SELINUS UNIVERSITY
OF SCIENCES AND LITERATURE

THE FOURTH INDUSTRIAL REVOLUTION & COMPUTER SCIENCE

By Sammy Njehu

Supervised by
Prof. Salvatore Fava Ph.D.

A DISSERTATION

Presented to the Department of
Computer Science
program at Selinus University

Faculty of Computer Science
in fulfillment of the requirements
for the degree of Doctor of Philosophy
in Computer Science

2020

Abstract

If a man in the 20th century was told that there would be another form of a man in the form of a robot, he could never have believed but this is a reality in the Fourth Industrial Revolution. The economies have evolved from, the first industrial economy which was the transition of the manufacturing process, which marked a period of the development process to the second industrial revolution marking a period of standardization and industrialization, the third marked a new era of technological revolution, the fourth is now marking advance technological revolution and shall come to make a lot of changes in how we live and react.

The fourth industrial revolution cannot be doubted and it is indeed coming. Most of the impact of the fourth industrial revolution can be heard now. Most professions currently have been automated to a place where most business meetings currently are not being attended physically, but by use of applications such as google meet Microsoft Teams and many others.

The fourth industrial revolution has a lot of terms (e.g. Artificial intelligence, machine learning, robotics, and many others) that have been introduced and it is little or no doubt that there shall be many other terms that are still being introduced and we should be ready to face up with them. Moreover, this revolution has many impacts and shall of course not miss having a lot of challenges. The developing countries shall be

required to keep in touch with the revolution else face some throwbacks, Nevertheless developed countries (for example the USA and the UK) should not be singularly assured of being the best benefactors of the industrial revolution but be wary of invasions by other countries by use of technology (for example by use of cyber-attacks).

Table of Contents

Table of Figures

1 Industrial Revolution and Computer Science

1.1 Historical background

2 Introduction

The globe has evolved over a while. It is currently in the fourth industrial revolution where technology is the key driver of the revolution. Currently, all systems are done through technology right from banks, hospitals to even the governments.

The fourth industrial revolution shall be with a lot of automation and many new technologies shall be used that is robots, machine learning, and many others.

3 Steps in Revolution

3.1 First Industrial revolution

The industrial revolution is also known as the first industrial revolution, it was the transition of the manufacturing process in Europe and America. It marked a period of development in the latter half of the 18th century. It used water and steam power to mechanize production. The process began in Britain and spread to other parts of the world. Before the industrial revolution, the British textile was done from home, but after the revolution, many innovations were made, like the flying shuttle, the spinning jenny, and many others (Ross, 2016).

3.2 Second Industrial Revolution

The second industrial revolution is also known as the technological revolution was a phase of standardization and industrialization from the late 19th century to the early 20th century. The second industrial revolution has introduced more changes since cities expanded, factories grew and people's lives became regulated by the clock rather than sunshine as in the first industrial revolution. Rapid advances in the creation of steel, chemicals, and electricity helped fuel production, including mass-produced consumer goods and weapons (Andriole, 2005). It became easier to travel in cars, trains and even bicycles and also ideas and news spread via newspapers, the radio, and telegraphs. Life got a whole faster. Also, all kinds of goods became standardized for the first time.

The second industrial revolution was caused by natural resources, ample labor supply, strong government policy, new sources of power, railroads, and American inventors and inventions.

3.3 Third industrial revolution

The 3rd industrial revolution also known as the digital revolution brought semiconductors, mainframe computing, personal computing, and the internet. It brought forth the rise of electronics, telecommunications and of course computers. Like every other communication and energy infrastructure in history, the various pillars of

the third industrial revolution must be laid down simultaneously or the foundation will not hold (Ross, 2016). The five pillars are

- Shifting to renewable energy
- Transforming the building stock of every continent into micro-power plants to collect renewable energy on sites
- Deploying hydrogen and other storage technologies' in every building and throughout the infrastructure to store intermittent energies
- Using internet technology to transform the power grid of every continent into an energy internet that acts as the internet
- Transitioning the transport fleet to electric plug-in and fuel cell vehicles can buy and sell green electricity on a smart, continental, interactive power grid.

