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The idea of the 4th Industrial Revolution. Attitudes of academic leaders at an urban South African University and its implications for University practice.

by

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ABSTRACT

The 4th Industrial Revolution (4IR) is the new buzzword in education circles, not least in South Africa. Political leaders, journalists, academic leaders, students and people in general are referring to the current period as the 4IR. This qualitative research sought to ascertain the attitudes of significant academic leaders (University management and lecturers) at an urban South African University to the idea of the 4th Industrial Revolution and its implications for university practice.

An industrial revolution is a period where there are technological inventions that cause a change in the way industry operates, transforming production, consumption and impacting on labour and society as a whole. The 1st Industrial Revolution (1IR) is said to have happened between 1750-1850 in Great Britain which caused a major shift in the way industry operated. This in turn had serious consequences for society. The analytic lense of the 1IR then provided the conceptual framework to determine the nature of an industrial revolution. This allowed for an analysis of the 4IR which then constituted the conceptual part of the research. The second part of the research was the empirical part which sought to determine the attitudes of academic leaders (lecturers and management) on 4IR.

The research used qualitative methods and interviewed eight of the most influential academic leaders in the institution. The findings showed that the academic leaders had a clear interpretation of what an industrial revolution is. The conclusions reached were

- All participants were able to identify the components entailed in an industrial revolution and the 4IR in particular.
- As academic leaders, participants believe we are in the 4IR and the country has got to put measures in place so as to move the country forward despite the challenges it faces as a developing nation. They feared being left behind economically if the country does not move forward into 4IR.
- On education, the participants believe the university should put in place infrastructure capable of 4IR technologies, train lecturers, change the curriculum, implement blended methods and change how they teach and learn so as to move into the 4IR.

Acknowledgements

I am grateful to my supervisor Dr Ian Moll for his guidance throughout the research process. I am also grateful to all the academic leaders (lecturers and university management) who allowed me to interview them. Without them this research process would not have happened.

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The research report comprises two parts of the study. The conceptual where the 1st industrial revolution was studied in depth in order to draw out an analytical framework so as to determine what is an industrial revolution. This was used to compare the 2nd, 3rd and 4th industrial revolutions. The second part is the empirical study which looks at the attitudes of academic leaders on the idea of the 4IR and its implication for university practice.

Chapter 1

INTRODUCTION

The introduction comprises the empirical part which will look at the idea of the 4th Industrial Revolution and what political leaders and academic leaders are saying about 4IR and it will form the background of the research.

Background of the research

The term 4th Industrial Revolution (4IR) is the new buzzword everywhere. Be it on television, on radio or print, political leaders, academic leaders, students and people in general are referring to the current period as the 4IR. The 4IR is said to have started towards the turn of the century with some saying it started in 2006 and others in 2016. The 4IR which is the fusion of the physical (robotics), the digital that is (internet of things) and the biological (genetic make-up) has taken the world by storm. These are now able to communicate intelligently and as a result can generate new forms of intelligence. Most of the technologies in the 4IR started in the 3IR which is known as the Digital Age but they are changing at a fast pace and becoming more sophisticated. Information technology (IT) has now huge analogue and digital machinery, specialized computing systems, mobile devices, tablets fuelled by massive social networks and multi-media digital services, collective information about people, products, places and workspaces and interconnected supply chains that work across many country borders. South Africa has also taken to the new phenomenon with a presidential commission on 4IR and a ministerial team to advice the minister of higher education and training on 4IR issues. The President of South Africa in January speaking at the Basic Education Lekgotla said, “Preparing children to excel from an early age especially in the priority areas of science, technology, engineering, arts and mathematics, South Africa will prepare them for the Fourth Industrial Revolution.” Again, in his State of the Nation Address (SoNA) in February 2019 he announced that he had appointed a Presidential Commission on the 4IR which will be tasked to identify and recommend policies, strategies and plans to help the country to become a competitive player within the digital revolution space. To show the seriousness of the matter, the President went on to say that the education sector will be introducing several new technology subjects such as technical mathematics, technical sciences, maritime sciences, mining sciences, aviation studies and aquaponics. The president in preparing for the nation for 4IR believes that the education sector plays an important role and as a result subjects should be realigned with 4IR dynamics.

The former deputy Prime Minister of Zimbabwe, also gave advice to the current government of Zimbabwe when he said that for the country to prosper economically it had to move into

the Fourth Industrial Revolution. He went on to say that the Fourth Industrial Revolution needed an education system that produced critical thinkers and schools had to integrate technology into their current teaching methods. Again, here the former deputy Prime Minister believes education is the key to unlocking potential to manage 4IR challenges.

In Namibia during the 3rd Society of Clerks-at-the-Table (SoCATT) Africa Region Professional Development Seminar, the purpose of the seminar "was to harness the delegates' understanding and knowledge of the Fourth Industrial Revolution in order to determine strategies and develop context-specific capacity building programmes for African Parliaments in the knowledge-based economy," (Kooper, 2018, p.217).

In Davos at the World Economic Forum (WEF), the theme was *Shaping a Global Architecture in the Age of the Fourth Industrial Revolution.* In response to the WEF, Psotka, (2018) said, "When the elites control more than 50% of the income and more than 50% of the wealth of a population, some powerful forces are unleashed. Top of the list, they control law and governance to suit themselves." The author is giving caution into believing what we hear as the positives of the 4IR because those who control the wealth will always have their interests first. Everywhere the term 4IR is being used to sensitize people of the importance of changing systems so as to be 4IR ready.

Kennedy, (1993, p. 339), states, "If my analysis is roughly correct, the forces for change facing the world could be so far-reaching, complex, and interactive that they call for nothing less than the reeducation of humankind." As suggested by the author, the changes happening in this time has implications on education and how the education fraternity view it is of great importance.

In his address during the Wits annual Fund, Wits Vice Chancellor described how the University was embracing the 4IR. He said that the University was integrating technology through all aspects of University life including teaching, learning and research. "We have invested R500 million in an ICT upgrade, adopted a new cutting-edge research strategy, and introduced innovative blended learning options, including a digital campus, online courses and high-tech classrooms," (Wits Annual Fund 2018). Academic leaders who are lecturers and University leaders have come together to find ways of navigating the 4IR. Partnership for the 4th Industrial Revolution in South Africa (#4IRSA) an alliance between Telkom and the Universities of the Witwatersrand, Johannesburg and Fort Hare was established and holds workshops to strategize on 4IR challenges. The secretary of the #4IRSA who is also a professor at Wits Business School said, "This wave of change is coming and we cannot control it. But what is important is how we respond to it." A senior lecturer in information systems at the University of Stellenbosch also shared the same sentiments that we are in the midst of the Fourth Industrial Revolution (4IR) and he believes there is a lack of appreciation of the impact on education. He is of the opinion that the current crop of students will not be able to meet the demands of the work place in 10-20 years as the 4IR is a "complex cyber-physical transformed environment." Another senior lecturer at Wits, had this to say also, "Behind the buzzwords such as data science or Fourth Industrial Revolution that we are constantly being bombarded with, is the promise of major disruption to every aspect of our lives, powered by the engine of Artificial Intelligence (AI)," he went on further

to say, “we need our own experts to harness these technologies towards our local challenges and priorities in Africa. We cannot afford to take a back seat in one of the most important pursuits of modern science.” Another lecturer points to the importance of developing our own home-grown technologies to champion the challenges coming with 4IR. Starley, (1970, p.138) concurs, “Do the technological needs of the less developed countries differ from those of the highly developed countries? The answer is yes in certain important respects.”

Two lecturers from University of Johannesburg had advice on what the university should do to prepare students for 4IR, “To equip students for the 4IR requires a holistic approach to curriculum development and teaching that will give them the ability and agility to keep pace with innovation and meet the challenges of this new world of work.” Another visiting Professor at the University of Johannesburg, in February 2019 said, “The Fourth Industrial Revolution (4IR) is not something that is being predicted- It is happening right now here in South Africa and across the globe. Kennedy believes the 3IR is over and the 4IR is much more than the technologies of 3IR in that the 4IR technologies are able to supplement and support human functions. There is something happening about 4IR as people are being urged to prepare to move with the times.

Problem Statement

The 4IR is a period in debate as academic leaders have differing attitudes on what it entails and when it started. A common misunderstanding of the idea of an industrial revolution is that it is about technological innovation only. Schwab, (2016, p.7) states the following about 4IR, “It is characterized by a much more ubiquitous and mobile internet, by smaller and more powerful sensors that have become cheaper, and by artificial intelligence and machine learning.” The research project then sought to find out about attitudes on 4IR from academic leaders (lecturers and University management) at an urban South African University through interviews and what would be the implication on educational practices at the university.

Research Objectives

- To determine what is an IR by analyzing the 1IR and to draw out an analytical framework of an industrial revolution from it
- To use this framework to decipher what the idea of the 4IR is about
- To ascertain connceptions, beliefs and attitudes towards 4IR from academic leaders (university management and influential lecturers) and
- To determine if they have a well-rounded conception of the 4IR and its implications for University practices

Research Questions

Conceptual questions

- What constitutes an Industrial Revolution?
- Why is the 4IR deemed an Industrial Revolution?

Empirical questions

- What are the conceptions, beliefs and attitudes of academic leaders on 4IR?
- What are the academic leaders'suggestions for making University practices more effective?

Methodology

The conceptual part of the study used conceptual analysis (that is analysis of the meaning of concepts and ideas in use. When we look at the definition of an industrial revolution we need to find out when and how it was used and in what context so as to understand the idea of the 4th Industrial Revolution. The questions posed make people aware of the importance of the words they use unconsciously or they take for granted they know their meaning when they say them. The questions might seem strange but the purpose is to make people aware of the words they use (Wilson, 1963)

The empirical part used a general qualitative research design and qualitative data gathering methods. Qualitative research poses questions about a certain phenomenon with the aim of making sense of it from the participant's point of view. The approach is flexible and the information is gathered through the use of interviews measured on nominal and ordinal levels, (de Vos et al, 2012). The researcher did the research with an open mind and collected extensive data from a small sample. The research used inductive reasoning that is moving from the general to the specific. (de Vos et al, 2012). The research carried out one-on-one interviews with academic leaders of the University in order to understand their take on the idea of the 4IR. Interviews were recorded and notes taken so as to have accurate information during data analysis.

Population and Sampling

"A population is a group of potential participants to whom you want to generalize the results of a study", (Welman et al, 2007, p.55). The research interviewed eight academic leaders (university management and lecturers) from an urban South African University.

A sample is a subset of a given population that is the research only used academic leaders (university management and lecturers). Non probability samples were used and the research used purposive samples. "Researchers rely on their experience, ingenuity and /or previous research findings to deliberately obtain units of analysis in such a manner that the sample they obtain may be regarded as being representative of the relevant population", (Welman et al, 2007, p.69). The sampling criteria used to select the participants were the following:

- Thought leaders on 4IR
- Influential academics
- Management

Ethical Considerations

An ethical clearance form was submitted to the Humanities Ethics committee for clearance to carry out the research. Letters were sent to the Head of School of the University in order to ask for their permission to carry out the research and separate letters were also drafted for the academic leaders. The letters expressly indicated that the research would be voluntary and that they would be free to drop out at any time. Interview questions would desist from personal issues and names of participants would be left out of the research.

Research Outline

Chapter 1 Introduction, problem statement and research questions

Chapter 2 Conceptual Framework and Literature Review

Chapter 3 Research design and data collection

Chapter 4 Research findings and discussions

Chapter 5 Conclusion

Chapter 2

Literature Review

The literature review is composed of two parts. The conceptual and the empirical. The conceptual part is made up of the literature on 1IR which is then used to derive an analytical framework. The framework was used to determine what constitutes an industrial revolution. The main features from the analytical framework guided the literature review on the 2IR, 3IR and 4IR in order to determine if they constitute an industrial revolution. The empirical part looked at attitudes and how teacher attitudes about technology are formed.

The 1st Industrial Revolution (1IR)

The First Industrial Revolution started in Britain and it spread to Germany, France and then North America. It did not just happen overnight but it was a gradual process that happened over a long period of time (1750-1850). Before the onset of the 1st Industrial Revolution there were characteristics of poverty, stagnation (The British system was an aristocratic one in which power was in the hands of a small governing class and Parliament was in disarray), dependence on agriculture and a lack of coordination and integration among the regions, (Deane, 1965). The revolution was unplanned and it happened without government help or planning for it. Britain was mainly an agricultural country with industries scattered everywhere. Marx and Engels (2008, p.51) points out, "Before the introduction of machinery, the spinning and weaving of raw materials was carried on in the working-man's house." The people first improved on agriculture which produced more yield. The introduction of enclosures (a system were freeholding land became private owned and fences put around it. This was passed as an Act of Parliament) caused a lot of suffering among the peasants who were the rural poor. The enclosures had restricted their animal pastureland and the places where they collected firewood for cooking their meals. They were also unable to hunt because the new land-owners imposed rules on their lands so protein in the form of meat disappeared from their tables. The enclosure system might also have been a catalyst for the revolution in that peasants had to find ways of making ends meet and most likely migrate in search of better opportunities. On the other hand, the enclosures improved on agriculture as innovations were being practiced in these fields. When harvests became improved and yields increased, it meant wages became higher and landowners also invested more in industries. The agricultural sector contributed to the rise in industries. "In terms of economic productivity this social transformation was an immense success, in terms of human suffering, a tragedy… which reduced the rural poor to demoralized destitution," (Hobsbawm, 1962,48).

The population growth and the demand for manufactured goods increased which resulted in more production and innovation, (Holland, 1968). Evans, (1983, p.104) concurs and posits, "The rise in the population of Britain during the eighteenth century… acted as a spur to industrial development… since it provided not only a potential workforce for workshop and factory but also rising demand for industrial goods." But it was not good for the environment, "Rising populations in the West have been supported by continual increasing the level of manipulation and exploitation of the environment," (Ehrlich, 1970, p. 54).

The transport system improved and created employment also in the construction sector through the building of canals and turnpike roads. The advantage of rivers and access to the sea allowed for easy movement of bulky goods and the development of foreign trade. Trade with colonies gave Britain an advantage. Imports, exports and re-exports of colonial goods through Britain to other mainland European countries increased drastically. Trade in textiles and metal goods with America triggered production and had a major impact. Slave trade also made a huge impact economically. "Possessing greater manufacturing efficiency than any other society at that time and enjoying ever-higher standards of living, many Britons became proponents of laissez-faire economics and of an "open" trading order in which national boundaries and ownership counted for less and less," (Kennedy, 1993, p. 9)

The invention of steam power was considered the most important invention. It increased the production of textiles which led to a demand for coal which propelled the steam engines. The engine was also used in coal mines and for iron works. Kennedy, "1993, p.7-8", submits, "Moreover, the coal needed to fuel those machines and the manufactures flowing from the newly established factories in which the machines were grouped could be hauled by locomotives possessing the capacity of hundreds of packhorses." The advent of steam power also caused the development of the profession of engineering. The expansion of scientific knowledge catapulted technological advancement although it had started in other European countries, it was perfected in Britain as it had a conducive environment.

