conditions in the contracts in real-time thereby facilitating quick turnaround times for transactions.

TWIGA is a Kenyan start-up that provides farm produce to the retail consumers directly from the farm to the retail consumers. blockchain facilitates the elimination of intermediaries thereby providing a peer-to-peer transaction mechanism, benefiting the farmer immensely due to direct connections with his stakeholders. The blockchain-based marketplace is two-sided, a farmer side and a vendor side. Vendors and farmers are registered online. TWIGA food distribution takes responsibility for ascertaining the authenticity of produce and timely delivery to the vendor. Payment to the farmer is done within 24 hours through e-wallet on completion of the transaction.

Figure 22 Twiga agricultural marketplace

5.1.2 Healthcare

If there's a silver lining to COVID-19, it's that it has induced a long-overdue examination of many archaic aspects of the healthcare system. When we apply these lessons to emerging markets, such as Africa, the horizon for change coming out of the crisis looks promising.

A simple technological revolution such as having a permanent medical history on record will allow doctors to know better about their patients. Firstly, when patients travel between two cities without a script, they are often sent away by the doctor for want of a script and medical history. The doctor's do not know much about the patient's allergies and side effects, so while administering a drug, the patient can face dire consequences. This becomes a precarious situation as the patient does not get the treatment that he deserves.

5.1.2.1 Case Study: Kenya Healthcare Platform

This year (2020), Kenyan health tech start-up Afya Rekod is sprinting to launch its artificial intelligence (AI) and blockchain built consumer-driven health data platform amidst the Covid-19 (coronavirus) pandemic. The platform aims to support global efforts to curb the disease by providing a portal for people across the world to store their health data in real-time, with a special focus on Covid-19.

This platform development is being accelerated with participation from other African member states cooperation. The platform aims to capture real-time users'/patients' health data; drive connectivity and engagement between patients, doctors, and other health care providers; the company is sprinting to launch 4 months ahead of original launch plans.

This advanced system is built to help users store their own health data, access health information and connect to health service providers that were set to launch at the end of July 2020.

Founder and CEO of Afya Rekod John Kamara said, "Afya Rekod is a medical data storage platform that allows patients to store their health records, the medication they take as well as keep journals of their statuses and that of their kids and families. The platform is AI-driven and uses various AI modules to help detect abnormalities, detect early outbreaks and monitor mobility and evolution of diseases via timely data analytics."

"Africa and most of the third world countries have limited doctors and access to health care services. Lack of patient data in real- time makes the problem even more damaging to both patients and health service providers across the continent. Over 65 percent of Africans live in rural communities that are not connected and are off-grid in terms of access to health care services. This is the problem we are trying to solve," explained Kamara.

5.1.3 Finance

There are many blockchain solutions that apply here. According to a McKinsey survey conducted in 2017, the global banking industry is expected to spend an estimated $400 million on blockchain related projects by 2019. Recent venture capital developments have indicated that the financial industry is mobilising around the potential impact blockchain will have on their business, and is beginning to invest in related research, development, and application testing.

Industry spend provides the opportunity for the public sector to partner with the private sector to create the skills (in youth and citizens) required for the continent to implement blockchain-enabled solutions. In addition, entrepreneurial opportunities could result from this work as well as opportunities for Africa to supply skills to the rest of the world.

5.1.3.1 Case Study: Decentralised Financial System (Cryptocurrencies) in South Africa

A new decentralised financial system made possible with cryptocurrencies could be much simpler by removing layers of intermediation, i.e., removal of intermediaries can be realised by automating some of the rules being managed by the intermediaries. This also removes a layer of cost which improves the cost of services offered to customers. Moreover, it could help insure against risk, and the ability to move money in different ways could open up the possibility for different types of financial products. Cryptocurrencies could open up the financial system to people who are currently excluded, lower barriers to entry, and enable greater competition. Regulators could remake the financial system by rethinking the best way to achieve policy goals, without diluting standards. We could also have an opportunity to reduce systemic risk: Like users, regulators suffer from opacity. Research shows that making the system more transparent reduces intermediation chains and costs to users of the financial system.

For instance, in March 2016, South Africa's financial services board (FSB) expressed the view that technological innovations, such as blockchain, with potentially transformative implications for the financial system, may have stability repercussions that should be managed. This implies that there are further research and analysis required to understand the risks and implications of blockchain on the stability of the financial system. This research should also take into consideration the countries that replaced their currencies with cryptocurrencies.

The South African Reserve Bank (SARB) won awards for the contributions made to the blockchain body of knowledge during project Khokha which demonstrated the use of distributed ledger technology for interbank payments settlement process between the SARB and about 8 banks. Some learning has been gained by the SARB. During project Khokha, the SARB contributed to the Blockchain body of knowledge by having a consensus algorithm developed to enable the required number of transactions to be processed within a given timeframe. This was achieved through an improved consensus algorithm as well as transaction commitment capability. Learning's from this project can also be leveraged by member states and the AU.
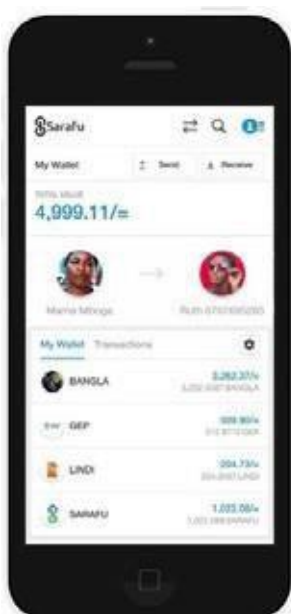
5.1.3.2 Case Study: Sarafu Credit