The entire system is interactive, integrated, and seamless; therefore, when these pillars come together, they make up an indivisible technological platform. (Andriole, 2005)

3.4 The beginning of the 4th industrial revolution and computer science

The fourth industrial revolution is coming with the name industry 4.0 coined by Henning kagermanman a German researcher. it is characterized by the fusion of digital, biological and physical worlds also growing utilization of technologies such as artificial intelligence, robotics, cloud computing, and advanced wireless technologies,

tough all these industrial revolutions has been done in other continents but most of the times Africa has been left behind, don't know whether these will be different. As a result of this perfect storm of technologies, the fourth industrial revolution is making way for transformative changes in the way we live and radically distributing almost every business sector. The fourth industrial revolution is built on foundations laid by the first three industrial revolutions. (Auer, Hortsch and Sethakul, 2020)

Klaus Schwab founder and executive director of the world economic forum and author of the book titled the fourth industrial revolution wrote that “like the revolutions that preceded it, the fourth industrial revolution has the potential to raise global income levels and improve the quality of life for populations around the world” continuing “in the future technological innovation will also lead to a supply-side miracle with efficiency and productivity. Transportation and communication costs will drop, logistics and global supply chains will become more effective, and the cost of trade will diminish, all of which open new markets and develop economic growth", the growth, however, comes up with some disadvantages as Schwab also suggested that the revolution can lead to a huge inequality "particularly in its potential to disrupt labor markets" these could lead to where those with little or no skills get to be paid less while those with higher skills are paid more leading to some tensions among the working class. The changes are so imminent that it shall either be a good gain to human or a great loss. (Andriole, 2018)

4 Literature review

The agrarian revolution was followed by an industrial revolution that began in the second half of the 18th century. The revolution has been in process of where we are today, *the fourth industrial revolution*. Professor Klaus Schwab founder and executive chairman of the world economic forum has been at the center of global affairs for almost four decades. Schwab says "together shape a future that works for all putting people first, empowering them and constantly and reminding ourselves that of all these new technologies are first and foremost tools made by people for people." he also says "only organizations driven by purpose and values will be fully able to shape and benefit from the seismic technological, social and economic transformations underway. (Auer et al., 2020)

"All of us are truly excited about the fourth industrial revolution and the changes it will bring to our company, industries, and countries. History however tells us that major economic disruptions came with social and political challenges that demand new ways of thinking, organizing, and working together. The fourth industrial revolution is in equal parts an eye-opening assessment of emerging technologies, a sobering look at potential negative impacts of transforming systems and a hopeful call to action "says Carl-Henric Svanberg, Chairman, BP, United Kingdom. (McDaniel, 2012)

With the rapid success of digital enterprises in the 21st century, the industrial revolution is approaching the fourth industrial revolution also known as industry 4.0. There is an agreement among academics, businesses, and industries that there will be

an integral paradigm shift. The future industries shall have unprecedented capacities to satisfy complex customer demands, but there is a little consensus on how individual organizations can utilize these trends. (Hamen, 2020)

4.1 Methodology of the Study

Research methodology provides the principles for organizing, planning, designing, and conducting good research, thus it is the science and philosophy behind all research. The methodology of this study is a historical background. The industrial revolution has evolved along many paths from the 1st industrial revolution to now the 4th industrial revolution, also known as industry 4.0. (Arnold and Wiener, 2015)

The 4th industrial revolution involves the usage of computers and technology at an advanced level. It is characterized by the fusion of the digital, biological, and physical worlds and also the growing utilization of new technologies such as Artificial intelligence, cloud computing, robotics, and advanced wireless technologies.

The fourth industrial revolution signals a series of political, social, cultural, and economic upsets that will arise over the 21st century. The fourth industrial revolution shall be driven largely by the meeting of digital, biological, and physical innovations.

Similar to the 1st industrial revolution steam-powered factories, the second industrial revolution application of science to mass production and manufacturing, and the 3rd industrial revolution start into computerization, the fourth industrial revolution

technologies such as editing, augmented reality, robotics, and 3-d printing are rapidly changing the way humans create, exchange and distribute value. (Auer, Hortsch and Sethakul, 2020)

The fourth industrial revolution involves a systemic change across all aspects of human life. Artificial intelligence is increasing processes and skills in every industry. More importantly, this revolution will be guided by the choices that people make today. All previous industrial revolutions have had positive and negative impacts on shareholders. Nations have become richer and technology has helped pull most people in the society out of poverty, but the inability to fairly distribute the resulting of benefits or anticipate externalities has resulted in global challenges.

4.2 Objectives of the Study

This revolution is about much more than technology. It is a chance to unite global communities, to build sustainable economics, to build sustainable economies, to adapt, and modernize governance models.