The Implications of the 1IR

Hobsbawn, (1962), pointed out that it was only later in the 1830s that literature started filtering out about 'the rise of the capitalist society' and the social effects of the industrial revolution. "Poverty stalked in the midst of plenty. While statistics revealed steadily mounting material welfare and the growth of national and per capita wealth, hundreds of thousands of wretchedly poor filled the slums of the great urban communities," (Haines, & Walsh, 1941, p. 653). Many towns grew because of the growth in industries and the undermining of domestic industries in the villages. Falkus (1987, p.84) in showing how the change affected workers poses,

> Groups of workers whose real wages and living standards deteriorated over much of the period 1780-1840 included agricultural labourers, especially in the populous southern districts where alternative factory labour opportunities did not push rural wages up. Other groups to suffer were those made redundant by new machinery.

There was movement from villages into towns with mostly young people moving to nearby towns. Holland, (1968, p.89) cites, "Since 1851 the proportion of town dwellers has increased so that today over four-fifths live in towns." With Haines and Walsh, (1941 p.652) suggesting pitfalls of the time, "Yet the coming of the machine was not an unmitigated blessing. The majority of men, the tillers of the fields and the toilers of the factories, became its chattel slaves, dependent upon its whims and fluctuating fortunes."

During that time sanitation, water supply and street cleaning were primitive. This caused major environmental decline which was worsened by coal mining. Kennedy, (1993, p.96) postulates, "The burning of coal and brown coal(lignite), especially by early industry, dirtied

the atmosphere and worsened people's health, in one week of December 1873, a great London "smog" killed an estimated seven hundred people with respiratory problems."

People stayed in crowded places. The effects of overcrowding were clearly shown by Kennedy, (1993, p.96) who outlines, "In the crowded cities of early-modern Europe-garbage was thrown into the streets, rivers were polluted, and deaths by disease multiplied. Entire forests were cut down to provide fuel, housing, ships so that the ecology of a whole region, and people's livelihoods in it steadily altered." There were hostilities between workers and employers. The other downside of the era was child labour. Children as young as 3 or 4 years were working in mines and factories in intolerable conditions. People worked long hours also. They did not have any rights. Falkus, (1987) portrays what was happening,

> There were obvious evils, like the appalling conditions in the fast-growing factory towns and the exploitation of child labour (there were some five thousand boys and even some girls between the ages of 5 and 10 working underground in the coal mines in 1841) Less obvious deterioration included the loss of independence experienced by factory workers, subject now to strict time-keeping, the factory hooter, and the need to keep the machinery turning. Factory labourers, suffered a loss of status as their lives and livelihood became determined by factors outside their control. (p. 85)

Marx and Engels sum the workers' plight, "The industrial revolution has simply carried this out to its logical end by making the workers machines pure and simple, taking from them the last trace of independent activity." The workers suffered the most during the 1IR as Falkus, 1987, pp. 85-86 further explains, "Periodic bouts of unemployment were a feature of industrial work from the beginning of the nineteenth century. Family ties were also changed by the industrial revolution as factories destroyed the family economies which had been part and parcel of the domestic system."

Practical education in the form of machine use and how to do the job was offered to workers. Learning to operate machines took time and it was ongoing. One third of all children were not going to school by 1840. Falkus, (1987, p.156), details,

> The state's first tentative steps into the field of education came in 1833. School provisions, largely ineffective were attached to the Factory Act of that year, and a small grant of 20,000 pounds was made to the two principal religious bodies which had set up a national network of schools from the early part of the nineteenth century.

Some areas did not even have schools and the government was not involved in the building of any schools. It was the church and private entities that build schools. During this time higher education did not cater for the needs of the industry. "Education above the primary level had practically nothing to do with business. The system catered to the landowning classes, and it prepared future clergymen, lawyers, doctors and secondary teachers," (Ringer, 1979, p.2). In short, the education system served the needs of growing government bureaucracies and these did not take an interest in technological progress and economic development. During the same period university education was done to find a high paying

job and it was a measure of status and power. (Ringer, 1979). The aristocracy who ran the countries were not interested in the growth of the industries and the bourgeoisie. Beer drinking became a problem with farmers growing too much grain which they sold to brewers. Parliament passed an Act that allowed brewers to buy licenses cheaply so that they could be more people selling beer. This made people to drink even during working hours. A lot of children also started drinking. Illnesses such as tuberculosis, typhoid fever, cholera and small pox became a problem especially with the overcrowding in the urban areas and sanitation. People emigrated in search of better opportunities, Kennedy, (1993, p.6) asserts, “people left the British of Isles in vast numbers, in search of better conditions elsewhere. While only slightly more than 20 000 emigrated in the 1820s, that figure trebled in the following decade and reached almost 2.5 million in the 1850s.

In summary the 1IR was marked by changes in manufacturing and consumption of goods due to revolutionary changes in industrial technology such as the steam engine. The growth of cities was catapulted by people moving from the villages to towns in search of work, human labour was commodified with women and child labour being at the helm. Environmental degradation and pollution due to mining, poor sanitation and so on. People stayed in overcrowded conditions and beer drinking became a problem. Government was not responsible for education and as a result many children did not go to school. (West,2001) sums it all up in the following statement, “The inadequacies of the Industrial Revolution remain a key factor in most critiques of capitalism and individual liberty”, and Castells, (1996, p.35) echoing the same sentiments, “The dark side of this technological adventure is that it was inextricably tied to imperialist ambitions and inter-imperialist conflicts”.

Literature Review- Conceptual Framework

The Conceptual framework looked at the 1IR main issues to derive an analytical framework. The main issues of the 1IR were presented in the form of a mind map and main themes were derived as shown in Fig 1 below.

An analytical framework of the 1IR

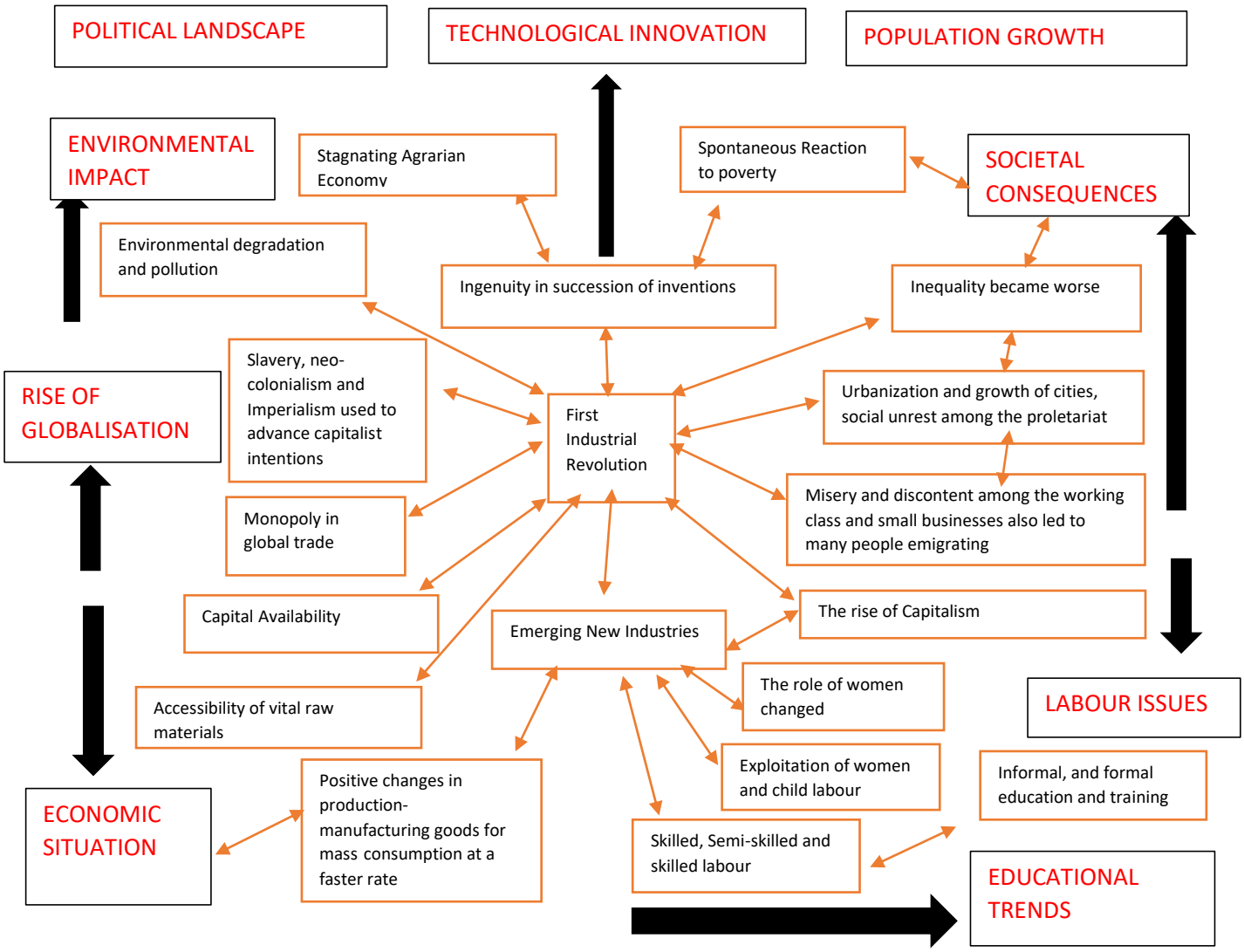


Fig 1 An Analytic Framework of 1IR

Major themes arising from the analytic framework are political landscape, technological innovation, population growth, societal consequences, labour issues, educational trends, economic situation, the rise of globalisation and environmental impact. The major themes arising from the 1IR were used as the analytic framework for an industrial revolution. The major themes are depicted in Fig 2 below.

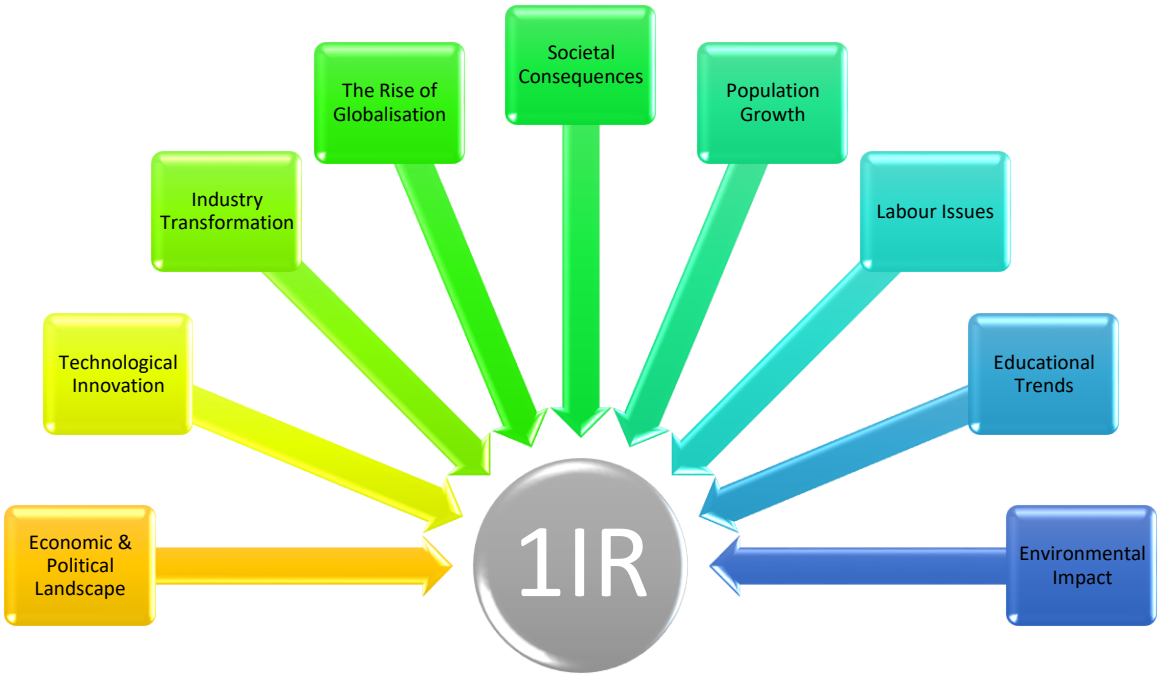


Fig 2 Major Themes in 1IR

Political Landscape- The British system was an aristocratic one in which power was in the hands of a small governing class and Parliament was in disorder. Britain was mainly an agricultural country with industries scattered everywhere. There was also a lack of coordination among the regions. Government was not instrumental in the changes that happened during 1IR. The government was in the hands of aristocracy and functioned in their interest. (Haines, & Walsh, 1941). During the 1IR, "the bourgeoisie and the aristocracy found a basis for co-operation and the mass of the people were still excluded from control," (Haines, & Walsh, 1941, p. 685).

Technological Innovation- The invention of steam power was considered the most important invention. It increased the production of textiles which led to a demand for coal which propelled the steam engines and the engine was also used in coal mines and for iron works. Kennedy, (1993, p.8) "No earlier technological breakthroughs produced anything like the rise in output that flowed from the Industrial Revolution." The advent of steam power also caused the development of the profession of engineering. The expansion of scientific knowledge catapulted technological advancement although it had started in other European countries, it was perfected in Britain as it had a conducive environment.