Sarafu-Credit is a blockchain solution that started as a mutual credit system that allowed communities to trade their goods and services even when they lacked liquidity. The aim of Sarafu -Credit is to empower marginalised communities to take charge of their economic and livelihoods through a proven community currency model which is digitised into a blockchain currency to enable exchange between communities and other community currencies. It is a solution that is at the forefront of social and financial innovation and has the capacity to the society especially the economically marginalised in a significant and sustainable way. The system is pseudonymous, and people use digital wallets to participate in this ecosystem. Digital wallets are stored on the phones of participating communities and work just like mobile money. Since 2010, Grassroots Economics (GE) has developed voucher programmes that were later digitised in Kenyan informal settlements, aiming at building local, resilient, and empowered communities.

These digital vouchers are a regional means of exchange that complement the national currency system. They provide low-income communities with a complementary means of exchange which allows trades of goods and services to take place without a scarce national currency. Moreover, they are used for trading between local businesses and allow the user to save their Kenyan shillings for reinvestments in their businesses, pool resources for cooperative businesses or for paying education and health services. In short, the digital vouchers systems leveraging on the blockchain technology launched by Grassroots Economics which create a a buffering countercyclical system of trade in rural and informal settlements by complementing the lack of national currency and matching unused resources with unmet demand. In these communities, the Sarafu-Credit is used as a spending currency while the national currency is used as a savings and investment currency.

Furthermore, GE helps marginalised communities in developing cooperative businesses and other local assets, which replace imports. Sarafu-Credit is therefore a commodity-backed digital voucher. The vouchers issued via zero-interest loans are backed by the assets of the cooperative businesses. The Sarafu-Credit vouchers can be used to trade goods and services among local businesses as well as to purchase cooperative assets (including profits in Kenya shillings). Via zero-interest loans, the Sarafu-Credit can be issued among the community directly to pay for social and environmental services based on both donor support and profits from cooperative assets. This mechanism allows non-members to also receive the Sarafu-Credit by contributing to community services.

The system highlights the problems faced by the rural and peri-urban communities such that tangible solutions can be found to help improve the state of communities, especially at a time when member states are faced with high rural to urban migration. It attests to the fact that there are solutions that with the support of member states can be used to empower the vulnerable in the society whose biggest problem is the lack of liquidity but have the potential and ability to innovate and meet not only their needs but also the needs of the society in general.

Sarafu-Credit is a blockchain solution in Kenya and is described as a CIC – Community Inclusion Currency. CICs such as Sarafu Credit are designed to circulate alongside and in addition to the national currency as locally owned and operated means of exchange. CICs are like IOU's that community remembers have agreed to accept and exchange in addition to a national currency. Because they are in addition to the national currency, people are able to save their national currency and use it for specific items not supplied by the community. Sarafu Credit has over 26,000 users in four counties in Kenya with a name unique to each community, where the communities use it to buy and sell goods and services that are locally produced regardless of the state of the national economy or the amount of national currency circulating within a community. It is a solution that is at the forefront of social and financial innovation and has the capacity to help the society especially the economically marginalised in a significant and sustainable way.

The system is pseudonymous, and people use digital wallets to participate in this ecosystem. Digital wallets are stored on the phones of participating communities and work just like mobile money. Since 2010, Grassroots Economics (GE) has developed voucher programmes that were later digitised in Kenyan informal settlements, aiming at building local, resilient, and empowered communities. In short, the digital vouchers systems are leveraging the blockchain technology for bonding curves and smart contracts that provide governance and regulation. Furthermore, blockchain provides additional benefits for the digital CICs: transparency (blocks), scalability (digital vs hard asset),conditionality (parametrics and anticipatory funding), liquidity (increase token supply), traceability (end-to-end tracking), fungibility (i.e., multiple CICs can be exchanged/traded), security (The end of the cash box), and diversification of funding pools (DAI, Cash, etc.). Economic data securely stored on the blockchain can help governments and humanitarian aid organizations to better understand local economies and support vulnerable communities by adding community funds and creating more credit for communities in need.

5.1.3.3 Other Opportunities for the Applications of Blockchain in financial services:

· Blockchain can facilitate instantaneous and low-cost transactions in areas like remittances and micro-payments as well as enabling increased transparency in crowdfunding. Shares, unit trusts, government bonds and similar investment products. intrinsically allow for the purchase of less than one token. This could stimulate financial inclusion as it opens up opportunities to people who may previously not have participated in such investments. Cryptographic consensus and automation will reduce the need for complex ecosystems of trusted parties. Such platforms will reduce the barrier to entry for shareholders/markets as fewer infrastructures will be required to operate the transfer of value that is already digitised.