Industry 4.0 refers to the combination of several major technology innovations, all maturing at the same time that is expected to significantly shift the landscape of the manufacturing industry. These technologies- advanced robotics, artificial intelligence, sophisticated census cloud computing, and big data analytics

The key objective of industry 4.0 is to drive manufacturing forward, to be faster, more efficient, and customer-centric while pushing beyond automation and optimization to discover new business and models. (Hamen, 2020)

Other objectives are

1. Real-time capability: smart factory needs to be able to collect real-time data, store or analyze it, and make decisions according to new findings.
2. Service-orientation: production must be customer-oriented.
3. Decentralization of the ability of CPSs to work independently this creates a more flexible environment for production.
4. Virtualization: PSS must be able to stimulate and create a virtual copy of the real world.

5 Results and Discussion

The industrial revolution began in 1820 1st, 1840 in Great Britain; the first industrial revolution was the transition to the new manufacturing process

In IR2.0 was again about large scale manufacturing became enabled by assembly lines and the harnessing of electricity, ford scaled from 11 cars a month to 2500 cars a day in 1925 (Auer et al., 2020).

IR3.0 also known as the technological era was classically given to “computers and automation”, but broader sciences also contributed. Chemical engineering and biochemistry giving rise to material science. This provided the building blocks for new material for manufacturing. Ultimately, it’s about scale-innovating new things to make current things old quicker.

"Industry 4.0 refers to the new phase in the industrial revolution that focuses heavily on interconnectivity, automation, machine learning, and real-time data. Industry 4.0 also sometimes referred to as Eliot or smart manufacturing marries a physical production and operations with the smart digital economy, machine learning, and big data to create a more holistic and better-connected ecosystem for companies that focus on manufacturing."Ritesh Rawal, founder of dudes and Ritesh Rawal foundation. (McDaniel, 2012)

Industry 4.0 as a name given to the idea of smart factories where machines are augmented with web connectivity and connected to a system that can visualize the entire production claim and make decisions on its own. It connects physical with digital and allows for better collaboration and access across departments, partners, vendors, products, and people. (Swain, 2018)

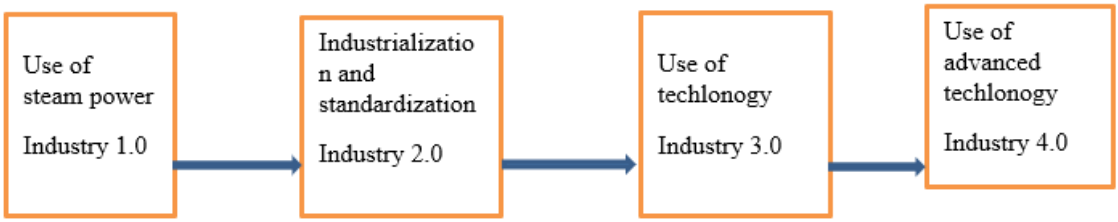

Figure 1: Steps of Industrial Revolution

5.1 Characteristics of the Industry

There are various characteristics given by the German government about industry 4.0, these are

5.1.1 Stronger Customization of Products

Modern expect the ability to customize anything and everything to fit their individual preferences, this concept can be elevated through mass communication, whenever a business can efficiently mass-produce products that meet individual customers' desires, they are offering their customers an opportunity to be unique. (Outman and Outman, 2013)

5.1.2 Required Automation Technology

Automated technology or labor-saving technology is the technology by which a process or procedure is performed with minimal human assistance.automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually in combination.there are several benefits of automation which include labor savings, savings in electric costs, saving in material costs and improvements to quality, accuracy, and precision.

5.2 Components of the Fourth Industrial Revolution

5.2.1 Cyber-physical systems

This is a computer system in which a mechanism is controlled and monitored by computer-based algorithms`. Cyber-Physical Systems (CPS) comprises interacting digital, analog, physical, and human components engineered for function through integrated physics and logic. These systems will provide the foundation of our critical infrastructure, form the basis of emerging and future smart services, and improve our quality of life in many areas. Cyber-physical systems will bring advances in personalized health care, emergency response, traffic flow management (NIST engineering laboratory). (McDaniel, 2012)

5.2.2 Cognitive computing

Cognitive computing is the use of computerized models to simulate the human thought process in complex situations where the answers may be ambiguous and uncertain.

Cognitive computing systems can synthesize data from various information sources while weighing context and conflicting evidence to suggest the best possible answers. To achieve this, cognitive systems include self-learning technologies that use data mining, pattern recognition, and natural language processing (NLP) to mimic the way the human brain works. (Hamen, 2010)

5.2.3 System resource

A computer system, system resources are the components that provide its inherent capabilities and contribute to its overall performance. System memory, cache memory, hard disk space, IRQs, and DMA channels are examples. In an operating system, system resources are internal tables and pointers set up to keep track of running applications. They may be limited by hardware resources, but are often as not arbitrary limitations within the software itself. (Arnold and Wiener, 2015)

6 Principles of the Fourth Industrial Revolution

6.1 Interoperability

Objects, machines, and people need to be able to communicate through the internet of things. This is the ability of computer systems or software to exchange and make use of information. It is important for example, that it makes it easier for medical patients to share information. This also the ability of different information systems, devices, and applications ('systems') to access the exchange, integrate, and cooperatively use data in a coordinated manner within and across organizational, regional, and national boundaries.

