

What are the key innovations behind Africa's rapid development?

Contents

Table of Contents

Contents	1
Abstract	1
Introduction	1
Literature Review	4
Methodology	6
Discussion	6
Connecting the World	6
Industrialisation	12
Digital Revolution in Africa	15
History of Finance & Banking	18
Banking and Industrialisation	23
Cryptocurrency in Africa	24
Conclusion	25
Reflection	26
References	26
Appendix	31

Abstract

This research looks at the history of internet and the projects that many organisations are completing to help Africa get connected. With a heavy interest in industry, this work looks at the timeline of industrialisation and the move into Industry 4.0. Africa are currently moving into this era due to the connection support from Google. Financial technologies have come a long way in recent years and a look into previous and modern technologies were completed. With industry being heavily supported by banking and finance, an in-depth investigation in how England was supported during their first industrial revolution to the modern day. With this knowledge, the comparison to how Africa are now developing and understanding how they can progress with new financial technologies. As with most areas of the world, cryptocurrency is starting to become more popular. This is very much the case in Africa as many countries are currently in the top five nations in the world for trading cryptocurrency. Although the technology is blocked by the policymakers, there is still a huge drive for adoption.

Introduction

There is a huge push in connecting third world countries and have been led by large organisation such as Google and Amazon. The sheer scale of the projects provides significant difficulties, and the problems made the projects cease operations. The Connection Africa Summit highlights the agenda for the United Nations and illustrates the power and potential of public-private partnerships. It joins together the African Union, the

African Development Bank, the UN Economic Commission for Africa, African governments and the private sector to tackle the obstacles to connectivity in the region. Google's project 'Loon' mission was to use the internet-connectable high-altitude balloons to deliver coverage to rural Kenya (Hole, 2019). With a population of over 45 million people, Kenya is the seventh-largest country in Africa and its eighth-largest economy. Even though its metropolitan centres are well connected, there are still many rural and suburban areas that remain without internet connectivity (Zukang, 2007). There is such a high emphasis on connecting Africa as it is stated to have only 18% of the population with access to the internet. There are many benefits to connecting countries like Africa which have significant untapped resource. It is intriguing to establish if connecting countries to the web can affect Gross Domestic Product (GDP) and support the change in industrial revolution.

The first development of technological change in history starts with innovations associated to steam power, cotton, steel and railways, coupled with mechanisation and the arrival of the factory system. The Second Industrial Revolution was initiated by the introduction of electricity, heavy and mechanical engineering and synthetic chemistry in the second half of the nineteenth century. The Third Industrial Revolution was driven by innovations in electronics and computers, petrochemicals and aerospace, together with demand becoming more volatile in many sectors in the last decades of the twentieth century. Each industrial revolution played a part in a country's economic growth. The next industry revolution is known as Industry 4.0. It is misleading to say that industry 4.0 is a new model that is totally oblivious of the industrial revolutions that occurred in previous decades. As a matter of fact, industry 4.0 fully utilises all the fundamentals of previous industrial revolutions. The main differences are with higher rates of integration, digitisation, virtualisation, technologies, and rapid response times.

Understanding where Africa currently resides regarding the industry revolution, is important to see how much support they need. With a new industrial revolution being implemented called Industry 4.0, there is opportunity to use many innovative resources which can create economic growth. "The history of the industry since its inception is marked by the acquisition of great knowledge, events, and discoveries that have changed the structure of cities, their populations, the types of products they offer and the way they offer them, innovation in the development of production processes, and the way employees work, among many other aspects" (Chromjakova, et al., n.d.). Innovation plays a significant part in the changing of industries and will ultimately be called disruptive in the early stages of adoption. Nevertheless, Innovation is important and the process of creating new knowledge that can be converted into innovations that drive the competitiveness of companies, industries and countries. Several new technologies are generating economic and social change: both shift the techno-socio-economic model of the economy and society.

It has been stated that banking is a catalyst for economic growth. To understand and agree with the statement, several areas need to be researched and explored. Schumpeter's Theory of Economic Development highlights a direct correlation to the growth of economy to the introduction of financial institutions. This is also confirmed by Gerschenkron's statement of banks being at the centre of economic growth. New financial technologies are

driving a new revolution in this sector and mobile devices are at the centre of this revolution.

The new age of digitation of finance and banking will play a significant role in economic growth. With Industry 4.0 being heavily focused on digitisation, it will be paramount that countries are connected to the internet. A mixture of cyber-physical systems, the Internet of Things and the Internet of Systems make Industry 4.0 achievable. It is important to understand if the integration of networks and 'clouds' can really impact the a countries GDP or if it will be disruptive in economic growth. (Chromjakova, et al., n.d.).

This was proven by a previous scheme called M-Pesa. Due to the inexpensive technology of mobile phones and devices becoming more widely available in developing countries, the M-Pesa project has positively affected the Kenyan economy. The program has considerably grown in terms of subscribers and the total of electronic funds transferred through it. M-Pesa's local success has driven its launch in several countries outside Kenya. This scheme is just one financial technology (fintech) that can be implemented in third world countries and there are many rivals to M-Pesa that are looking at ways to unlocking more ways to transfer and use currency. Is M-Pesa type schemes the future or is there is a new wave of finance incoming?

This work will also discover if cryptocurrency can be a facilitator for underdeveloped countries to 'skip' certain industrial ages and create a more cyber world. Over a third of the world population does not have access to fundamental banking services that can support them in certain cases of financial crisis (Finextra, 2019). To deliver a complete synopsis of the prospects of crypto currencies in Africa, it is crucial to understand the advantages and limitations crypto currencies offer for users compared to central bank-issued fiat currencies, such as the Euro or the US dollar, and to highlight how they emerge from the fundamental technology. This body of work will explore what opportunities crypto currency can offer and whether it can be a real benefit to the economic growth. It has already been stated that there can be a rise in economic activities due to cryptocurrency. The speed at which the cryptocurrency industry is developing is momentum and this can be established by initial adopters that became wealthy overnight and found opportunities to grow financially. Bitcoin, the most prominent of these cryptocurrencies, has already allowed many people and companies to advance and grow, whereas many also rely on trading as their source of income. The economy is gradually shifting to adapt to these needs and cryptocurrencies have an abundant potential in satisfying them. As with everything, there are advantages and consequences with adopting such technology. Cryptocurrency can speed up transaction times but if not policed correctly, there will be issues. The technology allows users to keep their identity a secret and may lead to security issues. This may be countered by creating complete transparency of the transactions that are kept in a public book is attained thanks to decentralisation managed by a public blockchain. The activities are clear and there is nothing hidden. This is incredibly important to generate confidence. (Daviescoin, n.d.). The adoption of blockchain is vital in the transition to cryptocurrency as it is the system of recording information. Bitcoin was intended to solve the issues above. By using a specific type of database called a blockchain we can create trust within the community. Most

standard databases, such as a Structured Query Language (SQL) database, have someone in charge who can modify the entries. Blockchain is different since nobody is in charge. Ultimately it is run by the people who use it. Additionally, bitcoins cannot be faked, hacked or double spent. Therefore, people that own this money can trust that it holds value. Blockchains have affected fields like e-healthcare, Internet of Things, smart contracts, e-finance and logistics. (Sharma, et al., 2020)

This dissertation will collate all the information from the above topics and conclude on whether the new age of connectivity and finance can springboard a country/continent into economic and social development. Will innovation be the key to facilitating Africa in gaining positions in the world GDP rankings? Cryptocurrency has many other benefits and Africa adopting such projects will create a more sustainable, more educated and drive social wellbeing.

Literature Review

There has been extensive research completed to find literature which will combine to determine on the important of innovation and finance in the growth of the economy. The literature will feature greatly on Africa and where they are currently industrially, socially and economically. Each industrial revolution is scrutinised from previous work and will discover where many influential countries sit in their industrial journey. The new wave of currency will be studied and due to the high popularity, there will be no shortage of important and captivating work.

The initial literature will be surrounding how companies have attempted to connect countries with internet. Conferences and articles from The Institute of Electrical and Electronic Engineers will highlight exactly what projects Google have completed and the effect they had. This will be supported by additional articles to understand the true effect of the projects.

The history of industrialisation will be assessed and literature surrounding the newest industry revolution will be the focus. Reports from IntechOpen will show the current status of industry 4.0 and what the future trends may be. This will be supported by many articles and journals. The main focus of the journals will be how the industry 4.0 can affect third world countries. Innovation is a key part of the transition to industry 4.0 and there will be significant research in how this is seen in the current climate and how this will benefit underdeveloped countries. The literature explains each industry revolution and will aid in identifying which country is currently ready for industry 4.0 or are currently fixed to a 'previous' industry. The Industrial Revolution in World History will be the centre of this research and will give a great insight to where countries are currently and heading to.

With finance being touted to be the catalyst to economic growth it is important to find respectable literature to back up the claim. Work from Schumpeter highlights how important banking is in the development of a country's economy and has shown how European countries benefited from financial institutions. This will be an important aspect to understand and similarities to other countries can be made. The article Banks as Catalysts

for Industrialisation will produce a theory on the role banks played in industrialisation and show how it even produced new industries in certain countries. The work from the National Bureau of Economic Research explores Rosenstein-Rodman's idea that is simultaneous industrialisation of numerous sectors of the economy can be profitable for all of them, even when no sector can break even industrialising alone. The new age of fiancé is coming and work from numerous economists will be explored to understand whether the changes to a decentralised banking system will be beneficial to Africa.

Article from many journals will be included in this work due to the importance of understanding what Industry 4.0 is capable of. There are an abundant of journals that will be used to identify which areas on industry 4.0 can be adopted in Africa and underdeveloped countries. A blog post from Christina Golubski titled 'Capitalising on industry 4.0 in Africa' does express that there are many exciting opportunities given to Africa if it can ensure the policymakers ask the correct questions and capitalise on the revolution. The blog also mentions an event called 'Industry 4.0 in Africa: Helping or hindering?'. This event along with other articles will be explored to back up or scrutinise any points the blog has made.

Work from Scott Burns will be assessed due to its excellent summary of M-Pesa or what he calls 'the mobile money revolution in Sub-Saharan Africa'. The article shows that the greatest examples of financial development have come from nations embracing a market-led approach that removes repressive regulations and gives entrepreneurs the freedom to discover innovative ways to access the unbanked. This work is supported by a journal article written by Caroline Ntara. The piece 'An Analysis of M-Pesa Use in International Transactions' details how the program has extensively grown in terms of users and the amount of electronic funds transferred through it. The work also states that M-Pesa's local success has prompted its launch in several countries outside Kenya. An understanding what the technology has done to Kenya and other adoptees will be explored. With all new innovations there will be significant teething issues, and these will be shown and explained from various literature including the work above.