· Luno and VALR are two crypto exchanges in South Africa that enable on-ramps and off-ramps for crypto-fiat exchanges. These exchanges provide South Africans with the opportunity to experience and trade cryptocurrencies and are required to comply with tax and other regulatory rules based on the use of current taxation laws for known types of financial instruments;
· Revix is a recently launched company in South Africa that has a vision of enabling the poor to invest like the rich. Their 4 bundles of shares allow investors to passively invest while their smart contracts execute the required trades. This is the benefit of a shared economy provided by blockchain.

· Maker is an international project attempting to build the facilitation of loan products. The initial product offers secured loans, and the future roadmap will consider unsecured loans. In places where the financial infrastructure is well established, blockchain is frowned upon as a possible solution. However, where financial infrastructure is not well established, blockchain can provide cost-effective infrastructure to enable financial inclusion on a global stage. This can be made possible by tokenising company stocks and government bonds and enabling peer to peer trade as the blockchain takes care of managing the share/bond registry in the underlying ledger. Two use cases being explored in Kenya are putting Makiba on the blockchain and tokenizing unit trusts.

· Use cases in the financial space should be incubated in sandbox environments so that the solution can be interrogated from various perspectives (security, economic, technical, cyber, privacy, policy impacts, etc); and

· Additionally, communities in the informal economy which are considered unbankable the Blockchain can provide a secure platform for financial transactions. These are all critical building blocks for economic access.

5.1.4 Education

Recording of student identities on an incorruptible ledger such as blockchain will provide an honest platform for uploading and storing degree certificates and other qualifications. This concept of Identity management introduces us to the idea of digitizing information that can be verified and reused by organisations. This enables educational institutions to issue digital qualifications and transcripts to students, into their identity wallets which may be reused when transferring universities or applying for jobs. The identity use case introduces data economy benefits to financial institutions that can now be paid when the digital transcripts and qualifications issued are reused by organisations. Students will also be able to sell their data when participating in student surveys or when needing to share their education data.

Blockchain can be used by any educational institution be they national or international, formal, or informal. As the educational system becomes more diversified, democratised, decentralised, and disintermediated, we need to ensure that reputation, trust in certification, and proof of learning is maintained. Blockchain has the potential to provide a massive open, online, secure database for educational systems. For instance, as of mid-October 2017, a hundred plus students at the Massachusetts Institute of Technology (MIT) will have a copy of their diploma stored on blockchain.

This solution can be extended to recognise on-the-job knowledge and skills gained through a peer to peer issuing of digital references which could stimulate a market for the provision of goods and services. The bursary and recruitment processes within organizations will now be able to make use of information issued for qualifications and transcripts by educational institutions without them having to contact multiple institutions during their recruitment process to verify the potential employee's certifications and credits. When students change universities, there is also a need for the new university to obtain a student's transcript to verify the courses they have completed.

Harnessing blockchain technology also provides the opportunity for educational institutions to include this topic in their curriculum. In Russia, many universities have included cryptocurrency and blockchain in their curriculum. In Africa, the University of Cape Town started an MPhil degree specialising in financial technology and includes a final project that uses blockchain technology.

5.1.5 Voting Systems

Blockchain's ability to create transparency makes it a good fit for implementing a legitimate voting system. Citizens can cast votes the same way they initiate other secure transactions and validate that their votes were cast—or even verify the election results. Potential solutions are currently working to blend secure digital identity management, anonymous vote-casting, individualised ballot processes (for example, a vote "token"), and ballot casting confirmation verifiable by (and only by) the voter.

5.1.5.1 Case Study: Sierra Leone

Sierra Leone is the first African country to conduct elections using a blockchain-based voting system. The votes were stored in an immutable distributed ledger which offered instant access to the election results. Leonardo Grammar of Agora has created the e-voting platform which can record votes /ballots securely in Agora's blockchain so anyone can review, count, and validate. Sierra Leone has proven the fairness of its polls by creating a blockchain immutable platform, which provided the legitimacy in the election and reduced the fall-out from opposition parties[36].

5.2 Conclusion

There is much R&D activity in the financial services industry. Many proofs of concepts, some pilots but little in the way of scaling except for the pure crypto solutions. 2019 will see further pilots within ecosystems and not only within the walls of one organization. The disruption of decentralisation in this industry requires close collaboration between the public, private and fintech communities to ensure that solutions can be tested thoroughly before conducting large scale pilots and scaling solutions.

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[36] Note: However, this election was not conducted on the Blockchain platform but voting results were stored and accessed to report results on the Blockchain.

6

Compliance, Policy, Regulation and Standards

Policy, governance and regulation must enable innovation and power the AU vision. Africa needs to adopt a policy of co-creation and co-ownership if Africa must become a contributor to this knowledge space.

6.1 Blockchain Policies

Governance, policies, and regulation are meant for the larger good of society and its citizens. A good policy evolves as a cyclical phenomenon, incorporating rapid change in technology, lessons learnt and global expansion of the technology. A good policy takes into account a set of goals that have clarity on their operation, compliance, and definition of authority under which they are set.

Many countries have established such policies within their jurisdictions that vary in both purpose and approach. E.g., the United Arab Emirates (UAE) government has actively participated in the blockchain initiatives, such as a Blockchain platform for government entities, a legislative sandbox for fintech start-ups, which enables them to explore the application and implications of blockchain in the businesses they work in, also it assists in defining what regulatory changes if any are required to adapt to the rapidly developing landscape.