6.2 Interconnection

In the English dictionary, this means a mutual connection between two or more things, but in industry, 4.0it is a way of connecting systems employing new energy utilization technology such as electric heating equipment, electrified rail transit, and electric vehicles.

By upgrading the level of electrification in the whole society, we can achieve the goal of meeting the world's electricity demand in a clean and green way thereby changing the development mode of human industrial supervision. (Outman and Outman, 2013)

6.3 Information transparency

Transparency implies openness, communication, and accountability, but these have a different meaning in industry 4.0 where information that is intentionally hidden or decrypted from public view, that is, only one with access can view the information which has been hidden. Information transparency in industry 4.0 is very important for individuals within a company feel they are working for a company with higher ethical standards for when transparency becomes a norm in a cooperative company, industry, employees will have good morale and be more engaged and committed to the vision of the company. (Hamen, 2020)

6.4 Decentralized decisions

This is any process where decision making is distributed throughout a large group. It also means that a higher authority gives power to a lower-level authority to make decisions, e.g. A company gives a branch to be a final decision maker in their jurisdiction. This in many ways reduces, delays, improves product development flows, and enhances faster feedback, and finally an innovative solution.

7 Basic concepts

Industry 4.0 is the most recent evolution and as most of the evolutions, there must be some changes and improvements. The first industrial revolution involved the upgrading of the manufacturing industry, plus the start of the use of steam power, which in this case became a great breakthrough in increasing human productivity.

The second industrial revolution which began in the 19th century, whereby there was the use of electricity and assembly line production. Henry Ford (1863-1947) a scientist and founder of the Ford motor company was the outmost developer of the assembly line technique of mass production, which drastically altered the industry. Before one in station handed all parts of an automobile, but after vehicles were produced in partial steps on a conveyer belt, thereby becoming faster and at a lower cost. (Swain, 2018)

The third industrial revolution came with its unique changes in the '70s of the 20th century. Computers now can into use, for instance, Bill Gates developed Microsoft which became a huge innovation in the 20th century. It also came by with a production process without human assistance, that is, by the use of robots. (Hamen, 2020)

The fourth industrial revolution is currently being implemented, and as the other revolutions, it has distinct characteristics and concepts which help develop and make great changes to the current system, Industry 4.0, has various trends and factors, these are

7.1 Internet of Things (IoT)

This is the interconnection via the internet of computing devices impended in everyday objects, enabling them to send and receive data. It is also a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers and the ability to transfer data over a network without requiring human-human or human to computer interaction. (Arnold and Wiener, 2015). Examples include connected security systems, vending machines, speaker systems, and more.

7.2 Industrial internet of things (ILOT)

This refers to the use of the internet in industrial sectors and application. These include robotic, medical devices, and software-defined production process.

7.3 Artificial intelligence

This is where machines work and think like humans, for example, where they recognize speech problem solving, sorting, and planning things. Artificial intelligence has four types, namely: reactive machine, limited memory, theory of mind, self-awareness.

Artificial intelligence is impacting the future of almost every industry and also acts as the main director of upcoming technologies, for example, big data, robotics, and

the internet of things and it's the technological innovator of the future Google, Alexas, sire are examples of artificial intelligence. (Hamen, 2010)

7.4 Machine learning

An application of artificial intelligence that provides a system with the ability to automatically learn and improve from the experience without being programmed. This where a machine can copy data and use it to learn explicitly for themselves. These are classified into three: supervised learning, unsupervised learning, and reinforcement learning.

7.5 Ecosystem

The marriage of advanced manufacturing techniques with information technology, data and analytics is driving another industrial revolution. We are moving rapidly from the industrial economy, reliant on single companies producing distinct products which most often gives customers a little or no choice at all, but this is about to experience some changes driven by a digital economy where all sides of value equations are connecting, where customers have a louder 'voice' over the products and manufacture will need to listen to and respond accordingly. (Outman and Outman, 2013).

7.6 Big data

Big data analysis has been identified as one of the significant components of industry 4.0. Big data analysis is somewhat of a bet on the future. It is the use of advanced computing technologies on huge sets to discover valuable correlations, patterns, trends, and preferences for companies to make better decisions.