With Cryptocurrencies popularity at an all-time high it, there will be a ludicrous number of journals that will be used explain the benefits and limitations to the technology. Even blog post from Finextra will give a very high-level view of the benefits of cryptocurrency but must be supported by more respectable sources. A paper from Moritz Holtmeier and Phillipp Sandner studies the impact of crypto currencies on people and industries within developing countries. The purpose was to show decisionmakers the opportunities to use crypto currencies to decrease developmental barriers. This work will show a great insight in how the new technologies can be utilised but does not show the full picture. Adoption will always be questioned when a new innovative technology is presented. Work from Ed Saiedi, Anders Brostrom and Felipe Ruiz discover the worldwide spread of infrastructure necessary to maintain and grow Bitcoin as a system and infrastructure supporting the use of bitcoins for everyday economic transactions. Understanding whether Bitcoin can be a leader in the region or other coins can be superior is key to the research. Additional statements in the article that questions why there is such a drive for a new financial system. In recent time, cryptocurrency has been presented and shown during project from other coins within the region. Research into these coins and exactly what they do will be supported by reports and

journals. Due to the newness of the adoption in Africa, it will be difficult to find reputable articles and assumption will be explored. There are many other coins that can be considered, and literature will be found highlighting the benefits and drawbacks of a coin. With the research in to Blockchains being critical in understanding the capabilities and recognise how blockchain technology can contribute to smart cities. Literature will be examined to see if this enables countries and cities to grow industrially. Work from Jianjun Sun, Jiaqi Yan and Kem Zhang try to show exactly that. From the article common links will be made and conclude on whether blockchain technology can aid industrial and economic growth.

Methodology

Each of the aspects above give clarity on how important innovation and change is to the industrialisation of a country. From early industrialisation to the new period of industry, each era brings insight to state of each country's economy. Digitisation is key to driving countries forward and must not be overlooked. Many projects have proven to have a great impact to areas within underdeveloped countries and many more are in the pipeline. Finance is deemed to be an essential component to industrialisation. The history of financial institutions has proven this in many cases. The new finance technologies (Fintech) that have begun integrating into many people's lives cannot be ignored. Fintech include the development and use of crypto currencies such as bitcoin. While you may see fintech in most headlines, the big money still lies in the traditional global banking industry and its multi-trillion-dollar market capitalisation. Nevertheless, a new wave is coming, and early adopters will see significant gains compared to its competitors. Underdeveloped countries are considerably behind, and it would be foolish to not take the opportunity to transition ahead of time. A lot have been done by large corporations to connect Africa and this thesis will explore how the continent can benefit from innovations.

Discussion

Connecting the World

The first description of what we call the internet can be dated back to the memo written by J.C.R Licklider in 1962. He described his theory as a Galactic Network concept. His vision was a global interconnected set of computers through which all users can quickly access data and programmes from many sites. His innovative and far-sighted idea also outlined several features the Internet offers today: graphical computing, user-friendly interfaces, digital libraries, e-commerce, online banking, and cloud computing (Internet Hall of Fame, n.d.). The concept resembles what we see the internet as today. If it was not for Licklider convincing his successors of the importance of his concept, we may not have the internet today. Leonard Kleinrock, a colleague of Licklider at Massachusetts Institute of Technology (MIT), published a key paper surrounding the packet switching theory. Kleinrock convinced fellow scientist Lawrence Roberts of the theoretical possibility of communications using packets rather than circuits, which was an important aspect towards computer networking. The additional step was to make computers talk to one another. This was first investigated by work involving Thomas Merrill, Roberts connected the TX-2 computer in Mass to the Q-32 in California with a low-speed dial-up telephone line generating the first wide-area computer

network ever constructed. The results shown by this experiment was a realisation that time shared computers may work well together by running programs and retrieving data. The outcome did confirm that the initial suggestion of using a circuit switched telephone system was insufficient for the task. Due to these findings, packet switching was the network chosen. The main difference between circuit and packet switching is efficiency. Due to the data being broken down into smaller data packets, they can then find the most efficient route available. Packet switching can also be seen as a way of reducing lost data packets due to switching allowing resending if packets (Brunau, 2020). By 1966, Roberts joined Defense Advanced Research Projects Agency (DARPA) to develop a computer network concept and highlight his plan for what he called the 'ARPANET'. A key component of the ARPANET was the packet switches called Interface Message Processors (IMP's). the development of these components was open for tender and was won by a group led by Frank Heart at Bolt Beranek and Newman (BBN). The team operated on the IMP's which played a massive role in the ARPANET architectural design, the network topology and economics. This was then optimised by Roberts cooperating with Howard Frank and his team at Network Analysis Corporation, and the network measurement system was primed by Kleinrock's team at University of California Los Angeles (UCLA). Since Kleinrock's involvement in the project, his network measurement computer was nominated to be the first node on the ARPANET. This was closely followed by another node being connected at Stanford Research Institute (SRI). In the years following, another 4 computers were connected on the ARPANET and the project was off the ground. Work continued finalising a functionally complete Host-to-Host procedure and additional network software. There were two key moments in December 1970 that helped shape the ARPANET. December 1970 sparked a surge in users and expanded to 10 nodes and 19 hosts computers. Four months later, the ARPANET had grown to 15 nodes and 23 hosts (Navarria, 2016). In the same month the Network Working Group (NWG) working with S. Crocker completed the initial ARPANET Host-to-Host procedure, called the Network Control Protocol (NCP). As the ARPANET sites completed implementing NCP during the period 1971-1972, the network operators could start to develop applications. Opening the network up for the public to develop applications, created a possibility to expand at a rapid level. The network was presented at the International Computer Communication Conference (ICCC) in 1972 with the inclusion of an initial mail application. This was the first case of transferring a message using basic email message send and read software. This continued when Roberts began developing the first email utility program to list, selectively read, file, forward and respond to messages. This is very much alike the email activity we see on the internet today (Ryan, 2010). With expansion comes volatility. The ARPANET combined and grew while remaining its anonymity to the general public. Due to the instability of the network, the Defence Communication Agency (DCA) took control. This action was deemed to be too late due there being 57 nodes already on the network. The larger the network grew the more difficult it became to determine who was on there. The combination of fast growth rate and lack of control became a serious problem for national security. The DCA, did try to control the situation by issuing several warnings against any unapproved access and use of the network. These warnings were mostly ignored and by the 1980 the network developed into an open access for official and unofficial users. With the use of computers rising, the potential threat of excessive growth was a major concern (Leiner, et al., 1997). This threat became a reality by mid 1980s when there was around 2000 host computers on the network. By 1987, as network traffic amplified, the National Science Foundation (NSF) commissioned International Business

Machines Corporation (IBM) and MCI to construct a new backbone, using TCP/IP procedures. Due to the original ARPANET backbone was almost 20 years old, it was decommissioned, and the original ARPANET was superseded into NSFNET. This led to it changes from ARPANET, and NSFNET to eventually become the Internet, a government owned network for the US academic and research community (Compbell-Kelly & Garcia-Swantz, 2013). From 1991 to 1995, the ways for browsing the Internet were disputed by both public and private groups. In 1993, the most common browsing aid was a system called 'gopher'. This was a key movement in the beginning of the World Wide Web as it showed potential ways of managing the internet. Gopher was constructed by scholars from the University of Minnesota as a way of finding documents on the internet with files that include human readable text. Gopher would then lead to its failure due to the University wishing to apply a licence to the software (Gihring, 2016). Another server like Gopher was Wide Area Information System (WAIS). This system was the first private initiative that incorporated content instead of just infrastructure. The WAIS was founded by Thinking Machines, Apple computers, KPMG and Dow Jones. The rise of the World Wide Web killed the momentum of WAIS and after it was acquired by AOL it is unclear what happened. The Web took over from the other systems and was deemed unique. This was due to the documents containing links to other documents. During 1993 the growth of the Web was significant growing over 130 servers. The growth was solidified when the development of MOSAIC web browser. The MOSAIC browser was a typical example of user-friendly, point-and-click software. This was released to the public in November 1993, and about a million copies were downloaded (Compbell-Kelly & Garcia-Swantz, 2013). The true benefit of internet is collaboration. The internet removed boundaries which is key aspect to development. The introduction of the internet was an industrial revolution and propelled civilisation. The internet is a large social disruption that brings with it not only new inventions and scientific advances, but perhaps most notably revolutionises both the ways of working and the workers themselves (Kaufman, 2012). After World War II in America labour productivity grew at almost 2.5% annually and allowed the standard of living would dramatically increase. This would slightly reduce from 1973-1995 to around 1.4%. reasons for this were the increase in energy prices and inflation. the larger gains can be seen from 1995 onwards. This falls in line with the development of the internet and where collaboration begun. From 1995 there were close to 3% gains in production. Although not completely linked to the internet, heavy investment into computer and telecommunications technology played a substantial role in the surge (Rivlin & Litan, 2001).

"From an obscure network of researchers and technology three decades ago, the internet has become a day-to-day reality for more than a quarter of the world's people. Today two billion are connected to the internet and almost \$8 trillion exchange hands through e-commerce each year" (Manyika & Roxburgh, 2011). This statement highlights how important the internet is to modern civilisation. The internet aids a countries GDP massively and there are statistics to back it up. "If the internet consumption and expenditures were a sector, its weight in GDP would be bigger than the energy or agriculture industry. The internet's total contribution to global GDP is bigger than the GDP of Spain or Canada, and it is growing faster than the GDP of Brazil" (Manyika & Roxburgh, 2011). This is staggering and with the statement being written in 2011, the growth since then has be monumental. This is supported by a study led by Harvard Business School, and it found that the internet economy grew seven times faster than the total U.S. economy during the past four years

and now account for 12% of the U.S. GDP. This helped create over 7 million jobs from 2017-2021 (IAB, 2021).

In recent years there have been a considerable drive to connect certain underdeveloped countries to the internet. Connecting these countries will help boost economic and human development. The internet will help improve essential services such as education and healthcare which are even more critical to underdeveloped countries. It is an enormous task to expand broadband to all but there are companies that are trying their best. As little as 35% of the population in underdeveloped countries has access to the internet compared to 80 percent of advanced countries. The internet has also developed a foundation for smart infrastructure that is enabled by new wireless technologies. It can support the creation of jobs in information and communication technology (ICT), engineering and other areas, as well as help accelerate job skills development, which is an important path toward poverty reduction and shared prosperity (World Bank, n.d.).