Policies that incorporate expansion, inclusion, openness and equalize the level playing field for tech companies are the work in progress for the adoption of blockchain on a larger scale. The case in point is Estonia, an east European nation, they experimented with the blockchain technology in the government, making adoption easy, and then used Blockchain as a trigger to boost their economy. Estonia became a giant hub for blockchain start-ups and larger companies to become e-residents, through a blockchain-based e-residency platform. People could own a company and become residents without setting foot in Estonia. The caveat was to qualify, they must invest, get the best offshore skilled resources, enjoy tax breaks etc.

Therefore, the policymakers need to outline strategic objectives that blockchain technology will fulfil in the betterment of the governance, the efficiency of processes, economic development, job creation, skills development, and small and medium enterprises (SME) development.

6.2 Governance

Regulatory frameworks[37] need to reflect the values of their citizens and should encourage rather than stifle innovation. Governance is a collaborative effort between relevant stakeholders such as tech companies, policymakers and regulators need to progress hand in hand, and innovators and policymakers should consult one another for decisions on an appropriate regulatory framework.

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[37] The Policy Environment for Blockchain Innovation and Adoption (2019) OECD Global Blockchain Policy Forum Summary Report
https://www.oecd.org/_finance/2019-OECD-Global-Blockchain-Policy-Forum-Summary-Report.pdf

Governing a regulatory framework follows the below-mentioned guiding principles:

· To ensure that this new regulatory ecosystem provides the same or improved protections as the current system. It should also acknowledge the impacts of other technological innovations, such as artificial intelligence and the internet of things in addition to blockchain;
· To use terminology while regulating blockchain by using terms that are well defined, standardised and reflect the overarching regulatory framework;
· To take cognisance of the digitisation process, how assets are digitised, and value created and transferred which is the fundamental building block of blockchain and on which the various financial and auditing systems are dependent; and
· To understand the ecosystem of blockchain and its current use of human behaviour in the integration of other technologies such as Blockchain, artificial intelligence, and the internet of things.

6.3 Anti-Money Laundering - AML/Terrorism Financing

The new Financial Action Task Force (FATF)[38] standards for virtual assets are an urgent priority for G20 governments, responding to serious and growing concerns about their use by criminals and terrorists. It is said that criminals adapt faster than government advent of any new technology. It boosts their activity and provides them with a vehicle to perpetrate criminal activity. The new rules were adopted in June 2019, but the real work of implementation has just begun.

· This poses challenges for the virtual asset sector, both technical and culturally: with blockchain technology here to stay, there is a need to build new tools and systems to implement the rules, to prevent crime.
· A public-private partnership is essential to make the new standards work. The virtual asset industry has taken important first steps to organise itself and develop technical solutions, and so have national authorities.
· FATF will monitor the impact of the new rules, and the development of the new systems.

6.4 Tax Administration

Since blockchain regulation is non-existent yet, cryptocurrencies business is rife and expanded worldwide to transact billions of US Dollars, on various platform, it is like the unleashed mongrel running amuck, with no controls. This lack of guidance on the tax treatment of virtual assets creates uncertainty which complicates tax compliance and hampers innovation.
Work should be undertaken at the OECD level to develop best practices on the classification of virtual assets for tax purposes as well as their tax treatment. Following is an extract from the OECD report on the Blockchain Policy Forum:

· The anonymity or pseudo-anonymity associated with virtual assets makes it difficult for tax administrations to trace their beneficial owners and risks undermining the progress made over the past 10 years in the area of tax transparency. Work should be undertaken to ensure that the tax transparency standards and in particular the Common Reporting Standard continues to provide an effective global firewall against international tax evasion;
· It is also important that authorities build strategies for ensuring compliance with tax obligations in respect of virtual assets. In this light, work should be undertaken to ensure that authorities have the tools to address the risks of financial crime posed by such assets, including through practical training, and developing systems allowing for speedy access to data. International co-operation between tax administrations in these areas is crucial; and
· Distributed ledger technology may offer useful solutions to be further explored in the context of the digital transformation of tax administrations.

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[38] The Policy Environment for Blockchain Innovation and Adoption (2019) OECD Global Blockchain Policy Forum Summary Report
https://www.oecd.org/_finance/2019-OECD-Global-Blockchain-Policy-Forum-Summary-Report.pdf

6.5 Compliance

Compliance of any solution falls into the domain of service providers to ensure that they are not contravening any regulations when utilising new solutions. The onus is on organisations to ensure that they are always compliant. The use of blockchain technology does not exclude a system from following any applicable laws and regulations. For example, there are many compliance considerations with regard to legislation and policies tied to the protection of Personal Identifiable Information (PII), for example the General Data Protection Regulation (GDPR) of the UK, which implies that PII should not be placed on the blockchain because Blockchains are immutable[39]. Additionally, certain countries or organisations may limit the type of data that can be transferred across its geographic boundary.

In other instances, certain legislation may dictate that the "first write" of financial transactions must be written to a node which is present within their borders. In any of these cases, a public, permissionless chain may be less appropriate, while a permissioned or hybrid approach may be required to satisfy regulatory needs. An additional example of laws and regulations are for any blockchain network which manages federal records. Federal records are subject to many laws and regulations. Federal agencies themselves must follow specific federal guidelines when utilising blockchain technology. These examples allow for one to see how blockchain-enabled solutions can be architected to adhere to required regulation/governance to be compliant. To reiterate, it is not blockchain that needs to be regulated but the underlying solutions and the service providers who build them should ensure compliance.