Population Growth- The population growth and the demand for manufactured goods increased which resulted in more production and innovation, (Holland, 1968). Evans, (1983, p.104) concurs and posits, "The rise in the population of Britain during the eighteenth century… acted as a spur to industrial development… since it provided not only a potential workforce for workshop and factory but also rising demand for industrial goods." Kennedy, (1993, p. 3-4) provides another side of population growth with the following observation,

> Town authorities grappled with a rising tide of homeless vagrants. In the larger cities, a floating population of tens of thousands unemployed slept on the ground

> overnight and poured into the streets the next day. Jails, pauper houses, foundling hospitals, and lunatic asylums were packed with human casualties who had not yet arrived at their common grave. Concerned observers did not need statistics to know that their societies were experiencing a population boom

Societal Consequences- Falkus, (1987**,** p. 85-86) opines, "Periodic bouts of unemployment were a feature of industrial work from the beginning of the nineteenth century. Family ties were also changed by the industrial revolution as factories destroyed the family economies which had been part and parcel of the domestic system." Life became intolerable for the working class during 1IR. Inequality became worse. Wages were little and were able to cover just the daily basic needs of most families. There was no extra money for leisure activities and savings. Many people left Britain for other countries in search of greener pastures. "Emigration …people left the British of Isles in vast numbers, in search of better conditions elsewhere. While only slightly more than 20 000 emigrated in the 1820s, that figure trebled in the following decade and reached almost 2.5 million in the 1850s," (Kennedy, 1993, p. 6). Begging was the order of the day such that it became the responsibility of the church to look after its own poor people. The living conditions were bad in urban areas and people stayed in overcrowded places. To make matters worse sanitation, water supply and street cleaning were primitive. A lot of illnesses such as tuberculosis, typhoid fever, cholera and small pox became a problem. Farmers grew too much grain and the surplus was sold to brewers who started brewing more beer. This made Parliament pass an Act that allowed brewers to buy licenses cheaply so that they could be more people selling beer. With beer being available in many places people began drinking anytime even during working hours. This caused many households financial stress as the money being earned was not enough to allow beer drinking on the budget. A lot of children also started drinking. The diet of the majority of the people was not balanced and people could not afford meat. The introduction of enclosures (a system were freeholding land was passed as an Act of Parliament which allowed private ownership of land and putting fences around it.) though caused a lot of suffering among the peasants who were the rural poor. The enclosures had restricted their animal pastureland and the places where they collected firewood for cooking their meals. They were also unable to hunt because the new land-owners imposed rules on their lands so protein in the form of meat disappeared from their tables.

Labour Issues- The 1IR not only messed people's living conditions but also their working lives. Kennedy, (1993, p. 8), explains,

> But apart from the critical issue of providing jobs for the expanding populace, it did not greatly benefit the first or second generation of workers, who, suffering under awful conditions in factories and mines, were organized alongside their machines in a strict, time-driven system of labour unlike anything known previously.

Many workers were unskilled and they were trained on the job. As a result, workers worked for long hours in poor conditions. The only rest they got was to go to attend to their physical needs. Child and women labour exploitation was another downside of this era. Children as young as 3 or 4 years were working in mines and factories in intolerable conditions. They did not have any rights. Falkus, (1987**,** p.85) paints this picture of what was happening,

> There were obvious evils, like the appalling conditions in the fast-growing factory towns and the exploitation of child labour (there were some five thousand boys and even some girls between the ages of 5 and 10 working underground in the coalmines in 1841) Less obvious deterioration included the loss of independence experienced by factory workers, subject now to strict time-keeping, the factory hooter, and the need to keep the machinery turning. Factory labourers, suffered a loss of status as their lives and livelihood became determined by factors outside their control.

Through Acts of Parliament that favoured employers, people worked themselves to the bone for little wages. Workers Union were not very functional then. Falkus, (1987 p.169), asserts, "between 1799 and 1824 parliament forbade the very existence of unions." Marx and Engels sum the workers' plight, "The industrial revolution has simply carried this out to its logical end by making the workers machines pure and simple, taking from them the last trace of independent activity," (p.51). With Haines and Walsh, reiterating the same sentiments on the plight of workers, "Yet the coming of the machine was not an unmitigated blessing. The majority of men, the tillers of the fields and the toilers of the factories, became its chattel slaves, dependent upon its whims and fluctuating fortunes," (1941, p.652).

Educational Trends- Formal education was not taken seriously as work in the factories and mines did not require much education with one third of all children not going to school by 1840. Some areas did not even have schools and the government was not involved in building of schools. It was the church and private entities that build schools. Falkus, (1987, p.158) clarified this and posits,

> The state's first tentative steps into the field of education came in 1833. School provisions, largely ineffective were attached to the Factory Act of that year, and a small grant of 20,000 pounds was made to the two principal religious bodies which had set up a national network of schools from the early part of the nineteenth century.

For those who had higher education, their curriculum did not cater for skills to work in industry after college as shown by Ringer, (1979, p.2),

> During the early industrial phase, there was in fact little connection between higher education and economic life. Education above the primary level had practically nothing to do with business. The system catered to the landowning classes, and it prepared future clergymen, lawyers, doctors and secondary teachers."

In short, the education system served the needs of growing government bureaucracies and these did not take an interest in technological progress and economic development

Economic Situation- Before the onset of the industrial revolution there were characteristics of poverty, stagnation**,** dependence on agriculture and a lack of coordination and integration among the regions, (Deane, 1965). The introduction of enclosures improved agricultural activity which in turn contributed to the rise in industries. The movement from rural areas to urban areas after the rural people could not till the land anymore due to

enclosures led to the demand for more manufactured goods which increased production and catapulted more innovation. The invention of steam power was considered the most important invention. It increased the production of textiles which led to a demand for coal which propelled the steam engines. The steam engine was also used in coal mines and for iron works. Kennedy, (1993, p.8), concurs, "No earlier technological breakthroughs produced anything like the rise in output that flowed from the Industrial Revolution"

The transport system improved also and created employment in the construction sector through the building of canals and turnpike roads. The advantage of rivers and access to the sea allowed for easy movement of bulky goods and the development of foreign trade. Trade in textiles and metal goods with America triggered production and had a major impact. With all these new developments Kennedy, (1993, p.8), noted some disadvantages for the ordinary person, "This is not to say the material benefits were immediate or, for that matter evenly distributed. Industrialization brought early gains to the entrepreneurs, inventors, mill owners, and their financial backers who realized the new methods of manufacture would lead to enhanced profits." With Haines and Walsh, (1941, p. 653) also sharing the same sentiments,

> The advantage for these were mostly with the employer, for labour like resources of nature, became a marketable commodity. Moreover, the legal rights of property made the employer the final judge of whom he would and would not employ. If he chose to terminate one's employment there was no appeal, and the only alternatives left were to face starvation…

Rise of Globalisation- Held, Mcgrew, Goldblatt and Perraton, (1999) are of the opinion that, there are three main forms of migration which are **economic migration** where people move from their country in search of greener pastures as in the case of many poor Europeans who left during 1IR for Australia, USA and Canada, **elite migration** where people who believe in their superiority conquers a nation and they become settlers as in the case with colonialism and **forced migration** as what happened with the transatlantic slave trade. Emigration became a part of 1IR as many British people left in search of better prospects in other countries. "Apart from those who headed to the labour-hungry United States, millions also streamed to colonies rich in land and resources (in Canada, Australasia, southern Africa) … There was thus no need to linger in the hovels and slums of England," Kennedy, (1993, p.6).

Neo-colonialism, slave trade, slave labour and imperialism contributed immensely to Britain's economy in 1IR and it led to the rise in global trade and labour. The advantage of rivers and access to the sea allowed for easy movement of bulky goods and the development of foreign trade. Trade with colonies gave Britain an advantage. Imports, exports and re-exports of colonial goods through Britain to other mainland European countries increased drastically. Trade in textiles and metal goods with America triggered production and had a major impact. Kennedy, (1993 p.9), highlights

> Possessing greater manufacturing efficiency than any other society at that time and enjoying ever-higher standards of living, many Britons became proponents of laissez-

faire economics and of an "open" trading order in which national boundaries and ownership counted for less and less.

The expansion of scientific knowledge catapulted technological advancement although it had started in other European countries, it was perfected in Britain as it had a conducive environment

Environmental Impact- During 1IR population growth meant that food production had to increase. "Rising populations in the West have been supported by continual increasing the level of manipulation and exploitation of the environment," (Ehrlich, 1970, p. 54). Rural-urban migration caused overcrowding and sanitation problems, water supply and street cleaning were primitive. This caused major environmental decline which was worsened by coal mining. Cities especially Liverpool were called dark cities because of pollution and smoke that came from the coal mines. Kahn and Bruce-Briggs, (1972 p. 218) sums industrial development in terms of environmental damage as follows "… all this marvelous technology, all this affluence created by industrialism and capitalism, has been unmasked at last: bourgeois progress has proven to be only a complicated way to produce garbage, to destroy the ecology and landscape, and to dehumanize the individual."

In summary an Industrial Revolution must have the following features:

- Technological Innovation
- Transformation in industry operation
- Economic & Political trends
- Societal Consequences
- Labour Issues
- Educational trends
- Rise in globalization
- Environmental Issues

The research used these features from 1IR to form a conceptual framework on what constitute an industrial revolution

Literature Review on 1IR, 2IR and 3IR - Conceptual part of the study (cont.)

The literature review looks at the origins of the term Industrial Revolution first and some literature on IR.

The Origins of the term Industrial Revolution

In England Arnold Toynbee gave a series of lectures at Oxford entitled 'The Industrial Revolution of the Eighteenth Century in England' in 1881 and it was believed he used the term first. The lectures alluded to the changes that had taken place in Britain between 1750-1850. He directed people to the rapid changes in population growth, the more organized way farming had become with the introduction of enclosures, the way industry was transforming with the introduction of powerful machines. For him these changes were revolutionary.

What is an Industrial Revolution?

Falkus, (1987, p.75), defines an industrial revolution from two perspectives and says,

> Broadly speaking economic historians have used the term in two distinct senses: short-term acceleration or long-term structural change. The first approach looks for a particular period when the economy began to move faster. The second approach takes a broader view and says that if, after a certain length of time, the economy has been transformed, then a revolution has taken place.

From the author's perspective an industrial revolution can be seen as a short-term speeding up of a transformation in the economy or a long-term process where a difference can be seen in the way the economy has changed. Deane, (1965, p.1) takes a broader view and sees it as "a continuous some would say self-sustaining process of economic growth, whereby (wars and natural disasters apart) each generation can confidently expect to enjoy higher levels of production and consumption than its predecessors…" What is coming out from the above definition is that an industrial revolution is a process that is able to act out independently without much help from government and is able to show results of improvement in the way goods are produced and consumed than it was done before. Deane, (1965), goes on further to say that an industrial revolution does not occur at the same time or take the same form in all countries but that there are specific changes in the economic activities which include extensive organized use of modern science based on observed information on the activities of the market, expertise in producing goods for national and international markets instead of family needs only, rural and urban migration in search for work, the use of money as compensation for wages, the rise of social and working classes depending on ownership of land, businesses and capital. What it means is that countries do not necessarily have industrial revolutions at the same time as the rate of growth and developments are different. As stated by the author, the process is to stimulate economic growth with more advanced ways of production and consumption and making each generation better at it. How this process is supposed to work without creating inequalities is an enigma. As we know for production and increased consumption to happen there should be owners who provides capital investment, labour and increased working hours. Marx and Engels, (2008, p.4), reiterates, "Society as a whole is more and more splitting up into two great hostile camps, into two great classes, directly facing each other: Bourgeoisie and Proletariat." These two camps remain unequal even if society advances. The proletariat remains the loser in spite of an industrial revolution. Mathias, (1983, p.2) defines an industrial revolution as

> the onset of a fundamental change in the structure of an economy; a fundamental redeployment of resources away from agriculture, becoming self-evident over time… growth in production, investment and the labour force grows more rapidly in other sectors of the economy, which therefore becomes more differentiated. The concept involves also the assumption that industrial production begins to expand at a higher and sustained rate – speaking of output as a whole.

The author takes on the broader view when he talks of “self-evident over time” on the change in the structure of the economy and the assignment of resources from agriculture to industrial production as a catalyst to an industrial revolution. Again, another author glosses over the term industrial revolution as an equalizer for humanity. The author does not bring out how the fundamental changes will advance capitalists interests over the workers who will toil every day to increase production. Reeve (1971, p.15) is of the same opinion in showing the utopian view of an industrial revolution, “it has become a shorthand summary for that period of unique transformation in the history of modern societies when the ancient reliance upon agriculture and craft industries was exchanged for a modern industrial structure and a largely urban way of life.” The author also shows the exchange for a modern society and urban way of life as a normal transition without any challenges. On the other hand, Kennedy, (1993, p. 8) offers a different side, “But apart from the critical issue of providing jobs for the expanding populace, it did not greatly benefit the first or second generation of workers, who, suffering under awful conditions in factories and mines, were organized alongside their machines in a strict, time-driven system of labour unlike anything known previously.”

Marx and Engels have got a different view on what an industrial revolution is. They believe an industrial revolution is about control, power and money. “The bourgeoisie cannot exist without constantly revolutionizing the instruments of production, thereby the relations of production, and with them the whole relations of society,” (2008, p.6). They go on further to show the hidden side of an industrial revolution and posits, “In proportion as the bourgeoisie capital is developed, in the same proportion is the proletariat… developed- a class of labourers, who live only so long as they find work, and who find work only so long as their labour increases capital. These labourers… are a commodity…” (p. 8)

In summary an industrial revolution has got to do with a transformation in the way an economy has improved from low levels of production and consumption to high levels which changes the way of life of a people negatively or positively.

Literature Review on 2IR, 3IR & 4IR

This section looked at the literature on the 2IR, 3IR and 4IR.

Fig 3 below show the periods and inventions during the four Industrial Revolutions

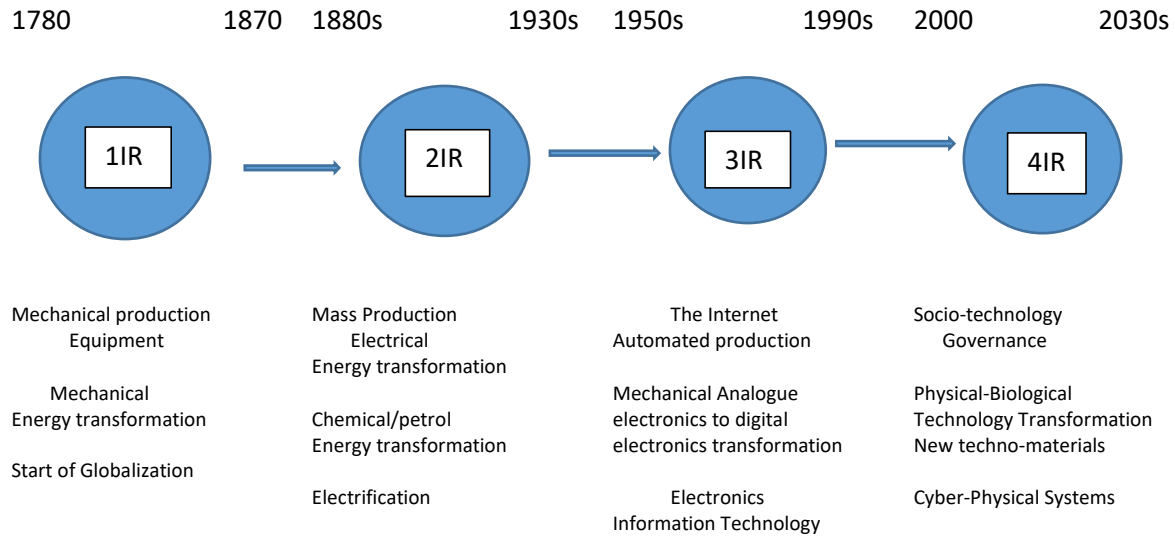


Fig 3 The Four Industrial Revolutions adapted from Skilton & Hovsepian (2018)

The 2nd Industrial Revolution (2IR)- 1870-1914 deemed The Age of Science and Mass Production saw the development of electricity, the internal combustion engine, science-based chemicals, efficient steel use and the invention of the telephone. The main **technological innovation** being electricity which was able to make many applications function by being connected to it. Greenwood, (1999, p. 9), states, "By around 1910 it was apparent that machines could be driven with individual electric motors. The realization had a great impact on the workplace productivity. Furthermore, the production process became more flexible…" Electricity then changed processes in the workplace and influenced **industry transformation.** Electricity also changed lives by lighting homes, and was instrumental in the invention of the radio, television and computers. These were positive **societal consequences. Globalisation** continued to rise. Other countries in Europe and North America caught up in revolutionizing their industries. German industry had the most success during this period with electricity being used in street railways. The first chemical laboratory was founded in 1827 in German and it improved scientific research. Castells, (2000, p.35), had this to say about the countries that revolutionized in new industrial technologies, "Nothing in the cultural, scientific, political or military history of the world prior to the Industrial Revolution would explain such undisputable "Western" (Anglo-Saxon/German, with a French touch) supremacy between the 1750s and 1940s." The 1IR and the 2IR had basic resemblances such as the use of scientific knowledge in developing new inventions. Castells, (2000, p.35), "They were indeed revolutions in the sense that a sudden, unexpected surge of technological applications transformed the processes of production and distribution…" Their competitive advantages were not without casualties though. Negative **societal consequences** were experienced between 1884-1900. Some European countries such as Britain, Germany, France, Portugal decided to begin a process of consciously colonizing Africa. Needless to say, that the colonization of Africa increased their

territories and monopoly of resources from colonies which cemented imperialism and increased their wealth at the disadvantage of colonial states. This is shown by Beaulieu, (1891, p. 166)

> The great value of colonies… is not only that they serve to catch the overflow population of the mother country, nor even that they open a particularly reliable area of investment for excess capital… Imperialism has caused the opening of new sources of production…unknown products have been brought to consumers of Europe to increase their comfort.