World Bank have been making progress is trying to connect countries through innovative strategies and models. Their initial plan was to help governments and companies employ sector reform to encourage private investment. "The public sector is the largest spender and employer in virtually every developing country, and it sets the policy environment for the rest of the economy. About one-sixth of World Bank projects in recent years have supported public sector reform. Improving the efficiency of government counterparts is also essential for the effectiveness of the Bank's support for development" (Webb, et al., 2008). Additionally, World Bank has issued over \$1.3B to contribute to projects for submarine cables and terrestrial backbone networks for specifically the south pacific, Caribbean and Africa. World Bank also invested in many more private ventures that aided in the expansion of digital infrastructure in the Democratic Republic of Congo, Gabon, The Gambia, Guinea, Liberia, Burundi, Malawi, Rwanda, and São Tomé and Príncipe (World Bank, n.d.).

Google have been the leader in connecting Africa to the internet. They have been leading the large projects which have been exceptional in helping countries in Africa grow economically and socially. The two major projects are Loon and Equiano. Project Loon is a unique project which at first sight seems unthinkable. The project involves a network of balloons which travel on the edge of space to connect people in remote locations. The main aim for the project is to reduce the coverage gaps and to ensure continuous network connectivity after disasters. If a disaster does occur, Loon balloons would be launched. One of the balloons, that is the closest to the location which has Internet access, creates a connection with the nearest mast. Additional balloons arrange a mesh network in the stratosphere through the actions above. Mobile devices on land can join the nearest balloon network in the sky over Wi-Fi and communicate with the balloon. The balloon advances the received data packets from the mobile device to the neighbouring balloon through the mesh network. If a balloon, which has an Internet connection, receives the packet, it sends the packet to the access point on ground (Tiwari, 2016). The impressive technology collects data to help accurately track, manoeuvre and observe the health of the balloons. Therefore, the speed, direction, temperature and GPS location is tracked to understand the exact scenario the balloon is facing in the air. Another impressive feature of the loon balloons is that a single balloon can provide coverage to near 40km diameter and provide connectivity to over

100 users at once. A common concern of the public is around security and integrity of the network. The data transmitted through the network is automatically encrypted and access can only be granted through designated Loon internet antennas (Kaur & Randhawa, n.d.).

The first tests began in 2013 in New Zealand where Loon technology was trialled by a small group of innovators. The trials were also extended to California's Silicon Valley and Northern Brazil in preparation for real life deployment. The project showed how great it can be in 2017, when flooding in Peru and a major hurricane in Puerto Rico knocked out life-threatening infrastructure. The Loon team deployed balloons to the disaster regions and delivered vital emergency connectivity to hundreds of thousands of people (Loon, n.d.). In Africa, Loon's research was run in Kenya in partnership with Telkom Kenya, Kenya's third largest mobile network. Loon launched 35 balloons mainly away from Nairobi, the country's capital, that is already saturated with internet connection from mobile network operators (Mbamalu, 2021). The initial service in Kenya was to supply connectivity to almost 50,000 square kilometres in western and central areas of the country. These areas include Iten, Eldoret, Baringo, Nakuru, Kakamega, Kisumu, Kisii, Bomet, Kericho, and Narok. To cover this region a total of 35 balloons were deployed into the stratosphere. Loon team also proposed launching more balloons in these areas to increase the coverage and ensure consistency. Initial tests showed very promising results. The service in the regions saw upload speeds of 4.74Mbps and download speeds of 18.9Mbps with 10ms in latency (Westgarth, 2020).

In 2020 the project was set to be grounded and questions were asked whether it was a success. Even though the coverage to Kenya was impressive, it was deemed as a little too late. The last decade has proven a significant improvement in mobile broadband across many areas. The issues arise when understanding who and how many people are using that service. People did not use the system due to illiteracy and lack of digital skills. Additional underdevelopment also played a part. For example, the average cost of an entry-level internet-capable phone in sub-Saharan Africa was more than 120% of income for the poorest 20%. Furthermore, Gender inequalities play a role. An instance of this is women in South Asia are 51% less likely to use the mobile internet than men, thanks to a lack of financial autonomy and disapproval in more traditional cultures.

Google increased its activities in connecting underdeveloped countries when they announced the Equiano Subsea Cable Scheme. Google's cloud global network spans over 22 regions, 67 zones and 140 places of presence. Google has an ownership stake in 14 subsea cable projects, but Equiano is the third Google-owned subsea cable. The two previous schemes are Curie stretching from Los Angeles to Chile and Dunant from the eastern United States to France (Shankland, 2019). Google's plan is to ensure the increase in internet traffic between Europe and Africa has additional capacity routes between the continents. The increase in capacity also allows Google to improve its presence and use of services between Europe and African countries. The scheme plans to run a cable system from Portugal to South Africa that has many branches to connect various countries along the route. The state-of-the-art cable system is based on space division multiplexing technology (Copenhagen Economics, 2021). Over the last decade optical communication technology has advanced significantly and has supported the needs of modern civilisation. Most of the progress has been in discovering innovative ways to increase the data-carrying capacity of a single optical fibre. This is achieved by researchers' attempts to optimise multiplexing in

time, wavelength, polarisation and phase. Commercial systems now use all areas to send additional information through a single fibre (Richardson, et al., 2013). The project predicts it will be able to transfer 12 terabits of data per second for each fibre on the Equiano cable. This is around 1200x the maximum speeds of modern computers, but subsea cables and various long range fibre optic lines generally send an uninterrupted transfer of data rather than short bursts that most computers and phones need (Shankland, 2019).

With more and more countries trying to connect to the network it is clear to see that there is a severe need to increase the data converge in the region. An agreement has been made on Paratus helping supply members of the Southern African Development Community (SADC) with high-speed internet. Paratus is the landing agent for the Namibia branch of Equiano. Paratus is a prominent pan-African network provider with operations in six SADC countries, which include Angola, Botswana, Mozambique, Namibia, South Africa and Zambia. It has extended network that provides satellite connectivity which focuses its services in 22 African countries with an additional 4000 satellite connections across the continent. The additional capacity offered by the Equiano cable, the largest on the African continent, further strengthens the Paratus SADC footprint and European network connection, as well as the providers long-term growth plan (Qiu, 2021).

It is stated that between 2022 and 2025, the average yearly real economic growth is expected to increase by 0.57 points, 0.32 points and 0.56 points in Nigeria, South Africa and Namibia all due to the Equiano project. By the end of 2025, the real GDP in these countries is predicted to increase by \$11 billion, \$5.8 billion and \$290 million, respectively. It is also forecasted to indirectly create 1.6 million jobs in Nigeria, 180,000 in South Africa and 21,000 in Namibia during those years. This is due to the improvements in connectivity that will expand the digital economy and peripheral sectors. An issue with internet in Africa is that the cost can be extortionate relative to the average incomes of citizens as mentioned previously, for many people in Africa, affordability of data with the high cost of smartphones, low awareness of mobile data and lack of skills create barriers to accessing the internet. Equiano is prepared to bridge the gap and ensure the cost of internet is reduced in the region. The price of long-haul transmission of data is a key factor of local IP transportation prices. Equiano's landing will generate a new, high-capacity route for international data transmission. The cable's reduced installation cost relative to design capacity, including the increased competition for the long-haul transmission of data, will be responsible for lowering IP transit prices. This will then lower IP transit prices and the savings could be passed on to end users through reductions in internet prices. This could also indirectly lower the costs through the supply of more data, uncapped data limits or faster speeds at the same price. Expected decline in IP transit prices are 56% in Nigeria, 57% in South Africa and 46% in Namibia respectively. Reduction in retail internet prices is expected to be 21% in Nigeria, 21% in South Africa and 16% in Namibia (Google, n.d.).

There is not a tech company that can fully solve this issue within Africa. This does not mean the population are powerless. If Google's end goal is to increase the use of mobile internet, it could help the governments in emerging markets to reduce obstacles to import low-cost used computers and mobile devices. It could also follow the lead of India's Jio Platforms Ltd. The scheme offers cheap feature mobile phones in low- and middle-income countries. The JioPhone was announced for less than \$20 in 2017, has sold more than 100 million

devices, and facilitated greatly to closing India's usage gap. Reducing illiteracy and improving digital skills will be more challenging. This should be an area where tech companies could support by developing voice-based interfaces for low-cost phones. Google could also increase its U.S.-based efforts to boost digital skills training in underdeveloped countries. Additionally, it can partner with local organisations and governments to fund adult literacy programs in regions, such as sub-Saharan Africa, where illiteracy is high. These steps will not advance Google's reputation for innovative technology but may over time, solve an issue that could make the world a better place. They could also make sure that the company's next invention aimed at developing markets does not fail at the first hurdle (Minter, 2021).

Industrialisation

Industrialisation is defined as a historical succession of ages of universal adoption of a variety of technological and organisational innovations. In combination they have allowed great rise in industrial output, productivity, and incomes, as well as reductions in the amount of time worked. Industrialisation first began in England during the 18th century. The initial technological innovations transform the production of textiles and rise to what became a new method of manufacture. This was known as the factory system.

The First Industrial Revolution began in the 18th century using steam power and mechanisation of production. What before produced threads on humble spinning wheels, the mechanised version produced significantly higher the volumes in equal time. Steam power was not a breakthrough during this era. The use of it for industrial purposes was the greatest breakthrough for increasing human productivity. Instead of weaving looms powered by humans, steam engines could be used to generate energy. Improvements such as the steamship or later in the century, the steam-powered locomotive that brought further substantial changes because humans and goods could move great distances in fewer hours (Desoutter, n.d.). Coal and Abraham Darby's coke in combination with the stationary steam engine set an end to fuelwood and charcoal shortages and offered for spatial power densities previously found only in locations of abundant hydropower. Charcoal and the puddling furnace produced the first industrial commodity and structural material. This material is what we now call wrought iron. Innovations in spinning enabled a reduction in costs and rising throughput, specifically in the production of cotton textiles. The connection of innovations relating to cotton textiles, the coal and iron industries, and the introduction of steam power constitute the heart of Britain's Industrial Revolution (Grubler, 1995).