6.6 Regulation

The intrinsic model of blockchain technology has been the major cause for initial resistance as many governments are central organisations that offer trust to the public. They provide trust through the control and oversight of the players. Blockchain on the other hand has a distributed architecture that is designed to inherently create trust through technology in what would be previously a trustless environment.

With the ubiquitous nature of blockchain whereby it can expand beyond different geopolitical jurisdictions and the fact that it is being used to transact value or as a store of value becomes a concern for government. Blockchain technology cannot be regulated; however, the underlying use cases and solutions can be regulated. This should be done with collaboration from stakeholders and various other regulators who represent other jurisdictions.

- Blockchain being an architecture there is no clear combination of governance mechanisms, however, according to OECD report, it will involve a mixture of 'regulatory levers' which need to be pulled in order to find the right balance.;
- Regulation of blockchain poses another major dilemma, is that on one hand, too much regulation can stifle innovation and regulation is certainly required to protect users and ensure security, particularly where the crypto assets are involved within the financial sector; and
- Regulation of blockchain is key to the successful adoption of the technology, therefore, the dialogue around regulation must continue and the stakeholders must ensure that all aspects of its governance are addressed, particularly with regard to privacy and security. Those governments that wish to accommodate decentralised business models may need to make significant amendments to their current legal frameworks.

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[39] Blockchain technology is on a collision course with EU privacy law https://iapp.org/news/a/blockchain-technology-is-on-a-collision-course-with-eu-_privacy-law/

6.7 Cryptocurrency and ICOs

Policy and regulation play a very critical role in the direction of any country. Since blockchain is an emerging technology, there is a need to review existing regulations to adequately facilitate its rightful use as well as put safeguards against malpractice or misuse of the technology. The cryptocurrency use case has been received with mixed reactions worldwide by different government regulatory agencies. Many government regulators of the financial sector c distanced themselves from cryptocurrencies because of the lack of regulation and the fact that no one could be held responsible in case of this decentralized technology. Some governments were open especially to blockchain but after massive losses through the fluctuations in price, some of them banned the crypto-exchanges notably China. This alludes to the fact that the impact of cryptocurrencies on the stability of the global financial ecosystem needs to be understood. Until then, regulation should continue to enable innovation through sandboxes[40].

6.8 Standards

In the digital world, technical and governance standards are required to ensure interoperability of solutions across multiple platforms and/or solution providers. It is therefore important to check whether solutions to current day problems utilise standards in order to minimise rework and ensure the sustainability of solutions in the long term. Governance and technology standards are emerging for crypto tokens and identity. As discussed in the earlier sections, it is imperative that regulators regulate the underlying solutions and use cases instead of regulating the technology itself.

6.9 Conclusion

Even though it is assumed that few real-world blockchain use cases exist and that the tangible value of these is not evident, the use of Blockchain crypto tokens (or cryptocurrencies) is being used for voucher-based economies, quick and easy cross border remittances as well digital identities. These use cases should be of interest to governments to ensure that people and the economy are protected. It is thus recommended that governments participate in the above use cases.

Responsible governments want to create a conducive environment for the development of its people. Innovation is a key driver for development and the balancing act when it comes to regulation is not to stifle and force the innovators out of the jurisdiction. Lack of regulation sometimes results in people going to more favourable jurisdictions or leads to a halt in innovative solutions. Thus, it is necessary for governments to publicise sandboxes in which policy and business rules can be co-created to enable the innovation of new business models using blockchain technology.

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[40] USD Is the Most Actively Traded Fiat Against Cryptocurrencies, Study Says (2018) https://cointelegraph.com/news/usd-is-the-most-actively-traded-_fiat-against-cryptocurrencies-study-says

7

Socio-Cultural and Ethical Considerations

The African continent is a melting pot of cultures, social norms change from country to country, many influenced by incumbents. Africa's strength lies in its diversity. Its people come from diverse socio-cultural and religious backgrounds which need to be understood before implementing solutions within any community irrespective of the technology that is used for solutions that are implemented. Extensive stakeholder engagement helps to understand public or target community concerns in the relevant context but also gives room to engage potential beneficiaries of the solution. It is important to factor in the cultural perceptions of different member states. For instance, while implementing the Sarafu Credit in Kenya, the implementing agency had to take adequate time to explain the novel technology as targeted communities viewed it with suspicion.

Whenever a new technology has been introduced in the market, there is a flurry of activity, there are opposing forces at work, on one hand, excitement, prolific entrepreneurial spirit, experimentation, quick adoption, and expansion, whereas on the other hand there is deep resistance, fear, confusion, denial, and total dissidence. In this quagmire, the winner has always been technology. There are lessons learnt and replicated here so blockchain adoption in Africa can be a streamlined, inclusive, and beneficial process with least resistance and quick adoption.

In this chapter, the socio-cultural phenomenon is visited and certain vital aspects of communities and societies that might resist the technological changes and transformation are elucidated. This provides change management interventions for the adoption of blockchain. Ethical consideration in organizations with respect to collaboration, collusion, job security is also visited.