The beginning of imperialism offered these countries monopolies over their colonies and trade advantages. (Lenin, n.d.), "Imperialism is the monopoly stage of capitalism…in which dominance of monopolies and finance capital has established itself; in which the export of capital has acquired pronounced importance." This state of affairs has never changed the status of most of these colonies even after 100 years.

Moving on to **educational trends** in 2IR. Education was offered in a practical manner so as to aid children, men and women to apply the learnt skills effectively at home and at work. Pollard and Holmes, (1972, p.461) details this on education according to one clergyman,

> Grundtvig taught that education should never be imparted so as to cause despondency or contempt for physical labour… Education must not only be scientific, taken from books, but the balance must be kept between knowledge of the world and knowledge of one's self. Science and literature should only be a means to an end. Knowledge must be educational and nourish the mind, strengthen morals and responsibility.

In the 2IR education was basically about imparting practical skills to workers for the type of work they will be doing. Government started showing some interest in it. As a result, in Britain the Education Act was introduced. The problem then was with the curriculum and the teaching methods. Attendance was made compulsory in 1876 for children up to ten years and in 1899 for children up to 12 years, (Falkus, 1987). Primary schools also just imparted the kind of education for the children of the working poor to join their parents as the proletariat. Education for the working-class children was limited whereas those for the middle and upper class where done by private organisations. In 1893, the then Minister of Public Instruction, M. Charles Dupuy put this in an official circular about the purpose of higher primary school in France,

> Who are the pupils attending them? They are not young people destined for wide careers, having indefinite time at their proposal, and asking from us high intellectual culture, they are children from the working classes, who will require to live by their labour, and in most cases by the work of their hands. If this is so, the higher primary school will merely direct its pupils, from start to finish towards the requirements of the practical life that awaits them; it will not turn their minds for a moment from the pursuit of a profession; it will be careful not to let them acquire habits, tastes and ideas which will separate them from the manner of life and work for which they are intended," (Pollard & Holmes, 1972, p.464-465)

The Balfour Act of 1902 brought secondary education into focus as many 14-year olds were out of school. Agricultural schools were prevalent in many European nations, technical schools, military schools also provided practical skills for adults. Higher education curriculum started realizing imparting skills for the industry for certain sectors. (Ringer, 1979). This change could have been brought by the bourgeoisie and the aristocracy who started to co-operate. Haines and Walsh, (1941, p.685) "It is not mere coincidence that the most far-reaching political compromises and the most important political revolutions since the nineteenth century have occurred in periods of depression." The bourgeoisie gained a foot in the corridors of power as they kept on growing their wealth and wanted laws that protect them and an education that will serve their interests in the workplace. The **political landscape** changed during this time. The downside of these revolutions though was that it furthered the interests of capitalists and created tensions in society between the classes as inequality worsened. As shown by Marx and Engels, (2008, p.4), "The modern bourgeois society that has sprouted from the ruins of feudal society has not done away with class antagonisms. It has but established new classes, new conditions of oppression, new forms of struggle in place of the old ones."

Labour issues continued also in 2IR. The motor industry was also developed with the start of the assembly line. Gottlieb Daimler built the first automobile in 1885. Ford introduced the automated assembly line in 1913 which subjected workers to "hierarchical discipline" (Harriss, 2004, p.331). Strikes over poor working conditions were plenty. The emperor of German in February 1890 gave this speech on workers,

"The protection to be given to the working classes against the arbitrary and almost unchecked exploitation of their labour; the restriction which dictates of humanity and the laws of natural development demand should be placed on child labour; the consideration of the position of women in the households of working men…" (Pollard & Holmes, 1972, p.313)

This was an improvement from the 1IR where the government turned a blind eye to workers' exploitation, child and women labour so on the whole workers' conditions improved somewhat. The introduction of trade unions who fought for better working conditions also was of help but workers continued to be overworked, poor, with some losing their jobs due to the improvements in machines that took over their jobs or being fired for going on strike. Some governments were not sympathetic to workers' plight also and would try to manipulate unions to agree to employers' demands. Mass production required mass consumption and as a result mass manipulation was born through advertising. Communication improved with the invention of the telephone. Sanitation improved with the development of the sewerage system in the cities but capitalism continued to grow and strengthen. **Environmental degradation** continued unabated with more technological innovation.

In 2IR all the features that constitute an industrial revolution were present as seen in the literature review

The 3rd Industrial Revolution (3IR) which is known as The Digital Revolution or The Information Age and many other names that differentiate it from the other two Industrial

Revolutions started in the mid-1950s. **Technological innovation** came in the development of micro-electronics and the use of ITs with a programmable logic controller in the United States of America which started this period. The continued improvements in telecommunication systems ushered in the internet in the 1970s. Castells, (2000, p. 47) iterates, "it was in 1969 that the US Defense Department's Advanced Research Projects Agency (ARPA) set up a new, revolutionary electronic communication network, that would grow during the 1970s to become the current internet." The internet took us to the Information Age where communication has become a part of people's daily lives. Computers were invented in 1975 with the first commercial one Apple II launching in 1977 and cellular telephones in the 1990s. "Thus, mobile telephony relying on computing power to route messages provides at the same time the basis for ubiquitous computing and for real-time, untethered, interactive electronic communication," (Castells, 2000, p.46).

Rifkin, (2017, p.34) describes the 3IR as, "the evolution into a digital age, with most significant changes being the prospect of exponential rather than linear growth and a more global impact enabled by the IoT." Toffler, (1980) agrees with Rifkin when he suggested that in the 3IR linearity should be resisted as what happens today cannot be an extension of tomorrow since trends do not continue in a straight line. The new technologies in 3IR **transformed industries** according to Toffler, (1980),

"the rise of dynamic new industries based on scientific breakthroughs: quantum electronics, information theory, molecular biology, oceanic nucleonic and the space sciences. Enhanced manipulative abilities via computers, data processing, aerospace, sophisticated petrochemicals, semiconductors, advanced communications, solid state physics, systems engineering, artificial intelligence, fuzzy logic, polymer chemistry."

Globalisation reached peak levels with the use of the internet. People know what is happening around the world anytime and are able to connect in real time with anyone in any part of the globe with those who are connected to the internet and with those with mobile access. Work places also have changed drastically with computers and internet. Information is readily available globally and advances in manufacturing and distribution of products continue to be improved and being changed. 3D printing and other technologies will slowly affect mass production as customers can order customized products. Workers continue losing their jobs with these advancements and the gap between the rich and the poor continues to widen. The information Age brought with it more **societal and economical challenges** as cited by one radical school who sees these advancements as, "Western- largely American Imperialism in which corporate empires and global markets have come to replace the world empires of the industrial era." (Harriss, 2004, p.349). The school of thought further argues that the reality of a first and third world divides the world as most of the world's population in the third world are excluded from global wealth. "Rather than globalization creating 'one world', it has been accompanied by deepening global inequality and marginalization…" (Harriss, 2004, p.349). The author further alludes to global capitalism which is reinforced by institutions such as IMF and the G7 in exploiting the third world. The 3IR has brought with it more challenges in which the world is continually being divided as the rich and the poor with the poor being further exploited by these

technological innovations which are used literally as tools of oppression for those who are trying to keep up with the innovators. Kennedy, (1993, p.13) reiterates the same sentiments,

> New scientific breakthroughs often create structural problems of transferring their benefits from the "haves" to the "have-nots" within that society, today's global community is presented with a far larger challenge, as advanced technologies threaten to undermine the economies of developing societies.

This shows that these technologies are developed in the context of their societies specifically and may not work in a different society altogether. In this age it means those who have access will progress whilst those without will stagnate. Accessing digital technologies require a reliable telecommunication system and access to electricity which are both 2IR inventions and which many populations in the developing world have no access to. Illiteracy also further divide the third world from digital use as the language that is mainly used which is English is of no use to them. Wilson and Heeks, (2004, p. 406) pointed out, "technology is embedded in social, cultural and economic relations of particular societies. In this view, technology both reflects and influences the society that produces it." As pointed out by the author that technology is firmly fixed in social and cultural practices of those who develop them, these innovations may not be relevant to third world countries in their poor situations. It is possible that they are being influenced to accept other people's cultures that do not suit their reality. There is no benefit to them when they have many other pressing issues that they need to address such as adequate shelter, education, healthcare and so on.

Negative societal consequences in urbanization as in 1IR and 2IR continued to pose challenges in providing adequate accommodation for everyone. With globalization they have been movements from one country to another but unlike in 1IR the economic movement in search for greener pastures is now from developing countries to developed countries. This is shown in the below quote by Kennedy,

> The basic difference today is that whereas that earlier migration went from the technologically advanced societies into less advanced societies, contemporary migrations chiefly move from less developed societies toward Europe, North America, and Australasia. Given the global imbalances in population trends, this movement ought in principle to help all concerned. (1993, p.42)

Countries with better economies have seen a major rise in their city populations. In the 1950s and 1960s, governments tried to build low cost housing in urban areas but by the 1970s it was proving difficult to meet the housing needs for everyone. The United Nations saw the importance of providing adequate shelter and reiterated it in their conference in 1976. Urban services such as the supply of water, sanitation and drainage for the working poor were a challenge and they still live in crowded rental accommodations.

Environmental issues gained some attention in 3IR. Green energies were introduced to counter the effects of the 1st and 2nd revolutions on the environment. The introduction of mining, electricity, oil, industry expansion and the growth of cities had negative effects on

the environment. The United Nations held the Earth Summit in 1992 in Rio and adopted Agenda 21, later on the Montreal Protocol and then the Kyoto Protocol in an effort to make governments reduce emission, built clean power-generating plants.

Educational trends in 3IR changed. Education began being used in earnest as a tool to prepare learners for the work place. Ringer, (1979, p.3) poses, "secondary and even university-level education has come to be sought in preparation for a greatly increased variety of occupations." New technologies were being integrated into the school curriculum so as to produce learners who were ready to work in digitized spaces. On employment the technological changes that took place in 3IR made a redundancy in manufacturing activities and an increase in the information processing employment. **Labour issues** continued in the same trends as in 1IR and 2IR. Workers continued working for salaries that left them struggling and unable to honour their monthly debts. With globalization some countries began offshoring manufacturing jobs in countries with cheaper labour creating unemployment in their countries. The capitalist continued to capitalize on cheap labour and to maximize profits. With new technologies the situation looked bad for the proletariat as jobs were now being taken over by machines. Workers in the digital age needed the skills and the education that allowed them to cope with the current job environment.

Fourth Industrial Revolution (4IR)

The literature review on 4IR started by showing a diagram on the origins of the 4th Industrial Revolution by Skilton and Hovsepian, (2018)

Artificial Intelligence (US)	Quantum Computing (US)	3D Printing (US)	Ubiquitous Computing (US)	Augmented Reality (US)	Internet Of Things (US)	Cyber-Physical Systems (US)	Industry 4.0 (D)	4th Industrial Revolution (US)	
1955-1960	1972	1980	1988	1991	1999	2002	2006-2008	2010	2016
Generic Engineering (us)	Nano- Technology (US/Japan)	Computer Integrated Manufacturing Virtual Reality (US)	Utility Computing (US since 1961)		Ambient Computing (US)	Cloud Computing (US) Graphene (UK)	Factories of the future (EU) Blockchain (US)	Manufacturing 2.0 (EU)	Made in China (CH) Mixed Reality (US)

Table 1 Origins of 4IR

The diagram above shows the 4IR's main features and when 4IR started which is in 2006 in Europe and 2010 in the United States. What comes out of the diagram also is that most 4IR developments are happening in one country which is the United States and a few others. This creates a monopoly and might leave mostly developing nations at the mercy of the developers of these technologies which cause a digital divide, inequality and worsening poverty in developing nations as they try to keep up with **global trends.** Pstoka, (2018) concurs, "The new technologies have a power to privilege and magnify inequalities in ways that are uncontrollable…"

Most of the above features are clearly 3IR judging by the dates they started but they show the 4IR as having technologies that are changing at a rapid pace. **Technological innovation** is at the core of 4IR. Schwab advances the following, "…I believe that today we are at the beginning of a fourth industrial revolution. It began at the turn of this century and builds on the digital revolution." So 4IR is an improvement of 3IR. He then explains, "Digital technologies that have computer hardware, software and networks at their core are not new but in a break with the third industrial revolution, they are becoming more sophisticated," (Schwab, 2016, p.7). The 4IR is the result of digital technologies fully showing their capabilities through automation, organization of value chains and seamless integration of virtual and physical systems globally. Schwab then expounds on 4IR,

> The fourth Industrial revolution however is not about smart and connected machines and systems. Its scope is much wider. Occurring simultaneously are waves of further breakthroughs in areas ranging from gene sequencing to nanotechnology, from renewables to quantum computing. It is the fusion of these technologies and their interaction across the physical, digital and biological domains that make the fourth industrial revolution fundamentally different from previous revolutions," (Schwab, 2016, p. 7)

Bonciu, (2017) agrees and asserts on 4IR as follows,

-the use of artificial intelligence and of robots in many areas other than business such as health care and education.