Businesses use data analytics to improve business decisions by understanding patterns and picking up on trends from huge amounts of customer data. Big data are used in industry 4.0 as manufacturers use it in the same way as most other commercial entities expect with a narrower focus. They collect huge amounts of data through ILOTS and cloud computing that gives them a chance to uncover patterns that help them improve the efficiency of supply chain management.

It also helps them discover hidden variables causing problems in production that they even didn't know existed. Big data analytics also increase efficiency by reducing breakdowns and unscheduled down the line. It is also used to automate production management, thus reducing the amount of human input and action needed in a manufacturing facility. It works by analyzing the history of production, mixing it with real-time information about that particular process, and the automated physical changes, which are connected to control the software. These take inferences made from big data analytics and send out targeted commands to the control software that will physically alter settings on equipment without human alteration. (Auer et al., 2020)

7.7 Cloud computing

This is the running workloads remotely over the internet in a commercial provider data center, also from how cloud computing works, it is a virtualized pool of resources from raw compute power to application functionality while on demand. It delivers services through the internet and also makes it possible to save and retrieve files to and from a remote database when demanded. Cloud computing will be of benefit to the 4th industrial revolution since it is highly flexible and scalable. It also reduces the business cost and ensures continuity in business. (Swain, 2018)

7.8 Real-time processing

Also known as Real-time computing in industry 4.0 is where all programs must be able to deliver within specified time limits 'deadlines. Currently, industry 4.0 has evolved and many of the current systems, e.g. bank ATM, traffic controls, and modern computer systems and mobiles. Real-time processing is usually found in systems that use computer control, where the processing is used when the output must be required at the time.

8 Impacts of industry 4.0

Industry 4.0 has many effects on all aspects of life, whether social, economic, or political. As the previous industrial revolutions. Industry 4.0 is expected to bring

tremendous and big effects on the world. Economists argue that it may bring adverse effects to the economy, business, and governments, but they are not certain whether it shall be upscaling or downscaling but for sure it shall bring enormous and gigantic effects as seen by the trends explained above. Namely, smart factory, big data, 3d printing, etc. (Veblen, 2011)

8.1 Government and people

The 4th industrial revolution is expected to hit the whole world significantly. It will tend to change how they relate, do their businesses, and even their boundaries. For example, Twitter users in a country in Africa tend to comment on anything posted by the current President of USA president Donald Trump yet they are not affected directly by trump's leadership.

The current revolution requires leaders to be the mastermind of everything done therefore it needs leaders with enough understanding to navigate through this revolution. "Technologies that are emerging today will soon be shaping the world tomorrow and well into the future – with impacts to economies and societies at large. Now that we are well into the fourth industrial revolution, we must discuss and ensure humanity is served by these new inventions so that we can continue to prosper" Mariette DiChristina, editor in chief of Scientific American, and chair of the emerging technologies steering committee. (Veblen, 2011)

The leaders, therefore, are needed to be co-active and be ready to use digital technology to govern their people. Moises Niam says “in the 21st century, power is easy to get, harder to use, and easier to lose. "Leadership is tougher today than in the past since there are various forms of the government ranging from Regional, national, local, and even individual. Different from the past where micro-governments could not effect change to national governments, now it can effect enormous change thereby making governance challenges. (Auer et al., 2020)

Ultimately, the ability of the government systems to adapt will determine their survival. If they prove capable to change, then they will flow with the system, but if the leaders become ignorant then they will face a lot of challenges.

The government will gain new technological powers to increase their control over populations based on pervasive surveillance and the ability to control digital infrastructure.

The fourth industrial revolution shall also be of a larger impact on national security, affecting both the probability and nature of the conflict. Previous countries that were seen as harmless due to the nature of just using the digital background are now very dangerous since the digital background now affects the government directly. Some governments use cyber-attacks to expose the vulnerability of others

These new vulnerabilities will also lead to new fears, but similarly, it will create the potential to reduce the scale or impact of violence, through the development of new modes of protection.

Eventually, it is the power of the governments to adapt there will determine their survival if they accept the exponential change and induce their structures to high levels of transparency and efficiency, then it will help them mitigate the expounding changes, thereby remodeling into much leaner and more efficient power cells. (Skilton & Hovsepian, 2017)

8.2 The people

Individuals will mostly be affected by the 4th industrial revolution from how we relate to how we do our daily works. These factors are certainly going to affect day to day activities. Most of the people in the developing countries haven't or not even had electricity, water, steam and yet we are currently moving from these to technological advances.