7.1 Communication & Community Engagement

Community involvement, citizen inclusion is of paramount importance when the government decide to adopt a new method of governance using a novel technology such as blockchain. E.g. if a country decides to use e-Voting system to facilitate electronic ballot which can be used from the comforts of the home or office, initially there is bound to be resistance. The different political outfits may get suspicious of the intention, the adoption of this new method will be possible only if the masses are educated and the benefits of the technology are communicated and explained to the beneficiaries.

There will be no real foreseeable challenge in implementing blockchain, since blockchain is like the Internet, or a database platform that will allow business solutions to be built on it. These solutions may face consequences that may result in resistance or protests e.g. the e-voting system, as explained above.

The use of media and information, education and communication, materials especially in local dialects is key to encourage uptake. Consequently, stakeholder and community perception of risk will and should inform the risk assessment process. Adequate stakeholder engagement can help ensure that the technology responds to the needs of the targeted member states and ensuring that any novel technology such as the blockchain has the best chance of acceptance and support at a local level.

As engagement can contribute to defining the values and preferences of community stakeholders and the public about the Blockchain technology is, in turn, ensures ownership of the solution by the target communities which in turn ensures sustainability in the adoption of the solution. The blockchain technology is, however, a relatively new concept in Africa and might raise previously unknown challenges, thus it is important to plan for effective engagement from the early stages.

7.2 Job Security

The use of Blockchain technology paves way for secure and hyper-efficient maintenance of shared and common data, which is likely to disrupt the jobs of many people, especially ones that are doing repetitive administration work that can be automated. However, this is not meant to discourage member states from going ahead and adopting the blockchain technology and thereby realising its immense benefits, it is prudent to be conscious, every step of the way of its impacts and to proactively adjust, retrain and encourage the affected workforce to move to more value-adding roles.

Another common assertion that there will be job losses comes from disintermediation and disruption especially as pertaining to work that was done by middlemen/brokers. However, it is important to note that with blockchain there is a different role for an intermediary around training, system integration, support, and governance, consensus building across the consortium and so forth, so there is an opportunity for intermediaries of today to adapt to blockchain and even leverage blockchain to their benefit. Job security concerns will therefore best be mitigated by upskilling, innovating, improving, and reskilling the current workforce.

7.3 Collaboration vs Competition

Blockchain solutions are meant to introduce new ways of working for entire industries and not just for isolated organisations. It is thus assumed that organisations within the same industry will come together to improve the products and services delivered to customers, however, this may affect the current organisational structures and revenue models.

We have seen some collaboration efforts through consortiums such as B3i which is a consortium working on Blockchain solutions for the insurance industry which was started by a few founding members who subsequently increased participation in the consortium before establishing the biotechnology company with a revenue generation model for participation and use of their tools.

Another fundamental ethical consideration is that of being uncompetitive. Most competing organisations are still trying to compete against each other to be first to market with new technology solutions and as a result, slow down the innovation of the industry. A possible solution to this is if the regulators of the industry run the innovation initiative requesting all organisations within the industry to comply with the new standards for improved services within the industry.

Ethical considerations for collaboration amongst organisations must thus be clarified in order to enable industry-wide improvement for customers and the organisations. It may be possible for organisations to have a first-mover advantage with blockchain-enabled solutions, but what ultimately will matter to customers is whether they are getting the best service for the price that they are paying. This can be achieved by improving end to end partnerships within industries such that value is delivered to the customer with the least disruption and admin and at the right cost.

8

Opportunities for Leapfrogging

Blockchain technologies are introducing new systems of trust and exchange on which users can send value directly from one party to another without the need for intermediaries. While Blockchain is still regarded as an emerging technology, it presents opportunities for researchers to make a difference on the global stage, especially because of our unique challenges and young society.

In this section, we consider the role of RDI and how it can be supported. Specifically, we refer to a model that brings together all the key ingredients, i.e., human capital (especially researchers and youth), technology, business, and knowledge base, all supported by a regulatory regime that looks out for the interests of society.

8.1 Capacity & Capability Building and Strengthening

Adoption of new technologies has already given a plethora of opportunities in the job markets. In 2001 with the advent of e-commerce and internet technologies, there has been enormous uptake of IT engineers and skilled workers in graphic design, digital marketing, website design and development and it has been booming ever since. Blockchain, Artificial Intelligence (AI), data management, Internet of Things (IoT), and cloud computing are new technologies and emerging IT wave. Every African country will need to build capabilities and capacity in Blockchain and related technology skills. The adoption cannot be complete without the capacity for development, implementation, and support of Blockchain solutions in the future.

Blockchain technology introduces a new subject and expected new income streams for universities government and businesses in general. Overall, in the African continent, we need to build skill sets of data scientists, software developers and coders at the technical level. Individuals active in the Blockchain field need support in the form of mentoring and assistance in the building of investor networks and investment funds that are open to taking risks on new technologies and companies developing them.

Education is the key to achieving the full potential of Blockchain in Africa. Education is required at various levels, including the general public, government officials, private sector stakeholders, especially start-ups and technical experts like business analysts, architects, and software developers. There is good progress within the African start-up community as we are starting to see the emergence of blockchain start-up hubs like Bit Hub Africa in Nairobi, Kenya. Blockchain Academy, Block starters, Linum Labs, Trustlab, Nona and One Connect Technologies are some of the start-ups in South Africa that provide blockchain education and services.