-the Internet of Things that connects many devices in business and in homes so that everyone can become a part of a global network.

-use of cyber-physical systems, (CPS) or large scale-complex automation.

On the other hand, Bonciu, (2017) explains that industrial revolutions do not emerge at the same time and people are only aware of the 1st Industrial Revolution as it changed the economic and social order of the West although the disruptions to people's way of life was huge. Since most of the major changes happened during 1IR, the rest of the revolutions have just been continuous improvements to what was started in 1IR and have gone by unnoticed by many. Why then have there been the 2nd, 3rd, and now 4th industrial Revolutions? The main reason is that **some inventions** affect the way people work, business and education in a way that cannot be ignored. As people battle with the idea of 4IR certain characteristics are emerging as shown by Bonciu, (2017, p. 11),

"…new technologies and a new level of knowledge are available simultaneously to almost all the population of the globe while at the same time all these new technologies and knowledge can connect, communicate and inter-act with each other and, in the process, further generate new technologies and new knowledge… **Ubiquity**, **availability** and **interaction** at a global scale are the three main characteristics of the 4th industrial revolution.

With these characteristics there are changes that do disrupt people's lives, either positively or negatively depending on what you use the technologies for. Schwab, (2016), believes that 4IR will both have **advantages and disadvantages to society** but with inequality being worsened. The consumer is the most beneficiary in the 4IR. There are new services that are now possible such as booking tickets online, ordering taxis online, ordering food, groceries, filling in forms and emailing, scanning and sending them without being physically present. The smartphone has changed the way people conduct business as long as you have internet access. You can read books online; you can do online courses and so many other things. The other beneficiaries are the innovators and those who provide capital for the innovations. The disadvantaged are those who labour.

Labour continue being at the receiving end of technological advancement as middle income jobs are hollowed out. Haines and Walsh, (1941, p. 654), posits, "Since the beginning of the Industrial Revolution, machinery has become both more productive and more automatic…the problem of unemployment is basically technological, and no solution of the contemporary economic difficulties will suffice unless this is taken into account." With Kennedy showing further how 1IR is the root of worker issues, "It is imperative, moreover, that we come to understand the interconnectedness of these issues in today's comparable dilemma," (1993, pp.11-12). Mechanically repetitive work and some manual work are in danger of being automated with some having been automated already. In manufacturing, robotics and A1-based technologies are doing routine work. Many other jobs will follow but it has been discovered that, "The fourth industrial revolution seems to be creating fewer jobs in new industries than previous revolutions," (Schwab, 2016, p. 37). An interesting observation has come to light that shows the relationship between technology and unemployment. Schwab, (2016, p. 38), "It shows that innovations in information and other disruptive technologies tend to raise productivity by replacing existing workers, rather than creating new products needing more labour to produce them." This means 4IR will make more workers lose jobs than it is capable of creating new ones to employ them. The amount of blue-collar jobs is on the decrease; the future is in ICT-based manufacturing and this is reiterated by these authors "…the need for problem-solving abilities in technology-enhanced settings as well as the ability to use ICT tools in decision making is increasing," (Hamalainen, Lanz & Koskinen, 2018, p.27). According to PIAAC (The Programme for the International Assessment of Adult Competences) findings, it is clear that the future holds challenges for the workforce due to lack of knowledge, an analytical mind-set and practical competence in problem solving. In another study carried out it is believed that by 2020 in 15 developed and developing countries which have a combination of 1.9 billion jobs or 65% of world total, about 5 million jobs will be lost due to technologies in genetics, Artificial intelligence and robotics, (Bonciu, 2017). In what is coming out of the statement above it

means the developed nations are the ones that could be most affected by these job losses. If we look in the context of population, then the results may mean that developing countries will be affected the most. The population explosion is now more concentrated in the developing world unlike in the 1IR and as a result unemployment is worsening. Kennedy, (1993, p.12) asserts,

> This problem is more sobering, because of the geographic disjunction between where the population pressures are and where the technological resources are. In late-eighteenth-century England, population explosion and technology were occurring in the same society, and interacted with each other in ultimately beneficial ways.

The author is showing how different this era is with 1IR in terms of **technological development.** Then there was a population explosion and technology being developed in the same place which meant the technology was for the actual use and need of that environment. Whereas now there are more people where the technology is not being developed which results in a disjuncture. Technological advancement in the developing world can create serious problems if not done properly. This is articulated below, "there are indications that some of the "First" World's new technologies, far from rescuing the booming populations of the developing world, may harm poorer countries, by making redundant certain economic activities…" (Kennedy, 1993, p.13).

The 4IR businesses will employ less people but will continue reaping huge profits. Capitalism seem to be reaching new levels as rising inequality and growing concerns of unfairness due to the proletariat being disadvantaged all the time. "The scope of change and impact determined by the 4th industrial revolution is also unprecedented because they include all areas of human existence and almost all areas of the globe," (Bonziu, 2017, p 12). **Industry transformation** is now happening at a fast pace as technologies allow for continuous improvement and changes. Companies have got to be on their toes to keep up and move with the times. Schwab, (2016) identified four main effects on business in the 4IR which are

- Changing customer requirements
- Data is improving products and therefore strengthening productivity
- Coalitions are being formed for collaboration
- Old models are being renewed into new digital models.

He describes the Uber model as a company utilizing physical assets (the car) with existing digital platforms (tracking of the car via the internet and a hassle-free payment process. The business model use products and services which disrupts boundaries between industries. Schwab, (2016).

Table 2 below gives a summary of the time that certain technologies have taken to reach 100 million users. Adapted from (Bonziu, 2017).

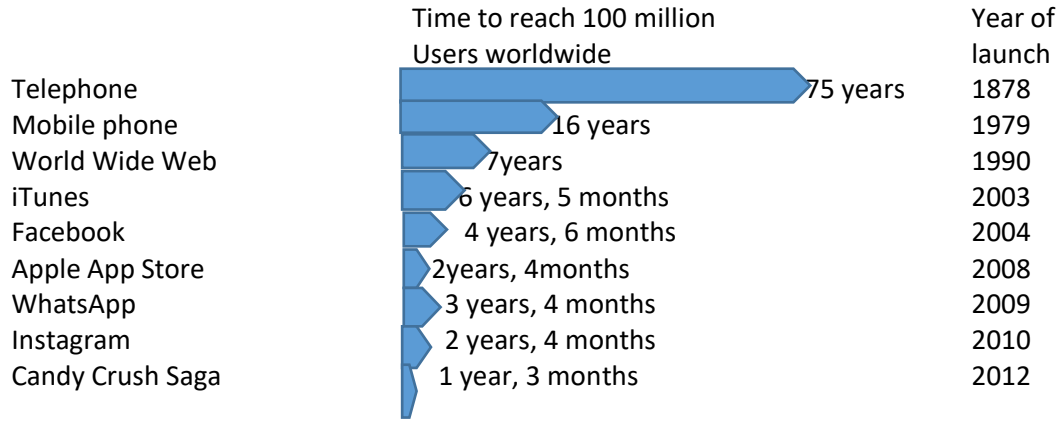


Table 2 How long a technology has taken to reach 100 million users

As shown in the above figure the time it is taking for digital technologies to reach a 100 million users is now very little as compared to the telephone that took 75 years. This means business has got to be on its toes and ready to act and operate with "speed and agility". The opportunities presented by technological breakthroughs such as AI, robotics, autonomous vehicles, biotechnology, materials science, energy storage and quantum computing appear to create a very divisive world as a limited number of people will afford to use them while the vast majority remain ignorant and unaware of them. The impact of the 4IR on the **economy** reveals that the most valuable companies created their businesses through digitization and the trend is continuing. Kennedy, (1993, p.47) "…the main creators and controllers of technology have increasingly become large, multinational corporations with more global reach than global responsibility." These companies are more concerned about remaining on top instead of them creating an equal and better society.

Societal consequences still being felt as in 1IR. Child labour is still a problem as in 1IR but now it is hidden as they are laws against it. The developing world use child labour more due to poverty and other circumstances. Now with work being done in virtual spaces or online it might even get worse. Women are being given same opportunities on paper but their discrimination unlike in 1IR is hidden also. Schwab, (2016, p. 43) reveals, "Because men still tend to dominate computer science, mathematical and engineering professions, increased demand for specialized technical skills may exacerbate gender inequalities." In the work-place those who do not keep up with new technologies are left behind or they lose their jobs. Kennedy sums it all up, "Clearly a society which desires to be better prepared for twenty-first century will pay a price to achieve that transition, it will need to retool its national skills and infrastructure, challenge vested interests, alter many old habits and perhaps amend its governmental structures." (Kennedy, 1993, p. 340).

On Social issues accommodation is still a challenge in the developing countries for the majority of the people. Rural-urban migration is still a challenge also with urban areas having many people who come in search of work. Health care also is still a challenge to many as they cannot afford quality medical care. The situation is different in developed countries but they still face some challenges with accommodation as they still deal with homeless people. Crime has become sophisticated with cyber-crime. Unemployment is rife with developed nations having low percentages and developing nations with higher percentages.

Education has quite improved the world over though developing nations still face many challenges with many children not finishing school. Girls are the most disadvantaged especially in the rural areas in developing countries. On the other hand, those with access to digital technologies have information and new knowledge available. Governments are under pressure to provide an education that is relevant to students when they leave school so continuous professional development in schools becomes mandatory. Schwab, (2016, p.40), iterates, "…leaders need to prepare workforces and develop education models to work with, and alongside increasingly capable, connected and intelligent machines." On the other hand, there are billions of impoverished, uneducated individuals in the developing world, whose prospects are poor, and in many cases getting worse," Kennedy, (1993, p.334). As education is now key to unlocking doors in the workplace, it is difficult for governments in the developing countries to provide quality education for all that will keep pace with the developed world who are mostly in the 4IR.

Political environment has changed drastically. The 4IR technologies have the potential to disrupt government activities. Schwab, (2016, p. 69), "Today's political legislative and regulatory authorities are often overtaken by events unable to cope with the speed of technological change and the significance of its implications." People can become vulnerable with the openness and availability of information on digital technologies. King-Hele, (1970, p.72) "Computers can also be used in a more sinister fashion, to store personal information about everyone in a country, or in the world…" **Negative societal consequences** as conversations done in private can be put out for public consumption. Unscrupulous people can hack computers smart phones and steal bank accounts and any sensitive information. "Since 2008, there have been many instances of cyber-attacks directed at both specific countries and companies, (Schwab, 2016, p.85)

Technology has continued to cause **environmental degradation** since the 1IR and the trend has continued. Increasing populations, industrialization, coal usage, thousands of aircrafts, ships and millions of motor vehicles have polluted the atmosphere, deforestation and many other land degradation activities have made this world worse off than it was two centuries ago. Irrigation removes water from the earth's rivers and streams which in turn has had an impact on shrinking lakes and seas and the destruction of wildlife and fish habitats. Ambitious projects in some developed countries have had devastating consequences but fortunately they are trying to reverse these ambitious projects because they can afford it. In the developing countries few countries can afford to reverse or find alternatives to such schemes. (Kennedy, 1993). Kahn and Bruce-Briggs sums it all up "… all this marvelous

technology, all this affluence created by industrialism and capitalism, has been unmasked at last: bourgeois progress has proven to be only a complicated way to produce garbage, to destroy the ecology and landscape, and to dehumanize the individual." (1972, p. 218). The only difference in the 4IR from the other Industrial Revolutions is that Governments are now most aware of the negative environmental impact. Many activists are showcasing it at many platforms such as the United Nations and World Economic Forum. Implementation is taking long though although some countries are making an effort. The use of digital technologies in the 4IR offers hope as the internet of things (IoT) can track materials and energy flows to keep track of any leakages, information availability gives citizens the right to question companies that are in breach also.

Whether these technologies are the 4th industrial revolution or not, the world has and is changing by their impact on life. Kahn and Bruce-Biggs, (1972, p.221), argues "Although in most cases evolutionary development is a more accurate picture of the real movement of human history, we do recognize that changes are sometimes so rapid and cumulative as to be revolutionary, creating a new stage, a whole new ball game." The authors go on to say that, "The question of where you draw the line, where the thresholds between fundamentally different societies are, is difficult and important," (Kahn and Briggs, 1972, 221). The authors believe that societies are in different stages of development and it should be considered when making decisions about technological implementation.

Challenges in the 4IR are the same as those in 1IR, 2IR and 3IR. Capitalism is worsening and the plight of the working class not changing and the gap between the rich and the poor widening still. Countries on the other hand, are not developing at the same time and as result some people do not have electricity which was developed at the end of the 19th Century. These people cannot be expected to even move to the 4th Industrial period when gadgets in this period are powered by electricity. Globalisation is also putting pressure on developing nations to move at the pace of the developed world. Kennedy, (1993, p.91) is in agreement and posits, "…we are once again looking at a technology-driven revolution that could keep poorer countries at the bottom of the heap, or weaken them further," He goes on to say that, "Alas, countries in the developing world have few capital resources, and interest payments on international debts… They also have relatively few engineers and scientists. Finally, their major problem is a massive surplus of labour…," (p.91-92). The author sees a whole lot of problems for developing countries in the 4IR which might worsen their situation as they try to digitize their operations. Shortage of capital, engineers, scientists and high unemployment which robotics and automation might worsen through job losses. If a country has surplus labour it should use robots where necessary and not do it because it is happening everywhere otherwise workers are affected by employment losses unnecessarily.

The literature review on 4IR shows the features of an industrial revolution. The **technological innovations** of the 3IR are being churned at a faster rate and at an unprecedented level. The world has gone completely **global** with internet use which permeates all facets of the globe. **Industry transformation** is moving at a fast pace with companies that fail to move with the times failing to remain competitive. **Societal**

consequences are being felt in both positive and negative ways. On the positive the new technologies have changed people's lives in that some operations can easily be carried at home like banking, shopping, working from home and so on. The negatives are that inequality is getting worse among the people, workers and developing and developed countries**.** Accommodation continue to be a challenge for workers with some living in squalid conditions as in 1IR. **Labour issues** are still bogging the workplace with workers losing jobs and constantly being required to upskill in order to remain relevant in the workplace. **Educational trends** have become wholly dependent on the needs of the workplace. Schools and colleges are now being required to change their curriculum in order to keep up with industry requirements. **Environmental issues** are now being taken seriously by many countries**. Political situation** has changed as governments are now involved in what happens in industry and the workplace and laws are put in place that informs many industry operations. The **economic situation** for workers has much remained the same as in 1IR as workers still exist on a hand to mouth existence and women and child labour still persists with women being paid less than men and children still being used but in subtle and hidden ways away from the law. Many features of an IR are still present in 4IR with some improvements here and there but overall the situation has not improved much as inequality has gotten worse.