The impact shall have on us individuals shall affect our individuality and even we much related factors-our privacy, our notion of ownership, our consumption pattern, the time we do devote to leisure, how we develop our careers, cultivate our skills. It will also influence how we meet people, how we relate, the system upon which we rely on. Our normal routine may change totally to a period where we can question

our form of existence. Such changes elicit a sense of fear and excitement as we move at an unplanned speed.

These many changes shall bring up inequality, where there shall be a class of “winners" (those who accept the change and are willing to adapt to the change) and a class of "losers" (those not taking the changes). These shall also lead to a situation where there shall be many conflicts in society and among individuals. The winners, at last, shall gain due to some technological advances, e.g. (genetic engineering) where they shall be fed with important information while the losers shall more of sympathizers. (Auer et al., 2020)

These risks creating indecencies and fights like never seen before caused by those who were born in this technological age and those who were born before the technological age who are seen as bystanders in this technology. It also gives rise to many ethical issues. The current exposure to many videos online has raised a point of discussion by the "losers" but the "winners" don't see anything to worry about it.

The individuals also risk being drawn into a big discussion where they will not be known the part at which they are leading and believe they are stagnating. Industry 4.0 therefore shall have big impacts both negatively and positively to the individuals.

8.3 Economy

The greatest and largest beneficiary of the fourth industrial revolution is the economy. Indeed, it shall be so huge and multifaceted that it will make it hard to differentiate between one particular effect from the other. Employment, GDP, trade productivity, and many others, shall be affected. Economists as I have stated are still not sure whether they shall be a rise or a downfall, but they all agree that there shall be great changes in the economy. The global economy before the great depression of 2008 had been on the rise by almost 5%, but after the depression, the economy fell by a large 2%, and now the economy is rising by just 3-3. 5%. The "pessimist economist "argue that the 4th industrial economy shall lead to a fall in the economy around the globe, they predict that there shall be a rise of just 2% of the world economy, therefore, taking almost 36 years for the economy to double but these have been under a huge discussion and the "optimistic" economist don't agree with these. (Auer et al., 2020)

They believe that the economy shall be affected by the upward trend and foreseen by the improvement in technology, there shall be a rise in the economy and great improvement in the way we live. The poverty level shall decrease and they predict that the economy with these technological advances shall double after every 14-15 years. (Skilton & Hovsepian, 2017.)

8.4 Labor

The advancement in technology shall create many employment opportunities but shall also affect the most of the opportunities created by the previous revolutions. Most manual works, e.g. mechanics have been automated rendering the professional who worked in these professions jobless. These and many other professions shall be automated in the 4th industrial revolution thereby making the labor supply useless.

The fourth industrial revolution, though thought as the best seems to be creating a few job opportunities than the previous revolutions. A city and oxford university joint report in 2016 estimated that 57% of jobs across the OECD are at risk of automation, the financial times reported in 2013 that 2016 that between 2000 and 2010, of all the jobs lost in the USA, over 85% were lost to new technologies, and the bank of England estimated that two-thirds of all jobs are capable of being automated within the next 20 years. (Arnold and Wiener, 2015)

The oxford martin program on technology and Employment estimated that only 0.5% of us workforce is employed in industries that were started in this century, a far lower than the 8% of new jobs created in the1980's and 4.5% jobs created in the 1990s. The USA adds content to these by their study that tends to shed light on the relationship between technology and employment. It infers that technology tends to raise productivity by replacing existing workers rather than creating new products needed in the labor market.

The table below shows jobs with the highest preference of automation and their probability of automation done by two researchers from the Oxford martin school, economist Carl Benedikt Frey and machine learning expert Michael Osborne

Probability	Occupation
0.99	Tele markets
0.99	Tax preparers
0.98	Insurance appraisers, auto damage
0.98	Umpires, referees and other sport officials
0.98	Legal Secretaries
0.97	Hosts, hostesses, restaurant, lounge, coffee shop
0.97	Real estate brokers
0.97	Farm labor contractors
0.96	Secretaries and administrative assistants, except legal, medical and executive
0.94	Couriers and messengers

Figure 2: Highly Risky to Automation

Probability	Occupation
0.0031	Mental health and substance abuse, health workers
0.0040	Choreographers
0.0042	Physicians and surgeons

0.0043	Psychologists
0.0055	Human resource managers
0.0065	Computer system analysts
0.0077	Anthropologists and archeologists
0.0100	Marine engineers and navigators
0.0130	Sales managers

Figure 3: Least Risky to Automation

From: Auer, M. E., Hortsch, H., & Sethakul, P. (2020).