The second Industrial Revolution was, very much a continuation of the first. In many industries there was direct continuity. However, it did differ in several crucial aspects. The introduction of chemistry including the production of synthetic chemicals was prevalent in the second industrial revolution. Germany was the driving force in this sector. While Britain were still capable of achieving such scientific discoveries, the patient, systematic search for resolutions by individuals with formal scientific and technical education matched the German traditions better. Despite the German dominance it was an Englishman who made the first major discovery for the modern chemical industry. It is rumour that the discovery

was made more by luck than judgement. Comparable to chemistry, electricity was an area in which new information was taken to solve economic issues. The use of electricity as a main method of transmitting and using energy was theoretically even more of a challenge than the development of the telegraph. Before it could be designed to function, an efficient way had to be invented to generate electric power using other sources of energy devices to transform electricity back into kinetic power, light, or heat at the receiving end had to be created. In addition to this, a way of transmitting current over large distances had to be developed. Electricity came in two forms, alternating and direct current, and a choice had to be made regarding which of the two forms was to dominate (Mokyr, 1998). Production engineering was deemed to be vital in the world's development in the nineteenth century. The second Industrial Revolution witnessed the growth in some industries of huge economies of scale and throughput. The efficiency in production was driven by developments in machines, tools, and computers which gave rise to the automatic factory (Briannica, 2021).

The third industrial revolution saw the global economy slowing down, productivity declining in many regions and unemployment remaining high in many countries. During this time, it was important to try keep productivity consistent and maintain growth. Another difficulty with this revolution was the damage done by the previous revolutions. After the two Industrial Revolutions in the 19th and 20th Centuries, the economic inactivity is deepened by the rapid acceleration of climate change brought on by the increasing emissions of greenhouse gases and associated rise in the Earth's temperature (Letzeburg, n.d.). Innovations in the electrical and computer industry was pivotal during this time. This led to this revolution to be called the digital revolution. This was also due to the introduction of automation using memory programmable controls. The main point of this phase maintaining mass production and extensive use of digital logic, metal-oxide-semiconductor (MOS) transistors, integrated circuit chips and their resulting technologies. This also included the use of computers, microprocessors, digital cellular phones and early access to the internet. This made serious changes to how we would mass manufacture products and was capitalised on by adopting new innovations. There are significant financial gains when implementing robotics into the plant and the third industrial revolution era exploited it very well. The pay back on these machines could be less than one year and remove some human error (Dima, 2021). Internet played a pivotal role in this period and shaped the future for manufacturing.

The fourth and current industrial revolution is said to be Industry 4.0. This time is said to be the last advancement of humanity and has started with technological advances due to what the population has to their disposal in recent times. Similar to the third industry revolution, it revolves around cyber systems. It is predominantly based on the digitalisation, automation, personalisation, customisation, and integration between IT management systems and production systems within factories. These systems will allow for smart machines, storage systems and production facilities that can autonomously communicate to each other, initiate actions and control the system without human interaction. This can be completed due to a system known as the Internet of Things (IoT). This is one of the key aspects of the revolution. The other features are cyber systems, cloud computing and cognitive computing (Supply Chain Game Changer, 2018). Additionally, it is said that

industry 4.0 is capable of lowering production costs, logistic costs and quality management costs. With the use of many sensors all connected to a 'cloud' or server to be used to process data. This shows that the information is closely associated to the characteristics of Big Data and data analytics. Similarly, the IoT is connected to the cyber security feature due to the communication between the devices connected to the internet, communicating between themselves continuously, making them exposed to a computer attack (Intechs, 2020).

Industry 4.0 is not just developments on the factory floor. It is beginning to almost be a way of live for modern civilisation. For example, the world is on its way to being almost fully digital and this era is at the forefront for that. This is also confirmed by finance, industry and economy ministries making substantial efforts for the digitalisation of many companies. Another example of implementation within organisation is with the tax agency. If they were left lagging behind, immense damage could be done by criminal organisations as the move to digital currencies become more prevalent (Ortiz, et al., 2021). Industry 4.0 is set to have a large impact on the modern global economy. The introduction of over 10 billion mobile phone devices in the global market supplies extreme amounts of money to the global economy. "Mobile continues to make a significant contribution to the global economy. In 2019, mobile technologies and services generated \$4.1 trillion of economic value added (4.7% of GDP) globally" (GSMA, 2020). Opportunities like these are linked heavily with Industry 4.0 technologies. Banking, insurance, mortgage, forex, stocks, and many other financial divisions are flourishing due to the positive push of digital innovation and financial process automation in all countries of the world. There are many reports that mobile devices will become the new normal for banking activities. It is also stated that the developing regions such as the Asia Pacific and Africa are becoming the major player in the adoption of mobile banking in the world. The adoption of using computer algorithms have seen a dramatic rise in the United States. This has led to over 70% of stock trading decisions being based on computer algorithms decision. The confidence in technology is for all to see when only 10% of trades made by professionals. This saves a vast amount of financial consulting services. Technology powered micro-loans in Bangladesh opened a new era of financial enablement of the underprivileged people in rural regions.

Industry 4.0 does have a considerable impact on financial institutions and services. Using this technology will ensure there is minimal delays with transactions and very low charges. Another benefit is for financial institution to begin lowering their operational costs. Many operations can now be done via the internet and does not need an attendant in a store. Using new technologies allow for banks to expand over countries and continents. Bots are the future of customer support and if programmed correctly, the effectiveness can be great. Issues do arise when adopting new technologies but when the public begin using the software, trust will start to grow. Trust will also grow since there will be basically no human errors when handling financial activities. Without industry 4.0 it is unlikely that we will see the growth in this sector. Adopting new technologies will enable the emergence of new business areas such as FinTech, Payment gateways and many others. There is also hope that the revolution may aid financial inclusion of the poor and disadvantage people. "Information asymmetries, market segmentation and transaction costs – prevent poor people from escaping poverty by limiting their access to formal financial services, new financial technologies (FinTech) are seen as key enablers of financial inclusion" (Demir, et

al., 2019). New technologies in finance can also allow for an increased volume of liquidity. This enables companies to highlight its ability to pay debt obligations and hopefully bring in more business (Maverick, 2021). Businesses can also use the technology to create a more sustainable and cost-effective business. Software can now be used for vast amounts of tasks such as, accounts recording, cash transfers and document storage. Document storage is particularly useful when the company has a many offices across the world. Building a safe community is paramount and using the new digital revolution will help achieve this. Although there will still be issues, adopting the new technology will aid in reducing the number of fraudulent activities and burglaries. (Stefanuk, 2021) Arguably one of the most important aspects in recent years are the use of smart contracts by blockchain technology. Smart contracts will have a significant impact on how many companies will operate in the future. This was confirmed by two Barclays innovation experts when they stated that the smart contracts will shake up the business and banking world for the better. "Smart contracts are automated agreements that are typically built on blockchain technology, are making processes simpler, more efficient and faster than ever before, due to their standardised processes and reduced need for human input" (Barclays, 2020).

Digital Revolution in Africa

Adoption of these technologies are key in ensuring growth within underdeveloped countries and Africa is a prime example of this. Given how much you can grow within the twenty-first century, it would be foolish for countries not to use industry 4.0 to their advantage. For example, it offers important opportunities for African manufacturers and small and medium enterprises (SME) to generate new business models and integrate into global supply chains. In Africa's unique situation, policymakers must ask the right questions to ensure the continent can capitalise on the revolution. There are many organisations that aim to help countries progress. The Brookings Africa Growth Initiative and United Nations Industrial Development Organisation (UNIDO) are two which are trying to identify the challenges the "New Industrial Revolution" is producing as well as how all of Africa can benefit from Industry 4.0. Both organisations have highlighted strategies for capitalising on Industry 4.0 in Africa must be able to settle the tensions between Africa's existing low level of industrial development and deprived infrastructure with the high requirements of a digitalised economy. Julius Akinyemi, entrepreneur-in-residence at the MIT Media Lab, confirmed that connectivity, arguably the most important issue, must be improved. This is due to it not only enabling people but also increases trust in the region (Golubski, 2018). It is clear to see that reputable persons are raising issues in why Africa need to progress with industrialisation. It has been mentioned to be one of the most talked about topics among policymakers. Africa is said to be less industrialised today that it was around four decades ago (Tafirenyika, 2016). It is clear to see that the African people had little trust in the decision makers during these times. The people stated that if the leaders listened to professional advice and pumped profits into stimulating businesses, the results may have been different (United Nations, 2016). When this statement was made there has been a conscious effort from large organisations to progress the country digitally and improve connectivity status. This has led to digital trade growing rapidly in the region and fintech services have become a significant enabler for growth and financial presence by delivering big numbers of services to individuals with low financial services. Connecting Africa to the new wave of industrialisation since "Africa is still the least connected region compared to other regions of

the world with about 28,2 per cent internet coverage and 34 per cent to mobile broadband” (Songwe, 2020).

Through all the industrial revolutions, whether it is driven by steam, production lines or computers, they have all been slow to deployed in the African continent. Industry 4.0, clean energy and artificial intelligence (AI) will be difficult for the region, but it has significant potential to have a large rise in innovation which could restructure industries and improve well-being in all areas. In theory, this can be progressed easier due to the industrial change due to a digital age does not requiring great scientific knowledge or major capital investment. This enables entrepreneurs and innovators in evolving markets to begin thinking of new and innovative ways to develop the continent. With all the support from large organisations like Google, Africa is well on its way to taking advantage of the digital industrial revolution. The progress has been impressive in recent years in all aspects. Areas in which have seen the greatest gains are internet penetration, venture capital investment and creation of a more skilled workforce. The continent does fall behind its counterparts in key areas such as artificial intelligence, big data analytics and advanced robotics. There are still many success stories in Africa where global growth hot spots are emerging. Morocco has a 200-company automotive collective which are launching research and development enterprises and work closely with universities and manufacturers. In Nigeria, start-ups have started to attract lucrative investments from outside sources. Some of the innovative ventures are Jumia, Interswitch, Kobo360 and Andela. The companies are associated with education, fintech, agriculture, healthcare, logistics, and travel. This made Nigeria the leading start up destination in 2018 and recorded almost \$95 million in deals. Due to the relatively low cost of internet compared to other countries in the continent, it was a haven for firm to make it their African headquarters. Technology such as a mandatory national Identify Number (NIN) is next to be employed in the country. This is a unique identity system, and it is claimed to be essential to developing countries. Nigeria still has a way to go to ensure significant growth. A place where Nigeria can improve is its use of digital payments. Almost 87% of Nigeria’s economy is handled in cash and majority of Nigerians had never heard of mobile money. This must be governed by the policy makers and ensure the use of mobile money is more mainstream. Trust in the technology must be grown over time and the population will begin to adopt. Finance Technologies are taking Kenya to a new dimension and are paramount in transfer of funds to one another. Due to the adoption of M-Pesa, the mobile payment’s ability offered by Safaricom, over 70% of Kenyans have a mobile money account, and over 75% of Kenyans aged 15 or older made a mobile payment in recent years. Throughout the last decade, Kenya has progressed rapidly as a hotspot for some of the continent’s most innovative digital initiatives. These include Ushahidi, M-KOPA and M-TIBA. In Kenya there are more than 200 digitised services that are obtainable through Huduma E-Centres and inclusive online government to citizen services platforms (BBC News, 2013). Policymakers within Kenya have endorsed favourable regulations and have encouraged a high use of digital payments. Kenya still has a long way to improve its current situation. New-borns in the region today are only predicted to only reach 52% of their potential if they survive to adulthood (Samans & Zahidi, 2017). This frightening statistic is due to limitation in the education and health systems. If a more digitised country is to happen, there needs to be major investment into infrastructure and reduce power outages. Cash is still king in Kenya even with the adoption of M-Pesa. cash accounts for 71% of Kenya’s total payments, mostly because non-consumer payments are excessively in cash.