Literature Review on the empirical part of the study- teachers' attitudes

Attitudes are feelings, thoughts and actions. They include our personality, values, behaviours and motivations. Ajzen, (2005, p. 3) puts this definition forward, "An attitude is a disposition to respond favourably or unfavourably to an object, person, institution, or event." He goes on further to say, "… that the characteristic attribute of attitude is its evaluative (pro-con, pleasant-unpleasant) nature." Attitudes according to the author are responses that are for or against something and that attitudes can be judged by their positive and negative responses. On the other hand, Mynhardt, (2009, p. 29) defines attitude "as an evaluation of various aspects of the social world," and Bizer, Barden and Petty, (2006) concurs and defines, "An attitude is a global and relatively enduring evaluation (e.g. good or bad) of a person, object, or issue." The authors here believe an attitude is an evaluation of certain things in the social world. Mynhardt adds more, "Some attitudes are stable and resistant to change, while unstable attitudes show variability depending on the situation," (2009, p. 29). Here he shows that there are some attitudes that are difficult to change as they are firmly fixed and some that can be changed as they are not firmly fixed depending on the situation. Attitudes have an impact on our thoughts.

Two types of attitudes namely explicit and implicit attitudes influence behaviour. Explicit attitudes according to Mynhardt, (2009, p.29) "are conscious and reportable, while implicit attitudes may be uncontrollable and not necessarily consciously accessible." In short explicit attitudes are easy to measure while implicit attitudes are not easy to measure. Attitudes though cannot be observed and therefore should be deduced from evidence and reasoning instead of explicit statements. Schwarz and Bohner (2001, p.4) concurs, "we cannot observe attitudes directly but infer them from individuals' self-reports and behaviour. Empirically, attitude measurement is highly context dependent." Attitudes are measured through

cognition, affect and behaviour characteristics and also through verbal and non-verbal responses, (Ajzen, 2005). Bizer, Barden & Petty, (2006) also think that, "Attitudes can be based on affective, cognitive, or behavioral information and can vary in their strength (e.g. how enduring, how resistant to change, and how predictive of behavior they are)." According to Pratkanis, Turner & Murphy, (2018), in most of the research done attitudes have the power to control cognitive actions such as social, inference, reasoning, perception and interpretation and as a result impact behaviour. Hence people are drawn to esteem and appreciate those things they like and disapprove, keep away, criticize and destroy those things they do not like. It is important to know how attitudes are formed as they are part of our social behaviour.

Attitudes are formed through classical conditioning. (Mynhardt, 2009) By being exposed to certain stimuli followed by a certain response an attitude can be formed. For example, if learners in a class are exposed to a certain technology with enthusiasm from the teacher every time, they are using it, the learners are bound to develop a positive attitude to the use of the said technology. Attitudes are also formed through instrumental conditioning. (Mynhardt, 2009) This is where parents influence certain attitudes towards a person, food, places by how they respond to it. Attitudes are formed again through observational learning. (Mynhardt, 2009) Thoughts and feelings are gained through observing others. Exposure to social influences through peers, parents, media, schools, religion and certain groupings that a person belong to also plays a part. According to Pratkanis, Turner & Murphy, (2018), social influence has certain effects on individuals. They can change their attitude because they need to comply so as to avoid certain repercussions. These attitudes are short-lived. Another effect from social influence would be to fit in. People change attitudes so as to belong to a certain group. Lastly social influences can bring attitude change through internalisation as someone actually accept a position because of its merits.

How do teacher attitudes to technology adaptation get formed?

Teachers' attitudes to technology use get formed by being exposed to technology through the media, through politicians, their school, other teachers, the Education Ministry, professional development and reform programs. The media acts as a platform that conveys messages to all the other sources through print, television, radio and digital technologies. Political agendas can be pushed also through the department of education. The most important channel that can influence teachers' attitudes is through their own professional network. These are programs arranged by their department, district, school and teacher associations. Cole and Weinbaum, (2010, p. 78), propose, "understanding the development of teacher attitude is important to school reform because research has documented the relationship between attitude and subsequent behaviours." as evidenced from research on 128 studies that attitudes have influence on future behaviour, (Cole & Weinbaum, 2010). In a school setting the teacher receives information through certain hierarchies that may make the information diluted and become ineffective as they get it. Information passed on directly is more effective. Teachers as shown by Cole and Weinbaum, (2010), have networks namely expressive and instrumental. Expressive networks are those that are not formal and maybe for friendships and socialising in general. These have strong ties and are very

supportive. Instrumental networks are meant for professional purposes. Both networks are important as they have a potential of channelling messages of reform agendas. Through talking to peers through the expressive network who have a positive attitude toward technology, teachers are more likely to have a positive change of attitude about them.

Professional development is also effective as it provides continuous training and has "numerous tactics and principles of persuasion," Pratkanis, et al, (2018). As stated in the above definition that attitudes can be formed through exposure to social influences it is important to expose teachers to technology use through training. "The teacher is pivotal in determining the extent to which innovations are adopted and implemented in educational practice. Therefore, the training and regular upgrading of teachers is important for the integration of technology into daily educational practice," Howie, Muller and Paterson, (2005, p.73). Since the teacher is important in making sure technology use is implemented in the classroom, it is important for the responsible authorities to offer training that is effective in changing their attitude. Whitehead, Jensen & Boschee agree also and say,

> as a result, to bring about change and establish equity in our schools, factors such as proper professional development programs, technical support, and time for learning must be provided. Professional development involving technology should be made highly practical by encouraging teachers to teach other teachers (2013, p.18).

As shown by the authors having professional development is effective if actual use of technology is done and coupled with letting teachers train each other. Peer training is important in attitude formation and persuading other teachers to do the same

Rushby and Surry (2016, p.480) also advised on how schools can help, "Schools must consider the knowledge and efficacy needs of teachers and plan for training impact by providing appropriate technological, pedagogical and content professional development along with providing adequate time for teachers to plan, experiment and develop fluency with technology." The school as an "instrumental network", (Cole and Weinbaum, 2010) and a professional organisation which is responsible for communicating information for changing teacher attitudes is vital.

Sandholtz, Ringstaff and Dwyer, (1997, p.160) discovered that after attending a staff development program, "many teachers began sharing their new skills and ideas with colleagues." They also concluded that, "the teachers who made the most changes were those who had the greatest level of support. Support included assistance from project coordinators, other teachers who participated in the teacher development program, and school and district administrators," (1997, p.161).

All the authors above show how important it is to help teachers have a positive attitude towards technology adaptation. Exposure to technology through reform programs and professional development where they learn from their school leadership, coordinators, and their peers help in building certain attitudes towards technology adaptation.

Chapter 3

Research Methodology

Location of the study

The research topic is the idea of the 4th Industrial Revolution: Attitudes of academic leaders (University leaders and lecturers) at a local university and its implications for university practice. The research was contacted on two levels. The conceptual which analysed the 1IR in order to identify a set of criteria to clarify the meaning of 4IR and the empirical which looked at attitudes of academic leaders at Wits.

The research was conducted at a local university with eight university leaders and lecturers who were then grouped as Thought Leaders and Management 1 and 2. The reason for choosing to conduct the research at a university was its proximity and accessibility.

Research Design

The conceptual part of the study used conceptual analysis that is analysing the meaning of concepts and ideas associated with the 4IR in use. When we look at the definition of an industrial revolution we need to find out when and how it was used and in what context so as to understand the idea of the 4th Industrial Revolution. The questions posed make people aware of the importance of the words they use unconsciously or they take for granted they know their meaning when they say them. The questions might seem strange but the purpose is to make people aware of the words they use (Wilson, 1963)

The empirical part used the qualitative approach method. The qualitative approach is research that produces descriptive data. This is data that depicts people's written and spoken words and observed behaviour. Taylor, Bogdan & Devault, (2016, p.8) explains further, "Qualitative research is inductive. Qualitative researchers develop concepts, insights and understanding from patterns in the data. The research is flexible as it starts with vaguely created research questions."

Population and Sampling

The research interviewed eight academic leaders (university management and lecturers) who were grouped in three categories. Qualitative research uses non probability and purposive sampling. "In a non-probability sample, units are deliberately selected to reflect particular features of, or groups within the sampled population," (Ritchie, Lewis, Elam, Tennant & Rahim 2014, p.113). In purposive sampling participants are selected for a purpose. The research chose the participants who were thought to be conversant to the research topic and those in management. The sampling criteria was as follows, Thought leaders who are involved in 4IR initiatives, Influential academics and those in Management.

Data collection instruments

One-on-one interviews were conducted with eight academic leaders at a local urban University. The interviews were semi-structured as the researcher prepared questions as a

guideline beforehand and was guided by these questions throughout the interview. De Vos, says (2011, p.351), “The method gives the researcher and participant much more flexibility.” He further says, “The researcher is able to follow up particular interesting avenues that emerge in the interview, and the participant is able to give a fuller picture.” Having questions on hand prepared the researcher to think of what the interview should address. All eight interviews were recorded. Recording the interviews captured the interviews better than taking notes.

3.5 Data Analysis

The research used qualitative data analysis. Miles, Huberman & Saldana (2020) posits, “One major feature of well-collected qualitative data is that they focus on naturally occurring ordinary events in natural settings so that we have a strong handle on what real life is like.” This means qualitative data collected well has got a better chance of showing the actual outcomes of the issue at hand. The authors go on to point out that there are three streams of data analysis which are data coding, data presentation and conclusions and verifications drawn from the coded data. This means qualitative analysis deal with loads of data that should be chunked so as to be interpreted. The research used open and axial coding. Open coding is where data is analysed line by line and highlighting certain issues and concepts that keep on recurring. After this process the research employed axial coding. This is where a theme was identified and categories formed around the theme. The research centred around nine emergent themes which were categorised according to the coded data which were then used to analyse the data.

Chapter 4

Research Findings and Discussions

Introduction

Schwarz and Bohner (2001, p.4) posits, "we cannot observe attitudes directly but infer them from individuals' self-reports and behaviour. Empirically, attitude measurement is highly context dependent." As the research delved on the findings the attitudes of the university academics emerged from what they said.

The research did eight one-on-one interviews with participants across the University. Participants were divided into three groups. The first one comprised Thought Leaders. These two leaders are involved in 4IR initiatives and are deemed to be clued about it and were referred as Group 1: TL1 and TL2, the second and third groups were made up of those in University Management respectively and were referred as Group 2: CM1, CM2, CM3 and Group 3: C4, C5 and C6. The themes and categories that were used were generated using the research questions, the analytical framework and the interview questions. The categories were then coded according to the themes. So, the themes are the same in the three groups but the categories differ according to the responses.

Group 1: TL1 and TL2 Themes and Categories

Major themes and categories coming from Thought Leaders 1 & 2. The themes are shown in blue and categories in purple. The words of the participants are in black. The column on the extreme right indicates whether the coding is answering the conceptual or the empirical part of the study in brown colour.

DEFINITION OF AN INDUSTRIAL REVOLUTION	**1IR, 2IR & 3IR**	**Representing the conceptual part of the study**
Technology	***Technology***	
-technological change	Steam engine, coal mines, train rail lines, factories being built, electricity, computing, analogue, putting digital infrastructure in place, computers, computer programming	
Industry Innovation	***Societal Consequences***	
-disruption to the way we do business, -changing how you work out things in industry -Massification and automating things	mass migration from rural to urban,	
Societal Consequences		
Disruption in the nature of society, politics, personal and social life		

4IR TIMELINE ***Indeterminate*** -still early stages of 4IR- about 10 years -no clear boundary with 3IR -initially an invisible thing -typical exponential trend	**4IR** ***4IR Components*** -machines start doing work that human beings used to do -cyber physical systems -network environment -digitization of things, -digital education -modernization project, -machine learning -powerful computing infrastructure, -digital business ***Societal consequences*** -globalization communication with people in different places made easier ***Technology*** Sakai, artificial intelligence, robotics, internet of things, data, informatics, online, quantum computing, IBM, Huawei	**Representing the conceptual part of the study**
DEVELOPING COUNTRIES ***Incapacitation*** -inheriting technologies that are out of context with our reality -Governments in the developing world will need to invest heavily but they do not have the money -They will get the money from the international community who gives conditions on how the money should be spent. ***Policies*** -Positive if: workforce is reskilled, fund the global growth segments emerging in the digital economy,	**DEVELOPED COUNTRIES** ***Cited Nations*** China and America impasse ***Strong leadership*** Invest heavily in research and development	**Representing the empirical part of the study**

technology is used to develop the working class -Negative if held back by: Poor human capital Poor education systems, outdated policies and politics, uncompetitive businesses -If we are left behind, we will suffer ***Leadership*** Visionary leaders needed who are going to take us forward		

CHALLENGES ***Inequality*** -The digitally disempowered at risk of being further marginalized -Gap between the digitally empowered and digitally disempowered will get bigger ***Labour Issues*** -People are going to lose jobs whether we like it or not. -Negatives would be poverty, loss of employment, loss of income. ***Preparedness*** -Develop technical know-how to be able to develop more complex robots as things are moving at a faster pace. -Quantum computing is here and it computes things faster and will make some jobs obsolete such as statistician, actuary, underwriter in an insurance company ***Profound Changes*** -Nature of work, the way society behaves, the way	**OPPORTUNITIES** ***Access*** -Digitally literate -economically and socially empowered -Able to harness the benefits of 4IR ***Business*** -Companies in digital markets will be digitally transformed It changes -the basis of competition, business models, allocation of capital, skills availability and scarcity, the way we reach customers, behaviours and buying patterns. -Business will change profoundly -Skills development for entrepreneurs to develop new products ***Digital Innovation*** -Globalization has made the world accessible to everyone -AI has made it possible to study patterns at a faster rate	**Representing the empirical part of the study**

politics happen, the way business is conducted	through the use of computers and robotics -Information retrieval from big data -Improvement on how things are done because of powerful computing infrastructure Machines are going to get things done more efficiently than human beings ***Reskilling*** Opportunities for human beings to develop new skills for future world of work ***Societal Consequences*** Positives would be increased productivity, do things in no time and be able to go home and be with our families, take care of our family responsibilities	
EDUCATION IMPLICATIONS ***Infrastructure*** -Invest in infrastructure for education to be in 4IR -Universities and institutions of higher learning should determine the resources needed to support students accordingly ***Curriculum*** -Evolve curriculum to ensure students are prepared with the skills and knowledge necessary to succeed -Supplement the old stuff with a lot of material that is more relevant	***Pedagogy*** -Significant impact on both what we teach and how we teach -Technology allows to tailor our modes of delivery and to be agile in terms of responding both to what we teach and how we reach	**Representing the empirical part of the study Empirical part of the study**