More established businesses like IBM, Consensys, Oracle, Accenture and others also provide education in blockchain technology. Luno and ValR are crypto exchanges that enable South Africans to purchase cryptocurrencies through their exchanges. This is further proof that fellow Africans have taken the opportunity to learn about this technology and positioned themselves to help the African continent to implement blockchain-related solutions. blockchain and cryptocurrency giants like Consensys, Binance[41] and Paxful[42] are also leading investments in African blockchain start-ups.

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[41] Binance Labs Seeking to Incubate African Blockchain Startups (2019) https://bitcoinke.io/2019/01/binance-labs-calls-for-applications-from-african- blockchain-startups/

[42] Welcome to the peer-to-peer finance revolution! https://paxful.com/

8.2 Stakeholders and Partners in Research and Development (R&D)

Research, development, and innovation need to leverage the creative skills of inquisitive minds on the continent and the diaspora. Skills are required from across all roles and industry is best placed to develop solutions and business models according to social needs and norms, whilst working with governments to protect society.

The need to hone in on knowledge creation, knowledge sharing, and solution implementation is now urgent. Thinkers, visionaries, intellectuals, and implementers are important cogs in the development wheels of research programmes that lead to market- ready products and services. In a digital world and for blockchain, we also need IT infrastructure, cryptography, web and app development, API development, networks, security, and data science skills.

8.3 Youth

"Youth are the backbone of society. Their participation in all aspects of society is very important at any time. Much effort is required for African youth to feel empowered and sufficiently trained to play an important role in society. Isolation of youth, either intentionally or unintentionally, can lead them to depression and migration, to name just two of many undesirable consequences".[43] This would be even more unfortunate given that youth is widely regarded as a net positive factor in the future realisation of a sustainably developed Africa.

For this, we propose the development of an ecosystem which can help our youth in taking advantage of the real-world challenges in Africa and provide solutions using emerging technologies to catch up with or leapfrog developed countries.

8.4 Incubation Centres

Today, incubation centres perform a fundamental part in a nation›s financial development and advancement. Small and medium endeavours are generally considered to play a noteworthy capacity in reducing poverty, economic growth, and creation of employment among the youth in developing countries. Incubation centres have generally acted as the drive behind economic growth, generation of employment and industrialisation. These can be housed within universities or specific, purpose-built incubation centres supported by public companies and tech providers.
The major objectives are:

·   Setting up and strengthening technology incubation centres in institutions of higher learning;
·   Nurturing technology entrepreneurship for commercial exploitation of technologies developed by individuals or
·   teams; Promoting product-oriented research and development;
·   Encouraging the development of indigenous products and packages; and
·   Bridging the gap between R&D and commercialisation.

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[43] Her Excellency Dr Dlamini-Zuma, former chairperson of the African Union Commission, on the occasion of International Youth Day https://www.niras. com/development-consulting/news/skills-initiative-for-africa/

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9

Recommendations

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Guided by the AU Programme on Infrastructure Development for Africa (PIDA), Africa is investing heavily in infrastructural development projects. Implementation of major infrastructure projects must incorporate sustainable knowledge management systems design as well as requisite human skills and competencies. While most of this knowledge has traditionally come from outside the continent, African institutions must take responsibility for integrating robust and sustainable knowledge production systems in major physical and digital infrastructure programmes.

The AU Agenda 2063 emphasises that Africa's growth, competitiveness, and economic transformation requires a sustained investment in new technologies and continuous innovation. Blockchain, as part of the emerging technologies adopted by the member states, can contribute to the goals set by the African Union.

9.1 Blockchain for Sustainable Development

According to the OECD[44] report, "Blockchain technology has the potential to assist in the achievement of the Sustainable Development Goals (SDGs) in numerous ways. This includes facilitating financial inclusion and banking the unbanked, ensuring that medicines and other products are genuine and reach their intended source, and transforming foreign aid delivery."
To this effect OECD recommends the following:

· Currently, there is a drive to experiment and use emerging technologies for efficient disbursement of funds and other goods within developing countries. To this effect, donors and other organisations have introduced pilot projects that range from blockchain to distribute humanitarian assistance in East Africa, the use of distributed ledger technologies in cash transfers, and programmes to improve digital inclusive finance. It is believed that blockchain can enable the trust in aid transparency, monitoring and evaluation which can facilitate a better understanding of what works and what does not work in development finance;
· Blockchain innovations should be further explored as a response to the imperative to do more to deliver on the SDGs, so funding can be optimised, and money can reach the people where it is desired to reach;
· Development actors should educate themselves on (1) how they can engage in blockchain opportunities, (2) where the use of blockchain can solve big challenges and (3) work together to capture the potential of the technology to leave no one behind.
· (4) Lastly learn lessons from Estonia, Malta, and Dubai to adopt the technology and follow the success stories.
At the 2020 Global Blockchain Policy Forum, discussions on how the OECD and its members could support developing countries in considering, opportunities to implement blockchain technology in their financial or public sectors.