Rwanda is slowly moving to transform into a digital hub and have implemented many initiatives which will drive the country to more innovative ways of life. These initiatives are Irembo, government-to-citizen services e-portal, high mobile account usage, expanded 4G coverage across the country, and improved digital skills. As you can see, there is a huge drive to implement usage of mobile devices in all of Africa. Rwanda is also manufacturing mobile devices through the Mara Group. The device is entirely made in Africa. Around 90% of Rwandans are within 5 km of a financial access point. This is due to the introduction of Umurenge SACCOs (USACCOs), which was established in 2008, gave a vital boost to rural savings and deliver important loans to Rwandans. Improvements in the mobile money adoption rates need to be made if Rwanda want to grow economically. Currently there are three mobile operators in the region enabling the use of mobile money services, but the banks must catch with their technologies. It is essential to ensure that Irembo reaches its potential as it can be an excellent benefit in improving areas such as digital education, connectivity, and acceptance and authentication of e-certificates. USACCO processes also need to be improved to reduce criminal on goings and theft, improve efficiencies, and increase the profitability of the early adopters. South Africa's ever changing health technology ecosystem includes more than 120 companies. With it having good infrastructure with low number of power outages, it is a great place for innovation to flourish. South Africa is seen as an African leader in the Ease of Creating Digital Jobs, supported by robust consumer demand for digital businesses and an institutional environment that offers helpful regulations. Unlike other African countries, there is a low censorship and high freedom on the net. This is a possible reason why you see the country developing innovative technologies such as biometric data and payment cards to deliver social security and drones in mining. South Africa is still below the global average for internet speeds with only a 64% penetration. For a more developed country this is rather low and hope to see this rise with new partnerships (Johnson, 2021). It is important for all citizens to adopt digital payments, but it is unlikely to see that due to underprivileged habitants not having the facilities. Adoption of payments can be seen as low as 30% in certain areas. With unemployment being high within South Africa, there must be a drive to promote new digital skills to ensure the region adopts such technologies. Creating an innovation hub will guarantee new job for society. Policies from the President Ramaphosa are trying to a drive a skills revolution (Ramaphosa, 2019). Ethiopia has made good progress in developing many areas to become more digital. It is arguably down to the Prime Minister Abiy Ahmed who shows an interest in the technology sector. His work has been to bring vast changes to strengthen the democratic process, improving the economy and has received the 2019 Nobel Peace Prize when resolving the long-standing conflicts with Eritrea (Mckenna, n.d.). Huge investments have seen great improvement in infrastructure and higher education facilities have seen a substantial rise in enrolment. This is due to policies in adopting STEM subjects the government have begun to enforce. Sheba Valley is a fast-emerging tech hub within Ethiopia and has become a place for many start-ups to call home. There are several examples of emerging technology companies changing lives in Ethiopia, from the way communication is made to how the way the banking sector functions. Ethiopia has an ever-growing manufacturing sector and often adopt using advanced technologies such as block chain in the coffee bean trade (Sundararajan, 2018). While Ethiopia's technology presence is developing swiftly, there are many challenges that innovators and investors must conquer in order to be globally competitive. Infrastructure remains a major concern and even though Ethiopia might have talented and well skilled individuals, there is a

hole in the form of resources, direction, mentorship, and business skills (IT News Africa, 2017). There are very little digital transactions due to the connectivity issues in the region. With Google committing to improve the current connections, there is hope that there will be more adaptors of digital finance. This will stop the country relying solely on cash and benefit from a regulatory environment that grow trust in digital money. Issues do arise due to an unreliable power supply, many intentional internet shutdowns during anti-government protests, states of emergency and to limit exam cheating. There are. Some of the many barriers to enabling the country's digital evolution. Incubators, entrepreneurship training, and investment funds are enabling Egypt to become region's fastest growing start-up ecosystem. Egypt has also began making worthy changes to become digital leading to the digital technology sector becoming the second fastest growing sector (Mordor Intelligence, 2020). Training is important within Egypt and has the highest number of higher-level graduates of other countries within Africa. Egypt leads other African countries in digital job creation by having online freelancer pools in creative and multimedia and in software development and technology. With approximately 8% of Egyptians over 15 years of age having completed a digital payment in recent years, policies to promote the use of digital payments are essential (Demiguc-Kunt, et al., 2017). New laws to enable citizens to receive their salaries and issue payment to the government electronically have been set. With Egypt having excessive censorship on online freedom, it will always be difficult to allow twenty-first century innovation (Miller, 2018). As mentioned previously, it is the government and policy makers to scale up the innovations within the continent. Ensuring that there is a real incentive and regulations for innovation is the challenge. Innovation and adoption of those innovation is paramount in growth of the region. Digital maturity has been the key focus of the continent and is improving dramatically in forcing technological advancement and innovation. (Chakravorti & Chaturvedi, 2019) In recent years there has been a huge increase in internet access, mobile usage and has seen rises in key skills in science, technology, engineering and mathematics. "From 2015 to 2020, the number of start-ups receiving venture capital funding in Africa soared around sevenfold. New public-private African innovation hubs anchored by some of the world's leading technology companies are proliferating" (Songwe, 2020)

History of Finance & Banking

Financial transactions occurred thousands of years before the creation of monetary currency. Archaeologists discovered and analysed ancient Mesopotamia, around 4000 years ago in what is now known as the middle east, the locals used clay tablets to provide proof of a commitment to specific financial transactions. The tablets were used primarily for the theory of accounting. During this time temples, royal palaces, and certain private houses were used as storage facilities for valuable commodities such as grain and the ownership of which could be transferred by means of written receipts. The clay tablet itself showed the details of the transaction including, what was borrowed, to be repaid and the date of repayment. This early technology ensured early accounting and financial transactions a possibility. The tablets would be use standardised units of account which are similar to modern currency values like dollars and euros such as grain or wool. This is the main reason for money, enabling storage of value or favours to cash in later. When you want to cash in, currency is the perfect medium of exchange and swap something you have, to something you would like. This is only possible if everybody trusts the value of each unit for each

transaction. The first proof of mutual trust and financial responsibility for political or economic choices, was one of the fundamental reasons civilisations have the economic system that it does today. The early concept of currency, you would think of possessions, barterable items such as the Mesopotamian wool or grain, together with gold and silver, that allow you to store value as stated. These commodities could be earned, made or stolen. There are many records of loans by the temples of Babylon around 2000 BC as temples were thought as safe stores since they were sacred places watched over by gods and their contents were said to be protected from theft. Companies of traders in ancient times provided banking services that related to the buying and selling of goods. Many early “banks” were mostly dealing with coin and bullion and a lot of their business was to change money and supplying people with a coin of the correct weight and fineness. Actual banks were not around until the medieval times. This is where we see the first bank with purpose of depositing and lending money and the creation of generally spendable IOUs that could be used in place of coins or other commodity monies. Many banks in Europe developed the methods by offering to assist people or companies in making distant payments by using bills of exchange instead of physical coin. This was developed due to many businesses trading internationally. For a long time, a bank stood prepared to accept orders to pay money to a certain person through one of its agents elsewhere. The amount of the bill of exchange would be withdrawn by the agent to the account of the banker. The banker would also look to make a little profit from exchanging one currency against another. During this time there was a significant emphasis on trust in each transaction. The first European banks traded in neither goods or in bills of exchange but in gold and silver coins and bullion. They did this in response to the risks involved in storing and transporting these precious coins. In Europe dealers in foreign coin were the first to offer fundamental banking services. In London we would see money scriveners and goldsmiths offering the same banking services. Money scriveners were witnesses where the enablers for bringing borrowers and lenders together. The Goldsmiths started their transition into banking by keeping currency and valuables safe for their customers. This enabled them to begin dealing with bullion, foreign exchange and start acquiring and sorting coin for profit. An incentive for customers to use the goldsmiths was an offering of a rate of interest. This was the beginning of the end for scriveners as deposit bankers.

Banking in Europe during the sixteenth century could be divided in to two classes, exchange banks and banks of deposit. Banks of deposit were important in issuing loans and enabling trade and industries within the continent. These banks were incredibly important during these periods but did start becoming inactive towards the late nineteenth century. Exchange banks were essentially founded to turn the valuables they were given into currency that traders accept immediately without having to check the value of a certain coin. The value the banks issued was equivalent to the value they received with a small fee added by the bank for executing the transaction. In more modern times we would see services change from safekeeping of coins to being a middleman to understand the finance between numerous parties and enable the transaction to be delivered in a trustworthy manner. This was done by oral and written confirmation of credit and endorsed by written deposit receipts. It was in the banks best interest to ensure that money was available. This was still a way which could lead to issues without enabling the correct checks and trust may be broken down at any time. Banks in the twenty-first century complete even more extensive checks completed by technology and access to bank records.

In certain reports the Bank of England were recognised for being the first to adopt widely circulated banknotes but after research, there are many other cases around Europe where it was adopted first. These cases were in Sweden several decades before and in Casa di San Giorgio, which is the Bank of Genoa, established in 1407. We would also find cases in Asia way before the Bank of England dating back to the ninth century. During this time, China used “flying money”, a kind of draft or bill of exchange that was developed by merchants which later was transferred into government adopted fiat money (Horesh, 2012).