From their study of carl Benedikt Frey and Michael Osborn, it means that most of those occupations that are likely to lose are those that require human labor, but we must note that there isn't a competition of machines versus human but the technological changes are just but enhancing human labor and cognition, thereby leaders should prepare the workforce and impacts enough knowledge on their people so that they can work with and alongside, increasingly capable and intelligent machines.

8.5 Countries

The fourth industrial revolution is far much moving faster than even the developing countries in which some of its members haven't got all the required

necessities, for example, electricity, water, and education are currently on the verge of feeling the 4th industrial revolution.

Since digital technology does not have any border, many people tend to ask themselves whether the developed countries shall follow back as of the previous revolutions or shall keep in line with the developed countries in this industrial revolution.

Statistics show that most of the most limited, enjoys huge support, and have huge capital are based in the USA, for example, Facebook, Twitter, and others. Will western Europe, The USA lead again in this industrial revolution, or will the other economies across the world keep in touch?

Answering all these questions is not easy, but one thing is clear and consents that the countries that will take into effect the emerging economies (artificial intelligence, robotics, 5G connectivity, and many others) are going to be the huge reapers of the 4th industrial economy. Countries that embrace their norms, shun the digital economy, and live by them shall be very unlucky for they shall not reap anything. (Veblen, 2011)

North America, Europe is developing very fast and most innovative economies, lead the way other countries are rapidly catching up. China, for example, has increased to 49% of the EU level in 2015, (up from 35% in 2006) as the country shifts its economic model to focus on innovation and services. Therefore, showing that a country or a

specific region can capitalize fully on the opportunities afforded by the technology revolution. (Auer et al., 2020)

Countries are experiencing a huge rural to urban migration. In this century more than half of the people are living in cities, thereby the cities are hubs of the industrial revolution and they shall be essential for the growth of the economy. Many factors affect the competitiveness and of countries- ranging from education, infrastructure, and leadership and may help raise countries. (Arnold and Wiener, 2015)

8.6 Business

Which business can a person now do without the knowhow of the computer, and if he can do, how many people can it reach in a single unit of time? Have the people embraced digital technology now or are we still under intense darkness?

These questions are just but an open book on how the technology has affected the current day to day activities, take for example Facebook took 6yrs to achieve 1 million turnouts whilst Google just took 5 years to achieve the turnout. Meaning most businesses started in this century tend to reach people faster and efficiently right now. (Andriole, 2005)

Many companies' chief executive after this revolution might be rendered temper ant if they are not preparing the workers for this fourth industrial revolution. The current revolution will not be a walk in the park for many businesses. Most business

are customer-centric but they will be tasted as real-time data and analysis are applied to the way to target and serve their customers, these digital is about accessing and using real-time data, redefining and refining the products to the current customer needs, and moving to the ever-changing continuous world that will ensure that the customer remains at the heart of the process. (Veblen, 2011)

The business should be worried, the trends being experienced now shall give the customers much power and much say as they shall have much data in their fingertips, therefore having a much one on one comparison of goods. Take, for example, the current online shopping in Jackman's online shopping mall, the customers can compare the price of let's say tv sets and choose one to purchase without coming into contact with the seller. the customer uses these websites to compare the quality of service and the performance by just a swipe of the finger. companies now cannot hide their poor performance since within a few seconds everybody can access their website and get the information. brand quality is a prize hardly got and easily lost. This will only be amplified in a more transparent world. (Wyatt, S. (2020)).

We are living in a century where digital technology is on the rise. more than 87% of the youths America are currently accessing WhatsApp, while almost 50 % of the youths also do not leave their phone behind no matter the circumstances. These cannot be controlled in the developing economy wherein sub-Saharan Africa more than 30% of the population have access to smartphones, therefore the business needs to be

upgraded so that they can be able to cope up with the current digital economy. (Ross, 2016)

9 Challenges

9.1 Challenges of the fourth industrial revolution

Anything that has advantages cannot miss having some disadvantages, this is also a fact with the fourth industrial revolution where although it can bring a lot of benefits, we also have to be ready to face the challenges of which I have highlighted some of the challenges, these are

- Government and the people-although most of the governments have embraced the revolution some in developed countries don't even have access to some simple amenities for example water and electricity therefore, they risk being left back in this revolution.
- The fourth industrial revolution might also bring a lot of climatic changes since the technology used requires a lot of emissions which might be detrimental to the globe.
- There is also a high risk of rendering a lot of people unemployed since the technological advance and automation of machines through the use of (A.I, machine learning, and many others). (Auer et al., 2020)
- Cybersecurity and malware-in the former century most of the fights were done through the head to head warfare but currently most of the fights are done

through the internet namely, most countries install malware to other counties' systems to block them from accessing their accounts, these can lead to another big war.