Summary of the themes and categories from TL1 and TL2

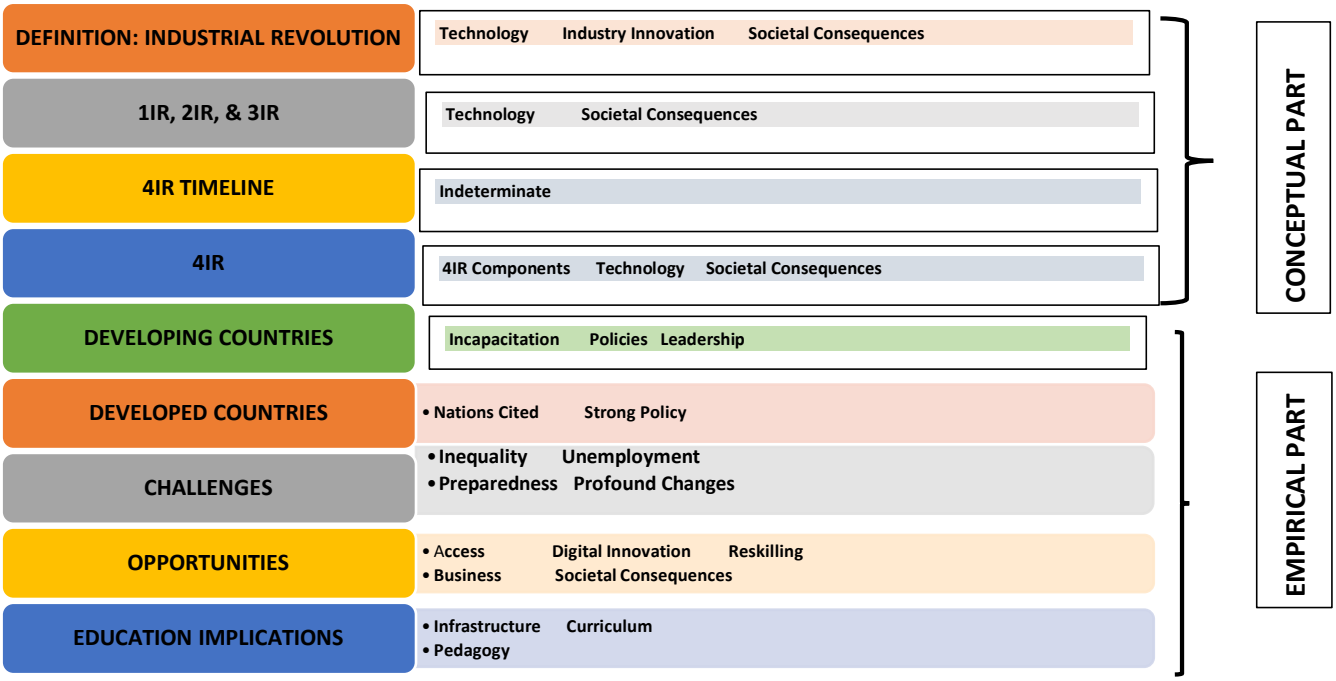


FIG 4 Themes and Categories TL1&2

FINDINGS AND DISCUSSIONS FROM GROUP 1: THOUGHT LEADERS (TL 1& TL 2)

The research started the findings by giving an overview of the themes and categories from Group 1 TL which are summarized in FIG 6 above. The coding on the themes and categories also indicated what part of the study they were representing, either the conceptual or the empirical.

The Conceptual Part: Findings and Discussions from Group 1 TL

Of all the categories from the conceptual part that came out from the themes, technology was more prominent followed by societal consequences and then industry innovation. These also came out on the analytical framework.

The Thought Leaders on the theme of the definition of an industrial revolution revealed the following categories of *technology* which imitated to technological change, *industry innovation* with such phrases as, "disruption to the way we do business, changing how you work out things in industry, massification and automating things." *Societal consequences* showed how these changes affected people's way of life. The definition means an industrial revolution involves the use of technological advancement to change the way industry is run but with consequences to society. This is retaliated from literature review by Marx and Engels, (2008, p.6), "The bourgeoisie cannot exist without constantly revolutionizing the instruments of production, thereby the relations of production, and with them the whole

relations of society." An industrial revolution although it benefits society in some ways, basically it is about making money so business is always trying to improve and innovate the technologies that they use in order produce more. *TL 1 &2 seem to know what an industrial revolution is judging from what came out of the themes and categories. The features of an IR of technological innovation, industry transformation, societal consequences, labour issues, political landscape, migration seem to have been captured in their definition of an IR*

On the theme 1IR, 2IR & 3IR *technology and societal consequences* where the categories that came out. During these revolutions there was invention of steam engine in the 1IR. Electricity in 2IR and Greenwood, (1999, p. 9), states, "By around 1910 it was apparent that machines could be driven with individual electric motors." On digital infrastructure in 3IR, Castells, (2000, p. 47) iterated, "it was in 1969 that the US Defense Department's Advanced Research Projects Agency (ARPA) set up a new, revolutionary electronic communication network, that would grow during the 1970s to become the current internet." These inventions had societal consequences in that there was movement of people from rural to urban areas in search of work.

What is coming out is that technological inventions in the first three industrial revolutions caused a major shift in the economy and caused people to move in search of better opportunities from the rural areas to urban areas. There was mass migration especially in 1IR. Holland, (1968, p.89) cites, "Since 1851 the proportion of town dwellers has increased so that today over four-fifths live in towns." *TL 1&2 new about the major inventions of the first three industrial revolutions and some consequences to people.*

On the 4IR theme the categories that came out were *4IR components*, *societal consequences* and *technology*. The category for 4IR components comprises phrases that relates to 4IR, like "modernization project, machine learning, powerful computing infrastructure." Thought Leaders are of the opinion that some of these components are what makes the 4IR. On societal consequences machines start doing work that human beings used to do. This will have an impact on employment. The same happened in the 1IR when people were displaced from their routine work with the invention of new machinery. Haines and Walsh, show how, "Yet the coming of the machine was not an unmitigated blessing. The majority of men, the tillers of the fields and the toilers of the factories, became its chattel slaves, dependent upon its whims and fluctuating fortunes," (1941, p.652).

Communication is now done from anywhere to anyone in the world through many different ways. You can do video conferencing where more than two people can share ideas. This has influenced globalization. The technology category brought out technologies that are mainly associated with 4IR such as "cyber physical systems, artificial intelligence, robotics, internet of things, data, informatics, online, quantum computing," which means TL 1 & 2 believe these technologies are the ones that show that we are in the fourth industrial revolution. Bonciu, (2017) agrees and asserts on 4IR as follows, "the use of artificial intelligence and of robots in many areas other than business such as health care and education, the Internet of Things that connects many devices in business and in homes so that everyone can become a part of a global network, use of cyber-physical systems, (CPS) or large scale-complex automation." The theme 4IR timeline shows a category of *indeterminate* meaning the actual

time that 4IR started is not really determined. TL 1 & 2 bring about phrases such as, “still early stages of 4IR- about 10 years, no clear boundary with 3IR, initially an invisible thing, typical exponential trend.” The 4IR’s timeline is not clear as to when it really started but what defines it is how fast it has become as compared to 3IR. “The scope of change and impact determined by the 4th industrial revolution is also unprecedented because they include all areas of human existence and almost all areas of the globe,” (Bonziu, 2017, p 12). This was the same with 1IR as many people could not pin down the actual point when it started but can point out the period around when things started changing. *Clearly TL 1&2 believe we are in the 4IR as they could articulate the technologies and the things that make the 4IR different from 3IR. They believe the 3IR was putting infrastructure in place and 4IR is the implementation where there are profound changes in the way things are happening. The features of an IR were articulated also with technological innovation, industry transformation, labour issues, globalization, societal consequences*

Empirical Part: Findings and Discussions from Group 1 Thought Leaders

The theme on developing countries had three categories that came out namely *incapacitation, policies* and leadership. The category of incapacitation deals with developing countries’ challenges in having enough resources to meet the needs posed by 4IR. Group one said that governments in the developing countries will need to invest heavily but they do not have money. They end up being funded by the international community who gives them money with conditions. This is articulated in literature review, “Alas, countries in the developing world have few capital resources, and interest payments on international debts…” (Kennedy, p.91). Thought leaders also highlighted the following, “we might end up inheriting technologies that are out of context with our reality.” Wilson and Heeks, (2004, p. 406) pointed this out also, “technology is embedded in social, cultural and economic relations of particular societies. In this view, technology both reflects and influences the society that produces it.” On policies, Thought Leaders believe that if workforce is reskilled, global growth segments funded and technology is used to develop the working class then 4IR will have a positive effect on developing countries but it will be negative, “if they are held back by poor human capital, poor education systems, outdated policies and politics and uncompetitive businesses. The developing countries will be left behind then and suffer.” *Attitudes coming out from this is that developing countries can make 4IR work for them if they put in place strong policies that are implemented fully and correctly. TL 1&2 believe 4IR can be utilized to develop the nation if it is harnessed wisely.* Lastly the leadership category requires developing countries, “to have visionary leaders who are able to negotiate funding options that do not disadvantage them and invest in infrastructure, skills development and research.” Be as it may the biggest stumbling block is that developing countries do not manufacture the 4IR technologies which is unlike in the 1IR where the steam engine and all the other inventions were happening in Britain where they were used to develop industry which made it ideal and easy to change and innovate industry operations. Kennedy, (1993, p.12) asserts,

> This problem is more sobering, because of the geographic disjunction between where the population pressures are and where the technological resources are. In

late-eighteenth-century England, population explosion and technology were occurring in the same society, and interacted with each other in ultimately beneficial ways.

Developing countries are in a capricious position as they have to pander to the whims of the developers of the 4IR technologies.

On the theme, developed countries there are two categories of *cited nations* where "America and China," which are developing 4IR technologies and have *strong leadership* and they "invest heavily in research and development." The point being put forward is that the two countries were involved in some misunderstanding where America stopped its company from doing business with a Chinese company but it did not cause much problems as the Chinese company had a back-up plan. These two countries are geared for 4IR as they do not rely solely on technologies that come from elsewhere.

TL 1&2 believe 4IR has drawbacks for developing nations but they can be overcome by a visionary leader who can put policies in place that move them forward and not backward.

Challenges theme has *inequality, unemployment, preparedness* and *profound changes* as the categories. On inequality TL1 & 2 suggested that the gap between the digitally empowered and the digitally disempowered will get bigger and the digitally disempowered are at risk of being further marginalized. Kennedy, (1993, p.13) reiterates the same sentiments, "New scientific breakthroughs often create structural problems of transferring their benefits from the "haves" to the "have-nots" within that society," and Pstoka, (2018) concurs, "The new technologies have a power to privilege and magnify inequalities in ways that are uncontrollable…"

Thought Leaders on unemployment say that people are going to lose jobs whether we like it or not and there will be loss of income and poverty. "Quantum computing computes things faster and jobs such as statistician, underwriter in an insurance company and actuary will become obsolete." Another challenge will be to be prepared so as to continuously develop technical know-how in developing more complex robots as things are moving at a faster pace. Thought Leaders also said, "they will be profound changes in the nature of work, the way society behaves, the way politics happen and the way business is conducted." Bonziu agrees, "The scope of change and impact determined by the 4th industrial revolution is also unprecedented because they include all areas of human existence and almost all areas of the globe," (2017, p 12).

Thought Leaders are clearly pointing out to the major challenges that 4IR poses to society. Inequality especially to those who do not have access to technologies already, unemployment to some in certain sectors, the need to be prepared to move with the times and the profound changes that are going to appear in every facet of life. Some of these challenges were faced in 1IR as Falkus, (1987, pp. 85-86) explains, "Periodic bouts of unemployment were a feature of industrial work from the beginning of the nineteenth century. Family ties were also changed by the industrial revolution as factories destroyed the family economies which had been part and parcel of the domestic system." Haines, & Walsh, (1941, p. 653) also reveals, "Poverty stalked in the midst of plenty. While statistics

revealed steadily mounting material welfare and the growth of national and per capita wealth…" *TL 1&2 are aware of the challenges in 4IR but they offer advice on how the challenges can be overcome through opportunities available.*

The opportunities theme had these categories, *access, business, digital innovation, reskilling* and *societal consequences*. Access according to TLs alludes to those who are "digitally literate, economically and socially empowered in that they will be able to harness the benefits of 4IR." Those with access to technologies will have opportunities to utilize 4IR. Business will produce companies that are digitally transformed. The TLs said, "4IR changes the basis of competition, business models, allocation of capital, skills availability and scarcity, the way we reach customers, behaviours and buying patterns. Business will change profoundly." They also said there would be skills development for entrepreneurs to develop new products. Digital innovation shows how globalization has made the world accessible to everyone. Bonciu, (2017, p. 11), iterates

> …new technologies and a new level of knowledge are available simultaneously to almost all the population of the globe while at the same time all these new technologies and knowledge can connect, communicate and inter-act with each other and, in the process, further generate new technologies and new knowledge… **Ubiquity**, **availability** and **interaction** at a global scale are the three main characteristics of the 4th industrial revolution.

Thought leaders go on to say that machines are going to get things done more efficiently than human beings. On reskilling, there would be opportunities for human beings to develop new skills for future world of work. Societal consequences would be on increased productivity as machines will be doing work in no time which would allow people to go home early and be with family.

Thought Leaders believe opportunities of having access will present better prospects in the 4IR. Business will change profoundly in all its operations. Digital innovation will make globalization possible; machines do things efficiently than human beings and they will be possibilities on reskilling as machines take over human jobs, human beings can be trained in jobs such as robot maintenance. Kennedy agrees and reiterates,"Clearly a society which desires to be better prepared for twenty-first century will pay a price to achieve that transition, it will need to retool its national skills and infrastructure, challenge vested interests, alter many old habits and perhaps amend its governmental structures," (1993, p. 340). The use of machines will improve efficiency and could allow people to finish work early.

TL 1 &2 show how 4IR is going to benefit business and people and they believe that everyone will benefit if we configure things correctly. Industrial revolutions though have been known to benefit a few not everyone and cause a lot of suffering to the working class. Haines & Walsh, (1941, p. 654), posits, "Since the beginning of the Industrial Revolution, machinery has become both more productive and more automatic…the problem of unemployment is basically technological, and no solution of the contemporary economic difficulties will suffice unless this is taken into account."

Lastly the theme education implications brought out categories such as *infrastructure, curriculum* and *pedagogy.* On infrastructure, TLs believe universities should invest to be in 4IR. "They should evolve the curriculum to ensure students are prepared with the skills and knowledge to succeed in 4IR. They should also supplement the old stuff with more relevant material. On pedagogy 4IR will have a significant impact on both what is taught and how it is taught and technology allows to tailor modes of delivery." *On this last theme on education implications TL 1&2 believe universities should invest in appropriate infrastructure and that pedagogy will be changed significantly as technology allows tailoring modes of delivery to suit students' needs. The curriculum also should be evolved in order to resonate with 4IR requirements.*

To sum up the attitudes of Thought Leaders on 4IR are positive. They seem aware of the importance of implementing 4IR technologies to a university setting.