The development of bank money would increase banks capability to extend credit by limiting occasions when their clients would feel the need to withdraw currency. You will start to see how the power will be with the banks and banking sector. The progressively higher use of bank money ultimately allows banks to take advantage of the law of large numbers, where withdrawals would be offset by new deposits (Investopedia, 2020). Lucky enough, we would see competition in the market stopping banks from extending credit past reasonable means and bank would have to ensure they had cash reserves to cover currency withdrawals. Banks were trying many ways to increase cash reserves and setting up clearinghouses was a way to branch out into major cities to support nonlocal bank money clearings and settlements. This promoted more opportunities for netting out offsetting items, and in turn, offsetting gross credits with gross debits, which left net dues alone to be settled with coin money (Britannica, n.d.).

In the twenty-first century we are beginning to see a new wave of currency. Bitcoin first originated in 2008 when a gentleman called Satoshi Nakamoto published a white paper explaining the new technology. The initial idea was to develop a cash like payment system that allowed electronic transactions with additional benefits compared to physical cash. Cash as we know it today is represented by a physical object. This is seen as a coin or a note. During a transaction the object, which has a unit of value, is handed to an individual, without a need for third party involvement. This is a reason why all parties may remain anonymous. By default, the person in possession of the cash is therefore the owner. This also helps ensure that the property rights to the units of value flowing around the economy are always clearly recognised without the need of a central authority needing to keep tracks. Using physical cash has its issues. One being the need to have a physical presence in the transactions and cannot be done remotely. Digital currency is what would be more beneficial in recent times. Ironically, it is very much what we do today. An individual cannot be employed without a bank account and the amount of physical cash someone would see has significantly fallen. The digital transaction can run into issues with not controlled correctly by organisation. A feature of electronic data or digital cash is that it can be duplicated several times at insignificant cost. This feature is unwelcomed when exchanging money. If cash data files can be duplicated and the copies used as currency, they cannot serve as a payment means. This issue is called double spending. To counter the issue of double spending, an electrical payment system was based on a central authority that continues to monitor and verify the transactions. These systems are mainly used by the banks and manages for both the buyer and the seller. The buyer begins the transaction by submitting an order and the bank will ensure the buyer has the funds required. The bank will then adjust the accounts accordingly. Centralised payment systems safeguard against

the double spending issue but involve a mutual trust between users and authority. The public have trusted the central authority to not misuse the delegated power and that the accounts are maintained correctly in every country of the world. Centralised banks are prone to having issues involving hacker attacks, technical failures and malicious governments that can effortlessly interfere and seize funds.

Cryptocurrencies are significantly different in how they are managed. They are managed on a decentralised system and there are no exclusive rights to keeping accounts. The fundamentals of this decentralised system can be explained when going back in time and considering the Stone Money of Yap. On Yap Island, stones were used as a means of exchange. The stones were extracted roughly 280 miles away on the island of Palau and transported to Yap by small boats. Every resident can bring new stone money units into the system. The money creation costs, in the form of labour and equipment including boats would protect the economy from inflation. Removing the need to laboriously move the stones, that can be up to 13 feet in diameter, with each transaction from a buyer's location to the seller's location, the ownership rights were reassigned virtually. This would see a stone remaining in its original location while seeing its value be detached from it and moved regardless of the stone's whereabouts. This is what the residents accepted, and everyone knew which owner was associated with each stone. The parting between the unit of value and the stone progressed so far that even the unit of value for stones that were lost at sea remained in circulation. The stone money of Yap can consequently be labelled as a semi-virtual currency due to each unit of value was roughly linked to a physical object. This system is based on a distributed ledger and every resident would keep track of a stone's ownership. When a purchase was made, the buyer would tell their neighbour that the owner of the stone has changed. The neighbours will then spread the news until all island residents have been informed about the change in ownership. This will ensure that all islanders have an accurate idea of what belongs to each person at any point in time (Goldstein & Kestenbaum, 2010). The Yap payment system has similarities to the Bitcoin System. One of the few differences is that a Yap system false report could not be quickly verified and issues with the ledger may arise. A group will have to be set up to manage these issues and that group will issue sanctions. In comparison, the Bitcoin network is developed to function in a system where no user can trust any other user. This feature is essential due to it is a permissionless payment system in which participants can remain unknown.

Bitcoin is a virtual currency unit and has no physical representation. A single Bitcoin can be divided into 100 million Satoshis, the smallest fraction of a bitcoin. To understand the how Bitcoin works you must start exploring blockchain. The Bitcoin Blockchain is a data file that transfers the records to all bitcoin transactions. The blockchain is often referred to as the ledger for the currency. The Blockchain comprises of an arrangement of blocks where each block builds on its predecessors and holds information about new Bitcoin transactions. Due to everyone being able to download and read the Bitcoin Blockchain, it is a public record, a ledger that contains Bitcoin ownership information for any point in time. Each user is free to manage his or hers copy of the bitcoin ledger. This is known as a decentralised system due to there being no centralised authority with the exclusive rights to the accounts. Due to the adoption of this style of system, there are rules that need to be followed by the community and those rules are monitored by the community. A Bitcoin transaction works in a way that

is like a transaction in the Yap payment system. A buyer broadcasts to the network that the seller Bitcoin address is the new owner of a specific Bitcoin. This information is circulated on the network until all users are informed about the ownership transfer. It is essential for a virtual currency to ensure that there is a monetary value associated to it and an understanding to how many units have been created. This also includes an agreement mechanism that ensures that all users agree about the ownership rights to the virtual currency units. The anonymity of users can cause trust issues within the community. Therefore, the agreement mechanism is so important to Bitcoin. This mechanism is the central innovation of the Bitcoin system and allows agreement to be made on a larger scale and in the lack of any personal relations (Schar & Berentsen, 2018). The move to certain Cryptocurrencies is happening rapidly since they are classed as secure investments without any political influence. Transactions can be completed as simple as using a mobile phone and a solid connection to the internet.

There have been five breakthrough Cryptocurrencies in recent times. The five are Bitcoin, Ethereum, Ripple, Litecoin and Monero. Bitcoin started the new generation of currency and is most used today. It is also classed as the gold standard of the industry. Ethereum uses another type of blockchain and is a Turing-complete programmable currency. For this reason, many regard the Ethereum blockchain to be more useful than Bitcoin. Ethereum supports developers to build various technologies and applications around it and process complex contracts and programs. This multifunctional blockchain is key to many future technologies and have even enables the development of new cryptocurrencies. Ripple has already been used by various banks including UBS and Santander. It was used to track other transactions and not solely used for cryptocurrency. Litecoin is a coin that was developed shortly after bitcoin and is very similar in characteristics. Litecoin has established new innovations and with its innovative mining algorithm, it enables faster payments than Bitcoin and Litecoin's processes allow many more transactions. Monero is an open-source cryptocurrency and has developed an algorithm that has enhanced security and privacy features over its competitors. Dissimilar to many of the other cryptocurrencies that are based on Bitcoin, Monero was established using the less visible CryptoNote protocol. Its opacity and open-source model, however, have caused doubts on its use, as users are cautious that it can be used to hide the activities of fraudsters and hackers (D'Amore-Mckim School of Business, n.d.). another issue with Cryptocurrency is the price volatility since the value of money must be stable enough, that there are no huge financial variations, during the value transaction. To achieve a more stable price level and lower fluctuations, numerous crypto currencies proceed in the direction of a more formally regulated currency. There are also cases that crypto currencies change from a totally decentralised system to a more centralised system, to allow some organisations to have the concluding decision on transaction to grow the development possibilities. Lots of crypto currencies move from a decentralised system to a centralised system, even though the change can result in the decline of the key benefit. This benefit being complete uncontrolled financial freedom of crypto currencies. An over centralised system would totally go against the beliefs of the users and will slowly begin to die out. To start being accepted virtual currencies must receive political backing. Governments will seek monetary control and can cause conflicts with the community. It is questionable if Cryptocurrency will ever replace fiat currency as it

does have various drawbacks. Currently authorities are classing it as a digital asset rather than currency. Cryptocurrency has similarities with gold, since it is also uncertain whether it should be perceived as an asset or as a form of currency.

Various financial innovations that include the development of bailment and bank money that created efficiencies in transactions complemented the process of industrialisation. Additionally, the introduction of cryptocurrency may bring even more transparency to economy and finance. With that in mind, many economists, including the Scottish philosopher Adam Smith, have credited to banks a vital role in promoting industrialisation.

Banking and Industrialisation

There have been cases where economists have stated that finance instigates growth by encouraging the process of industrialisation. As industry in England began to grow, the demand on banking services also started to grow. To help with increased demand, bankers created a system called country banking. This is where individuals and small partnerships provided the demand of entrepreneurs for banks and industrial credit. It also increased the public demand for an enlarged monetary circulation by issuing their own notes to deliverer, billed on demand. In 1750 country banks were only in major cities around the United Kingdom which later increased to eight hundred around the Napoleonic Wars. During this time banking was at the centre of progressing war induced industry and the country banks supplied around half the entire circulation of banknotes and provided the main source of credit for the rapidly growing industries. Even with the country banks made important contributions to the industrial revolution in England, there are some serious limitations to the system that was used. The Bank of England limited other banks partnerships to no more than six people which did stunt growth. It has been estimated that the typical equity capital of a country bank at the start of the nineteenth century was near £10,000. When 1825 arrived, the total capital involved in country banks totalled to close to six million pounds, or lower than half that of the Bank of England. During the introduction of banking within England, there was a lack of skills in finance. Bank managers were often inexperienced in the banking business; many of the country banks functioned as mere assistants of industrial businesses, this is where they issued most part of their loans. This started to create issues within the sector and governments needed to bail them out. This has happened on more than one occasion in history.

Commercial banks issue short term credit for working and enable industries to dedicate more of their own assets to fixed investment. Within industries that have high rates of profits and look to reinvest, you can begin to see great gains from adopting this method of financing the company. To explain more clearly, “imagine a firm with total capital requirements of 100,000 currency units, of which one half is invested in fixed capital and the other half in working capital with a relatively short turnover period. Suppose further that the annual value of sales is ten times the capital involved, or 1,000,000 currency units, and profits (exclusive of the wages of management) amount to 5 per cent of sales, or 50,000 units. If all profits are reinvested, the growth rate of the firm (which is also the rate of profit on invested capital) will be 50 per cent per annum if it is completely self-financing, but 100 per cent-doubled-if it resorts to bank credit to supply its need for working capital”

(Cameron, 2011). Improvements in ways to pay and be paid using banking services can promote growth if the individual uses it correctly and in a productive way. This is the true reason why industrialisation has seen rapid growth. Speed in all areas of banking is paramount to see substantial gains.