- Threats to transparency and accountability-most people access their news online but now it is difficult to differentiate fake news from real news. Most of the news online do not go through check and verify protocol hence many stations and governments face the threats. These has led to a lot of insecurities among the government and businesses.
- Over-reliance on technology by mankind-though technology is perfect and very important in the current system, mankind has now over-relied on it. Saudi Arabia currently granted citizenship to a robot. This has led to some discussions about whether humankind has been now compared to robots and if these continue it shall backlash on humankind. (Hamen, 2010)

10 Conclusion

This industrial revolution cannot be assumed as it is just the beginning of something big and challenging. Most economies in the world are now on the verge of digitalizing their records and are relying on real-time data to analyses and make conclusions on their customer needs. These however cannot be said to be fully on the industrial revolution there are still many more to be done.

The fourth industrial revolution is not just a revolution it is a period where we are experiencing huge technological advances with most systems being automated. Therefore, the governments should get ready to create jobs and move one on one with the people since many are going to lose jobs as their professions become automated.

11 Recommendations

The 4th industrial revolution shall lead to the enormous usage of technology. It shall represent a fundamental change in the way we live, work, and relate to one another. It is a new chapter in human development enabled by extraordinary technological advances. The 4th industrial revolution is not just about technology-driven change but also an opportunity to help everyone including leaders, policymakers, and men from all around to pick and get used to the developing technology to create an inclusive, human-centered future.

The 4th industrial revolution will depend on the leadership from all sectors working together to balance the opportunities and address the challenges of the 4th industrial revolution. Collaboration is critical during transformation or change.

The 4th industrial revolution shall not only disrupt business agencies but also the government and society. For example, the challenges of projected job losses in unskilled job categories due to the introduction of robotics will lead to job massive job losses that will further deepen unemployment, poverty, and inequalities, therefore the government and business entities have to be ready and take into consideration such kind of unskilled workers. Wyatt, S. (2020).

Humans as for now must be pro-active in shaping this technology and disruption. Companies should heavily invest in their data analyzing capabilities and technical infrastructure, as well as making a move to be smart, well-oiled, and

connected, or soon they will be left behind. Leaders need to be skilled so that they can manage organizations through these dramatic shifts. (Ross, 2016)

The education and training schools need to adapt to prepare people for flexibility and critical thinking they will need in the future workplace. The youths also need to be fed knowledge and capabilities to perform a specialized task, to give them technical or domain-expertise to perform specific task for example ,Be trained on computer programming, coding, project-management, financial-management, mechanical functions, and other job-specific skills(e.g. farming, nursing). (Skilton & Hovsepian, 2017)

12 Reference**s**

Ross, S., 2016. *The Industrial Revolution*. 3rd ed. London: Evans.

Auer, M., Hortsch, H. and Sethakul, P., 2020. *The Impact Of The 4Th Industrial Revolution On Engineering Education*. Cham: Springer.

Auer, M., Hortsch, H. and Sethakul, P., 2020. *The Impact Of The 4Th Industrial Revolution On Engineering Education*. Cham: Springer.

Andriole, S., 2018. *The 2Nd Digital Revolution*. Hershey, Pa.: IRM Press.

Wyatt, S. (2020). *Management and leadership in the 4th Industrial Revolution: Capabilities to achieve superior performance*. Kogan Page.

Veblen, T., 2011. *Imperial Germany And The Industrial Revolution*. New York, NY: Barnes & Noble Digital Library.

McDaniel, M., 2012. *The Industrial Revolution*. New York: Children's Press.

Hamen, S., 2010. *Industrial Revolution*. Vero Beach, Fla.: Rourke Pub.

Arnold, J. and Wiener, R., 2015. *The Industrial Revolution*. Danbury, Conn.: Grolier.

Outman, J. and Outman, E., 2013. *Industrial Revolution*. Detroit: UXL.

Hamen, S., 2020. *Industrial Revolution*. Vero Beach, Fla.: Rourke Pub.

Skilton, M., & Hovsepian, F. (2017). *The 4th Industrial Revolution: Responding to the impact of artificial intelligence on business*. Springer.

Auer, M. E., Hortsch, H., & Sethakul, P. (2020). *The impact of the 4th Industrial Revolution on engineering education: Proceedings of the 22nd International Conference on interactive collaborative learning (ICL2019) – Volume 2* (4th ed.). Springer Nature.

Swain, J., 2018. *Industry Before The Industrial Revolution*. Manchester, UK: Published for the [Chetham] Society by Manchester University Press.