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[44] The Policy Environment for Blockchain Innovation and Adoption (2019) OECD Global Blockchain Policy Forum Summary Report
https://www.oecd.org/_finance/2019-OECD-Global-Blockchain-Policy-Forum-Summary-Report.pdf

9.2   Continent-wide Strategy on Blockchain Adoption

The AU commission needs to take cognisance of the various member states, their specific developmental requirements, their status in terms of economic progress, education, governance, etc. which are pertinent in blockchain adoption. A well- thought strategy on Blockchain adoption is necessary as a starting point to roll out blockchain initiatives in favour of member states.

No state should suffer because they have no wherewithal, we need to cluster \ technology leaders such as South Africa, Kenya, and Nigeria, to mentor and uplift the other member states such that the strategy benefits every African citizen without discrimination. The strategy should be a live document that evolves with time and technology advancements; it incorporates new use cases and uses a testbed to evaluate the benefits of the Blockchain solutions.

The strategy, in addition to capacity and capability building, must lay emphasis on educating the youth to become entrepreneurs and skilled workers in blockchain technology products, so they can help build the nation with enterprising solutions.

9.3   Policy Formulation for Blockchain Initiatives

The blockchain panel has a few recommendations to propose to the AU and member states. Key among these recommendations is the formulation of policies and laws that create an enabling environment for the adoption of blockchain technology while protecting the data both in the public and permissioned blockchain in member states. The envisaged laws and regulations should strike the right balance in protecting population data while ensuring that these laws are deemed by innovators to be sufficiently flexible to retain those committed to entrepreneurship as well as research and development. That is not to stifle innovation going forward.

9.4 Capacity & Capability Development

African States would be better served by building the capacity of institutions to enable them to train communities on the right skill set, especially for the ballooning youth population in the continent to manage and sustainably run blockchain technology programmes. By default, these institutions should have linkages with international establishments with similar mandates so that the African blockchain development trajectory is aligned with those of international organisations. This is essential to avoid wasteful investments in technology solutions that do not meet regulatory, standards and other requirements outside of Africa's borders.

9.5   Public-Private Partnerships

Public and private partnerships should be supported to ensure efficient uptake of blockchain technology. A concerted effort should be made to attract global technology companies to establish their research operations on the continent. The young average age of Africans is widely regarded as a positive factor, and a lot must be done to capitalize on this advantage.

In deciding which Blockchain (and technology) projects to support, it is recommended that authorities consider the following key questions:

· What is the narrow use case being put forward?
· What is the purpose of the bigger offering within which this process exists? ; and
· Who are all the participants of this solution today?

This approach to blockchain solutions, in particular, will consider the full ecosystem of suppliers and customers across the value chain to ensure that the maximum benefit can be gained. Governments, corporates (especially financial technology companies) and educational Institutions should co-create sandbox environments to ensure that solutions developed for Africa or Member States protect citizens. This can be achieved through rigorous testing and understanding of the solutions from multiple perspectives, namely: business (people, process, consensus, incentives, and governance structures), information, data, application, technology, and token economy before they are taken to market.

9.6 Conclusion

Blockchain has the potential to significantly transform the fortunes of the African continent in critical aspects, especially public service, and the various economies. Hopefully, this document has shown real-life examples of Blockchain being in various stages of implementation globally and, especially, at home in Africa.

To date, most use cases will have an impact on financial services. In this area, the technology will change the lives of the unbanked in ways that include the transfer of cross-border remittances and community-based bartering. These changes would reduce poverty as they will reduce the worst levels of poverty prevalent in communities throughout the entire continent.

Government services are critical for service delivery and core services like identity, refugee, land, voting and health management would be vastly improved through strategic implementation of blockchain technology. Improvement in services at country level would go a long way in the quest to realise Agenda 2063 and other worthy ideals pursued by the African Union.

This report has identified various use cases that show promise as to how economies would be gradually but surely transformed by blockchain. Specifically, applications in supply chain management and financial sectors are just a few examples of how the alignment of cross-border trading would be enhanced. Therefore, it is conceivable that the implementation of blockchain solutions could be one of the many interventions that could contribute towards the economic unification of different regions and, ultimately, the entire continent.

While cryptocurrency risks are real, we must not be blind to the new models of capital raising that are associated with them. Initial Coin Offering (ICOs) and other examples of the emerging token economy are worthy of attention from regulators, not only to mitigate risk but to look for solutions for funding new infrastructure projects, businesses for entrepreneurs, especially the youth. The risks associated with cryptocurrency are acknowledged but the distinction between cryptocurrencies and the underlying (blockchain) technology needs to be recognised. It bears repeating that public blockchain has not been compromised to date. Other risks have been cited in this report, but they should be expected as is the case with any technology, whether emerging or established. What matters is that they are identified, and solutions are being worked on daily and the advance of technology suggests that the benefits will outweigh residual risks.

Risks that aren't associated with the technology per se depend on regulators for mitigation and it is hoped that the necessary regulatory interventions will not retard progress and innovation, which are sorely needed to reduce the continental challenges of (youth) unemployment, poverty and in some countries, massive inequality.

 It is difficult to accurately predict how much transformation will be driven by blockchain, but what is certain is that Blockchain can be one of the mixes of technologies that, if strategically deployed and supported by a pro-innovation regulatory environment, will catapult Africa into a much more competitive continent with a much-improved quality of life for its populace.

10

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