The history does show that banks have contributed to the process of industrialisation in various ways. Banks have not solely been a facilitator to capital accumulation by being the intermediaries between lenders and investors. While providing other critical financial services, the finance sector has also aided to industrialisation directly and indirectly using their own lending services. An important area that was managed by banks was the facilitation of changes within the economic structure that was required by industrialisation and accelerated the rate of growth of the economy by offering more ways of issuing payments. Industrialisation can progress when the shackles are off, and innovation can flourish. Removing certain barriers such as private monopolies and ill-advised government policies can have proven beneficial. This has also been the case regarding banking and removing policies have helped greatly (Cameron, 2011). Cash flow into Africa has been growing over recent decades and there is an interest of understanding how this external resource can be leveraged for economic development. There are reports that show that with early levels of industrialisation, cash flow can help drive industrialisation through adopting banking tools. The direct limitation of bank efficiency in Africa may be noticeable issue and slow down progression. If banking starts to progress nicely in Africa, you can see dramatic gain in industry since the continent is in the middle of a growth resurgence that started in the mid 1990s and was recently named sixth fastest growing economies in the world. It is time for banking to catch up to what Africa wants to achieve given their resources (Efobi, et al., 2019).

Cryptocurrency in Africa

In many countries cryptocurrency is in an infant stage and true benefits cannot be capitalised on. The real positive point for Africa is that they are truly enabled to begin taking advantage of the digital revolution. Road block will occur since the policymakers must also be on board which has always been a real issue for African countries. The regulation of cryptocurrencies must be well balanced. Rules and guidelines must not be strict enough that all benefits are lessened, but the regulation must be strict enough that cryptocurrencies are politically supported. Only with political support, a massive adoption of cryptocurrencies can be seen. It is impressive to see that Nigeria were ranked high in the countries that have used cryptocurrencies the most while the country was in a recession during 2020. Nigeria trade volume of bitcoin was around \$400million which is just \$20million lower than Russia. This was seen as a serious issue by policymakers and the government clamped down on cryptocurrency exchanges, with a ban on cryptocurrency exchange operations within the country. Kenya is another country in Africa that are making inroads with cryptocurrency after being ranked fifth nation in the world with the most cryptocurrency adoption. As you can see in Table 1, African countries are in between some very large economies and some other developing countries. Around the world cryptocurrency implementation and trade volume has been relatively volatile with repressive economic regimes reign, that makes the people from those parts of the world in doubt of their own economy. Numerous people

believe this to be a significant reason why there is a growth of cryptocurrency in places like Africa. Another significant reason is the high cost in transaction within the continent. Institutions, transaction costs, and innovation play a vital role in promoting company performance (Barasa, 2020). Cryptocurrency can be the enabler to ensuring company progression and aid the development of Africa. This is since sending cash flow internationally from or into the continent is cheaper with cryptocurrencies than with traditional payment method, giving huge influx to Africa's local currency market. Undependable local currencies and ever-increasing hyperinflation has played a noteworthy part in cryptocurrency popularity in Africa. Zimbabwe experienced severe hyperinflation over a decade ago. This caused many people to abandon the country's legal tender for a variety of international currencies led by the US dollar. Since there were serious dollar shortages, numerous people turned their attention to Bitcoin, after noticing the rise of Bitcoin since its development. The adoption of virtual currency and blockchain in Zimbabwe cannot be ignored. Using the new technology will see Zimbabwe make transactions in the country practically tamperproof. Another compelling reason is that a mass cryptocurrency adoption will save the country a resounding \$90 million yearly in remittance (Lwanda, 2019). Lowering these costs will aid all of Africa and the untapped agricultural potential can be explored while supporting smaller villages around the continent (Sergeenkov, 2021).

Financial technology services have seen a somewhat positive response in Africa. This position could be traced to Africa's limited financial services, against a rapidly growing population of 1.2 billion people, a significant drop in internet cost, and a growing smartphone usage, as well as other aspects. African countries such as Seychelles are starting to open up to cryptocurrency, aligning themselves as the next global crypto hub. The new wave is coming to the continent, and it is up to the policymakers and communities to start embracing change.

Conclusion

There has been every effort by very large organisation such as Google to enable Africa to grow economically, industrially and socially. For many developed countries, internet is a normality. The connecting Africa scheme, Loon, did start the initial growth in the region and allowed Kenya to adopt M-Pesa as a financial technology. The second and larger scheme in Africa, Equiano, has lowered the cost of exchanging data between Europe and Africa and therefore removing the barriers to trade. It also helps Vital digital infrastructure, enabling and supporting possibilities for teleworking and online meetings, thereby increasing the time spent working. Removing barriers is the vital point in ensuring Africa can begin to realise new investment opportunities and innovation. In the twenty-first century the importance of being connected is astronomical. Moving into the new industry revolution, Industry 4.0, the reliance on the internet is easy to see. It has been noted that Africa has been left behind in many cases industrially and the new connection system can support the continent in a phase of rapid industrialisation. More and more success stories are starting to come to light. Whether it is regarding South Africa being seen as an African leader in the Ease of Creating Digital Jobs or Rwanda moving to transform into a digital hub while implemented many initiatives which will drive the country to more innovative ways of life, Africa is slowly creating a new and improved pathway for themselves.

Banking and Fintech will be at the forefront of industrialisation in Africa. History does show that banking has a direct and indirect impact to industrialisation. Given more opportunities for companies to spend, lend and transfer money will always help grow the economy. New technologies make it easier for this to become a reality. M-Pesa was good insight to what can be done when given the opportunity to use new financial technology. Africa need to adopt a policy or scheme like JioPhone to enable the citizens to take advantage of the new technologies. Policymakers must also put a significant emphasis on upskilling the people in Africa to make sure they are literate. Lowering the costs of accessing this technology and improving education is the most important aspect for growth.

Banking and finance have been transformed to reflect the current industrial revolution. Digital banking is now the norm in many countries around the world. There are many benefits to adopting such technology and Africa are starting to take advantage. New technologies such as cryptocurrencies are soon to be an important aspect of the economy in Africa. Cryptocurrency is in such an infant stage in the world, and it is not completely known where it will be in the coming years. Moving to a decentralised banking system shows promise given the policy issues within Africa and one can hope that the restrictions on the digital asset can be lifted soon. While in this state on unknown, it would be greatly beneficial if a hybrid type banking system was developed. Understanding the benefits of the decentralised system and merging them with a centralised system may be best placed short term. The African people have taken a stance against the regime before due to hyperinflation issues and trust must start to be built back up. Regardless of which coin is used as the digital currency, blockchain will be the enabler. A system that promotes innovation while given complete transparency to the people is an ideal scenario for the African population.

Reflection

Africa is developing exponentially, and large organisations are doing their best to remove restrictions to trade. Whether or not they are doing it to meet their own business needs and growth aspirations, it is good to see them support the people that need help. It was disappointing to see the termination of Loon. It is defiantly a technology that should be kept ready and waiting if a disaster happens. Due to the infancy of the cryptocurrency, it is extremely difficult to understand how underdeveloped countries will use the technology to their advantage. The exciting thing is, there are many benefits that can be especially useful in these countries. I predict in five to ten years cryptocurrency will be seen as a means of payment in almost every area of the world. I also predict blockchain technologies will also have very promising few years ,where more entrepreneurs and innovators will look to develop the technologies to benefit their organisations. This research could be completed again in the next decade and people are hopeful that the policy makers will begin to lift restrictions. As a millennial, the world of cryptocurrency and blockchain is exciting. With recent issues of corruption, the open book style of operating is exacting what the people want.

References

Ayesha, J., n.d.. Big Push Theory of Economic Development | Economics. *Economics Discussion*.

Barasa, L. N., 2020. *Corruption, Transaction Costs and Innovation in Africa*, Nairobi: AFRICAN ECONOMIC RESEARCH CONSORTIUM.

Barclays, 2020. *How smart contracts are set to reshape the business world*. [Online] Available at: <https://home.barclays/news/2020/09/how-smart-contracts-are-set-to-reshape-the-business-world/> [Accessed 14 December 2021].

BBC News, 2013. Kenya launches Huduma e-centre to cut bureaucracy. *BBC*, 7 November.

Britannica, 2021. *Industrial Revolution*. [Online] Available at: <https://www.britannica.com/event/Industrial-Revolution>

Britannica, n.d.. *Conquest of Peru*. [Online] Available at: <https://www.britannica.com/place/Latin-America/Conquest-of-Peru> [Accessed 17 December 2021].

Britannica, n.d.. *Historical Development*. [Online] Available at: <https://www.britannica.com/topic/bank/Historical-development> [Accessed 27 December 2021].

Brunau, C., 2020. *What's The Difference Between Circuit Switching vs Packet Switching*. [Online] Available at: <https://www.datto.com/uk/blog/whats-the-difference-between-circuit-vs-packet-switching>

Cameron, R., 2011. Banking in the early stages of industrialization a preliminary survey. *Scandinavian Economic History Review*.

Chakravorti, B. & Chaturvedi, R. S., 2019. Research: How Technology Could Promote Growth in 6 African Countries. *Harvard Business School*, 4 December.

Chromjakova, F. et al., n.d.. *Industry 4.0: Current Status and Future Trends*. London: IntechOpen.

Compbell-Kelly, M. & Garcia-Swantz, D., 2013. The history of the internet: the missing narratives. *Journal of Information Technology*, pp. 8-33.

Copenhagen Economics, 2021. *The Equiano Subsea Cable: Extending International Connectivity between Portugal and Africa*. s.l., Copenhagen Economics.

D'Amore-Mckim School of Business, n.d.. *GUIDE TO THE RISE OF CRYPTOCURRENCY, DIGITAL CURRENCY AND BITCOIN*. [Online] Available at: <https://onlinebusiness.northeastern.edu/masters-in-finance-msf/knowledge/guide-to-the-rise-of-cryptocurrency-digital-currency-and-bitcoin/> [Accessed 29 December 2021].

Daviescoin, n.d.. The role of cryptocurrencies in the global economy. *Davies*.

Demiguc-Kunt, A. et al., 2017. *The Global Findex Database*, Washington: World Bank.

Demir, A., Pesque-Cela, V., Altunbas, Y. & Murinde, V., 2019. Fintech, financial inclusion and income inequality: a quantile regression approach. *The European Journal of Finance*.

Desoutter, n.d.. *Industrial Revolution - From Industry 1.0 to Industry 4.0*. [Online] Available at: <https://www.desouttertools.com/industry-4-0/news/503/industrial-revolution-from-industry-1-0-to-industry-4-0>

Dima, A., 2021. Short history of manufacturing: from Industry 1.0 to Industry 4.0. *KFactory*, 25 January.

Efobi, U. et al., 2019. Remittances, Finance and Industrialisation in Africa. *Journal of Multinational Financial Management*.

Finextra, 2019. How Cryptocurrencies Can Help Global Economy and Build a Better Future. *Finextra*.

Gihring, T., 2016. The rise and fall of the Gopher protocol. *Minnpost*.

Goldstein, J. & Kestenbaum, D., 2010. *The Island Of Stone Money*. [Online]
Available at: <https://www.npr.org/sections/money/2011/02/15/131934618/the-island-of-stone-money?t=1640726310066>
[Accessed 28 December 2021].

Golubski, C., 2018. *Capitalizing on Industry 4.0 in Africa*. Washington, The Brookings Institution.

Google, n.d.. *EquianoSubsea Cable: Regional Economic Impact Assessment*. [Online]
Available at: <https://africappractice.com/wp-content/uploads/2021/10/Equiano-Regional-Economic-Impact-Assessment-6-October-2021.pdf>

Grubler, A., 1995. *INDUSTRIALIZATION AS A HISTORICAL PHENOMENON*, Austria: International Institute for Applied Systems Analysis.

GSMA, 2020. *The Mobile Economy 2020*. [Online]
Available at: <https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/03/GSMA-MobileEconomy2020-Global.pdf>

Helms, K., 2020. Ukraine, Russia, South Africa, Nigeria Among Top Countries by Cryptocurrency Adoption. *Bitcoin.com*, 9 September.

Hole, K., 2019. Google's 'Loon' Internet Flies Into The Amazon After Connecting. *Forbes*, 23 November.

Horesh, N., 2012. *From Chengdu to Stockholm: A Comparative Study of the Emergence of Paper Money in East and West*, s.l.: Provincial China.

IAB, 2021. *The Economic Impact of the Market-Making Internet*, s.l.: IAB.

Intechs, 2020. *Industry 4.0 Current Status and Future Trends*. London: Intechs.

Internet Hall of Fame, n.d.. *Internet Hall of Fame*. [Online]
Available at: <https://www.internethalloffame.org/inductees/jcr-licklider>

Investopedia, 2020. *Law Of Large Numbers*. [Online]
Available at: <https://www.investopedia.com/terms/l/lawoflargenumbers.asp>
[Accessed 22 December 2021].

IT News Africa, 2017. *Sheba Valley- Ethiopia's 'Silicon Valley'*. [Online]
Available at: <https://www.itnewsafrika.com/2017/07/sheba-valley-ethiopias-silicon-valley/>

Johnson, J., 2021. *South Africa online usage penetration 2017-2026*, s.l.: Statista.

Kaufman, M., 2012. The Internet Revolution is the New Industrial Revolution. *Forbes*, 5 October.

Kaur, S. & Randhawa, S., n.d.. Google LOON: Balloon-powered internet for everyone. *AIP Conference Proceedings*.

Leiner, B. et al., 1997. *Brief History of the Internet*, Reston: s.n.

Letzeburg, n.d.. *The 3rd Industrial Revolution*, Luxembourg: s.n.

Levy, G., 2016. *A Brief History of Fiance*, s.l.: Research Gate.

Loon, n.d.. *Loon*. [Online]
Available at: <https://x.company/projects/loon/>

Lwanda, G., 2019. Cryptocurrency could help Zimbabwe overcome its economic crisis. *World Economic Forum*, 24 June.

Manyika, J. & Roxburgh, C., 2011. *The great transformer: The impact of the internet on economic growth and prosperity*, s.l.: McKinsey Global Insitute.

Marrs, T., 2020. *Understanding Modern Finance, in Theory*. [Online]
Available at: <https://historyofyesterday.com/understanding-modern-finance-in-theory-baace6ddc0b4>
[Accessed 18 December 2021].

Maverick, J., 2021. *Should Companies Always Have High Liquidity?*. [Online]
Available at: <https://www.investopedia.com/ask/answers/011215/it-important-company-always-have-high-liquidity-ratio.asp>
[Accessed December 2021].

Mbamalu, S., 2021. Google's ambitious Loon internet balloon project has crash-landed. *Quartz Africa*, 22 January.

Mckenna, A., n.d.. *Abiy Ahmed Prime Minister of Ethiopia*. [Online]
Available at: <https://www.britannica.com/biography/Abiy-Ahmed>

Miller, E., 2018. *Egypt leads the pack in internet censorship across the Middle East*, s.l.: Atlantic Council.

Minter, A., 2021. Google's Loon Failure Raised an Awkward Question. *Bloomberg*, 6 February.

Mokyr, J., 1998. *The Second Industrial Revolution, 1870-1914*, s.l.: Northwestern University.

Mordor Intelligence, 2020. *ANALYSIS OF KEY SECTORS OF EGYPT: AGRICULTURE, TOURISM, DAIRY, MEAT, ICT, MANUFACTURING AND MINING ALONG WITH PRODUCTION AND CONSUMPTION DATA*, s.l.: Mordor Intelligence.

Navarria, G., 2016. *How the Internet was born: from the ARPANET to the Internet*. [Online]
Available at: <https://theconversation.com/how-the-internet-was-born-from-the-arpamet-to-the-internet-68072>

Ortiz, J., Marroquin, W. & Cifuentes, L., 2021. Industry 4.0: Current Status and Future Trends. In: *Industry 4.0: Current Status and Future Trends*. London: Intechs.

Qiu, W., 2021. *Paratus and Telecom Namibia to Land Equiano Cable in Namibia*. [Online]
Available at: <https://www.submarinenetworks.com/en/systems/euro-africa/equiano/paratus-and-telecom-namibia-to-land-equiano-cable-in-namibia>

Ramaphosa, C., 2019. *1st South African Digital Economy Summit*. Johannesburg, The Presidency Republic of South Africa.

Richardson, D., Fini, J. & Nelson, L., 2013. Space-division multiplexing in optical fibres. *Nature Photonics*.

Rivlin, A. & Litan, R., 2001. *The Economy and the Internet: What Lies Ahead?*, s.l.: Brookings.

Ryan, J., 2010. *A History of the Internet and the Digital Future*. London: Reaktion Books.

Samans, R. & Zahidi, S., 2017. *The Future of Jobs and Skills in Africa*, Geneva: World Economic Forum.

Sarkissian, A., n.d.. *The Impact of the Stock Exchange Market in Economic Development*. [Online]
Available at: <https://finance.zacks.com/impact-stock-exchange-market-economic-development-8358.html>
[Accessed 18 December 2021].

Schar, F. & Berentsen, A., 2018. A Short Introduction to the World of Cryptocurrencies. *Federal Reserve Bank of St. Louis Review*.

Sergeenkov, A., 2021. *The Current State of Cryptocurrencies in Africa*. [Online]
Available at: <https://hackernoon.com/the-current-state-of-cryptocurrencies-in-africa-7a2237hv>
[Accessed 31 December 2021].

Shankland, S., 2019. Google's third subsea cable will pump data from Portugal to South Africa. *CNET*, 28 June .

Sharma, D. K., Pant, S., Sharma, M. & Brahmachari, S., 2020. Chapter 13 - Cryptocurrency Mechanisms for Blockchains: Models, Characteristics, Challenges, and Applications. *Handbook of Research on Blockchain Technology*, pp. 323-348.

Songwe, V., 2020. The Role of Digitalization in the Decade of Action for Africa. *UNCTAD*, 07 September.

Songwe, V., 2020. *The Role of Digitalization in the Decade of Action for Africa*. [Online] Available at: <https://unctad.org/news/role-digitalization-decade-action-africa>

Stefanuk, A., 2021. Industry 4.0 And Its Impact On The Financial Services. *Fintech Weekly*, 11 February.

Sundararajan, S., 2018. *Ethiopia Explores Blockchain Role in Tracking Coffee Exports*, s.l.: CoinDesk.

Supply Chain Game Changer, 2018. *The Industrial Revolution from Industry 1.0 to 5.0!*. [Online] Available at: <https://supplychaingamechanger.com/the-industrial-revolution-from-industry-1-0-to-industry-5-0/>

Tafirenyika, M., 2016. *Why has Africa failed to industrialize?*. [Online] Available at: <https://www.un.org/africarenewal/magazine/august-2016/why-has-africa-failed-industrialize>

Tiwari, R., 2016. Study on Google's Loon Project. *International Journal of Advanced Research in Computer Engineering & Technology*.

United Nations, 2016. *Economic Report on Africa 2016: Greening Africa's Industrialization*, Addis Ababa: United Nations.

Webb, S. et al., 2008. *Public Sector Reform: What Works and Why?*, Washington DC: CHR Michelsen Institute .

Westgarth, A., 2020. *Loon is live in Kenya*. [Online] Available at: <https://x.company/blog/posts/loon-is-live-in-kenya/>

World Bank, n.d.. *Connecting for Inclusion: Broadband Access for All*. [Online] Available at: <https://www.worldbank.org/en/topic/digitaldevelopment/brief/connecting-for-inclusion-broadband-access-for-all>

Zukang, S., 2007. s.l., United Nations.

Appendix

Country	Score	Rank	Rank of individual weighted metrics feeding into index			
			On-chain value received	On-chain retail value received	Number of on-chain deposits	P2P exchange trade volume
Ukraine	1	1	4	4	7	11
Russia	0.931	2	7	8	5	9
Venezuela	0.799	3	19	14	15	2
China	0.672	4	1	1	95	53
Kenya	0.645	5	37	11	57	1
United States of America	0.627	6	5	6	39	16
South Africa	0.526	7	12	9	41	10
Nigeria	0.459	8	14	7	112	3
Colombia	0.444	9	25	18	61	4
Vietnam	0.443	10	2	2	44	81

Table 1 (Helms, 2020)