Themes and Categories from Group 2 which is referred as CM1, CM2 and CM3

DEFINING AN INDUSTRIAL REVOLUTION ***Technology*** -Technological advancement -Forms of technology have changed the way that people live -Additional particular technological advancements ***Industrial Innovation*** -Fundamental changes on the industrial process -Historically moving towards great industrialization -Manufacturing becomes industrialized ***Societal Consequence*** -Substantial leaps on people's intentions in life -Increase the capacity to accommodate a larger population -Particular forms of development socially, politically	**1IR, 2IR & 3IR** ***Technological Development*** -Technology around steam 3rd the use of computer technology Communication Mechanization ***Industry*** -Conditions for the rise of factories -Energy production -Production of commodities massified ***Social Consequences*** -Greater levels of unemployment -Civil strife	**Representing the conceptual part of the study**
4IR ***Digital Innovation*** -Exponentially increasing capacity based on previous technology	**4IR TIMELINE** ***Indeterminate*** -It's been going for a while Slowly been creeping- 10-15 years	**Representing conceptual part of the study**

-Developments in the science of artificial intelligence -Use of data analytics -Use the machine's ability to manipulate data -Make decisions beyond our capability -Understanding credibly complex mechanism -The internet -Smart phones -Big data ***Societal Consequences*** -Impact of far reaching changes in society -Problems around social relating and disconnectedness less reading of books	-Defining by particular technology or era very difficult -Started reasonably slow around 1970s, -More profound in the 1980s and 1990s	
DEVELOPING COUNTRIES ***Limited Resources*** -Implications for developing countries are much more extreme as they do not have resources to mitigate unemployment -Not advanced as we wish -Realignment of the workforce -Address the issues that underlie the concerns of the people otherwise they will be left behind economically -View this threat as an opportunity to change the wellbeing of the people ***Climate Change*** -Broad society to agree to the same thing about global climate change- if not the consequences for the under-resourced components of this world are going to be unpleasant ***Inequality***	**DEVELOPED COUNTRIES** ***Monopoly*** -Technological development happening completely in the absence of concerns from developing countries -Major beneficiary of technological advancement ***Labour Issues*** -Able to provide basic grants for unemployment	**Representing the empirical part of the study**

-Developing countries do not own technologies as a result there is a possibility of a new wave of imperialism		
CHALLENGES ***Societal Consequences*** -Big challenge is for society to manage that transition -greater social challenges -increased social strife -political unrest ***Labour Issues*** -Labour market to be changed in quite fundamental manner -Serious concerns about its impact on employment Realignment of the workforce -Capacity in terms of workforce not sufficient to address the need ***Inequality*** -4IR in its current form and current world will reach greater levels of inequality -Equal opportunity not immediately available across the world's total population - Social good realized with access is not apparent in situations overlaid with inequality -The marginalized likely to benefit least	**OPPORTUNITIES** ***Business*** -Create new entrants into business -Owners of capital, big data analytic companies are the biggest beneficiaries -Mechanisms to be a significant component of business -Opportunities to collaborate -Gaps of bringing some of the technology into under-resourced communities shrinking quite dramatically -We will have devices doing things for us at affordable prices across the world -Many jobs related to 4IR yet to be created -Increased mechanization -People will move out of formalized systems in terms of money, transactions, business, buying and selling markets -Top five companies in the world are technology drivers or big technology users -Profound impact on business the way you think about markets -Profound impact on sales-you don't need money any longer if you have a smart device -New skills that have to be acquired ***Greater Good*** -All of humanity will benefit from it in time	**Representing the empirical part of the study**

	-Technology brings a degree of POSSIBILITY for progress and advancement in the social world e.g. the understanding of bacteria produced antibiotics which reduced death from basic infections -Cell phone has made greater access to connectivity for many people -Marginalized can use technology in the service of liberative politics to highlight atrocities e.g. Arab Spring in Egypt, Tunisia -Uptake of those technologies even in under resourced environments e.g. the mobile devises are now used across the world less than 30years since the first one was launched in 1990 -Use of data to improve the health and wellbeing of all South Africans -Technology can be utilized in disabilities through possibilities of speech, hearing, sight, paralysis	
EDUCATION IMPLICATIONS ***Readiness*** -Lecturers need to be more prepared and being exposed to technologies -People in leadership in the universities have an important responsibility to prepare staff	***Inequality*** -The elite will still have the best form of education especially in higher education -Will increase inequality as those who can pay for university education will get a superior product ***Learning***	**Representing the empirical part of the study**

for it and we sort of doing some of that at this university ***Pedagogy*** -the way we learn, the way we teach and the future of the classroom are quite important changes that are likely to happen -lecturers to start thinking more creatively about blending traditional models with new initiatives -Tools that will change the way we do vocational training in many ways -universities to be structured less around common disciplines but around common problems -more online learning through MOOCS	-applying for university place through the internet whilst anywhere in the world -Doing practicals through Virtual Reality -Information overload for students and teachers -Less reading because of no depth but reading bits all over	

Summary of the themes and categories emanating from Group 2 CM1, CM2 & CM3

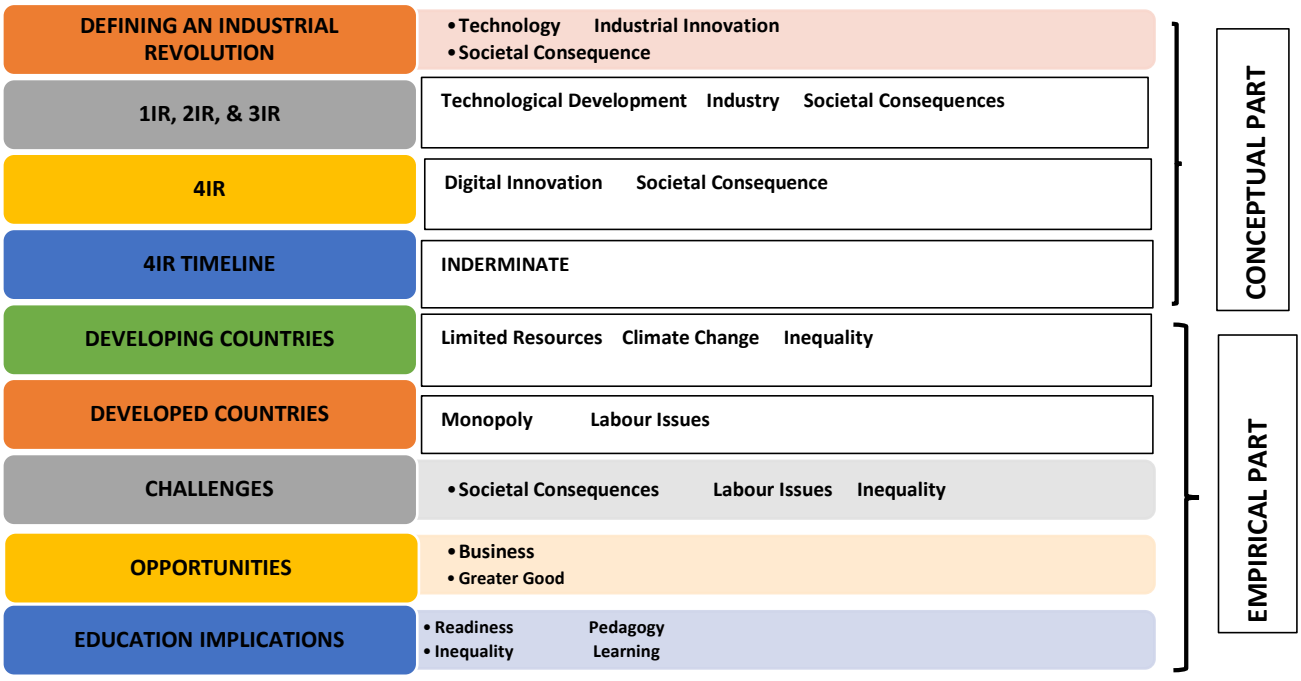


FIG 5 Themes and Categories CM1,2&3

FINDINGS AND DISCUSSIONS FROM MANAGEMENT GROUP 2

University Management Group 2 members are referred as CM1, CM2 & CM3.

Conceptual Part: Findings and Discussions from Group 2

The themes produced different categories (refer to FIG 7) and the categories that came out the most from Group 2 on the conceptual part are Technology, Industry Innovation and Societal Consequences.

On the theme Defining an industrial revolution three categories came out which are *technology, industrial innovation* and *societal consequences*. On technology the CM group posited that in an industrial revolution there is technological advancement which change the way people live. On industrial innovation there are "fundamental changes on the industrial process" and on societal consequences "there is an increase that capacitates and accommodates a larger population and there are particular forms of development socially or politically." So basically, an industrial revolution would have technological advancement which cause industry to innovate and increase the capacity of this world to accommodate a larger population but has got consequences on people's lives socially and politically.

The definition forwarded by CM1; 2 & 3 resonates with the features of an industrial revolution so they could have a clear grasp of what an industrial revolution is.

On the theme of 1IR, 2IR & 3IR there are three categories namely *technological development*, *industry* and *social consequences*. On technological advancement, there was "technology around steam in the 1st industrial revolution, increasing levels of mobility, 2nd was mechanization and third was computer technology and communication. On industry there was a rise in factories, energy production and massified production of commodities." Castells, (2000, p.35), "They were indeed revolutions in the sense that a sudden, unexpected surge of technological applications transformed the processes of production and distribution…" On social consequences there were greater levels of unemployment and civil strife. This is depicted in the following quote from literature review, Haines & Walsh, (1941 p.652) suggesting pitfalls of the time, "Yet the coming of the machine was not an unmitigated blessing. The majority of men, the tillers of the fields and the toilers of the factories, became its chattel slaves, dependent upon its whims and fluctuating fortunes."

CM 1, 2 & 3 described the inventions of the first three revolutions and basically what was going on in industry and its societal consequences. All three of them know about the revolutions though CM2 is not keen on calling them industrial revolutions but rather significant steps or a progression that has been around for 10 000 years starting with the identification of particular grasses that allowed humans to cultivate food.

The next theme on 4IR timeline, the category is *indeterminate* as the respondents could not give a definite date on when it started. Answers such as, "it's been going for a while, slowly been creeping on over 10-15 years, started reasonably around 1970s and became more profound in the 1980s and 1990s." On 4IR theme the categories that came out were *digital innovation* and *societal consequences.* On digital innovation the respondents believe, "there is an exponentially increasing capacity based on previous technology, developments in the

science of artificial intelligence, use of data analytics, use of machines to make decisions beyond our capability, understanding credibly complex mechanism, smartphones, big data." They believe these differentiate 4IR from any other industrial revolution. On societal consequences there are, "far reaching changes in society, problems around social relating and disconnectedness and less reading of books due to information overload on the internet." *CM 1,2 &3 have heard of 4IR but are not sure when it really started but CM 1& 2 estimated it in the 10-15 years whereas CM3 believe it started slow but has exponentially increased its capacity based on previous technology.* So 4IR has built on 3IR technologies. Schwab, (2016, p. 7) "…I believe that today we are at the beginning of a fourth industrial revolution. It began at the turn of this century and builds on the digital revolution. Digital technologies that have computer hardware, software and networks at their core are not new but in a break with the third industrial revolution, they are becoming more sophisticated." *What came out of CM1, 2 & 3 iterates the same sentiments by the author. CM2 clearly stipulates that categorizing eras does not go down well with them and they say, "It's not defining the tool but the purpose and the outcome." So, there is no industrial revolution for them but movement from a point where machines worked for us to a point where machines are going to do the work for us.*

CM1 and CM3 believe we are in the 4IR but CM3 believe the 4IR should not be about technology only but about the challenges that technology throws up on the social and political scene. Challenges such as, Falkus, (1987) portrays below,

> There were obvious evils, like the appalling conditions in the fast-growing factory towns and the exploitation of child labour (there were some five thousand boys and even some girls between the ages of 5 and 10 working underground in the coalmines in 1841) Less obvious deterioration included the loss of independence experienced by factory workers, subject now to strict time-keeping, the factory hooter, and the need to keep the machinery turning. Factory labourers, suffered a loss of status as their lives and livelihood became determined by factors outside their control. (p. 85)

Many challenges have manifested during all the industrial revolutions which impacts on people's lives. Kennedy, "It is imperative, moreover, that we come to understand the interconnectedness of these issues in today's comparable dilemma," (1993, pp.11-12).

Group 2 can define an Industrial Revolution and are aware that technologies have become sophisticated and that this era is different from previous ones. The features of an industrial Revolution could be found in their responses.

<u>Empirical Part: Findings and Discussions from Group 2</u>

Three categories namely Inequality, Labour issues and Societal Consequences appeared more than once with one category Greater Good showing how technological development can be harnessed for improving people's health and livelihoods.

The theme on developed countries shows the category of *monopoly* and *labour issues*. On monopoly, "developed nations are developing technologies without any concerns about developing countries and that they are the major beneficiaries of these technological

advancements". Kennedy, (1993, p.47) "…the main creators and controllers of technology have increasingly become large, multinational corporations with more global reach than global responsibility." Developed countries are also able to cushion those displaced in the workplace with a grant.

Clearly the CM group are aware of some of the advantages in the developed countries which pose a threat to developing nations.

Developing countries have three categories which are *limited resources*, *climate change* and *inequality.* The category on limited resources deals with the implications on developing countries according to Group 2, "in which they lack resources to mitigate unemployment during job losses. The countries are also not as advanced due to lack of resources and the realignment of the workforce is a drawback. If this is not addressed properly, developing countries will be left behind economically. They believe these technologies should be viewed as an opportunity to change the wellbeing of the people." On climate change they think, "it requires the broader society to agree to the same thing about global climate change otherwise the under-resourced components of this world are going to be unpleasant." On inequality, "developing countries do not own technologies as a result there is a possibility of a new wave of imperialism." *What is coming out of the categories is that developing countries lack resources to cushion their citizens when they become unemployed. Developing countries also lack resources to realign the workforce in 4IR. Climate change impacts developing countries more if the world does not agree to the same thing. Developing countries also do not own technologies as a result there can be taken advantage of.* This is articulated by Kennedy, "There are indications that some of the "First" World's new technologies, far from rescuing the booming populations of the developing world, may harm poorer countries, by making redundant certain economic activities…" (1993, p.13).

The CM group though believe these technologies should be viewed as opportunities to change the wellbeing of the people. The CM group see that there are challenges for the developing world posed by 4IR but believe they should move with the times regardless because if not we will be left behind economically. So, they suggest that issues that underlie the concerns of the people should be addressed first. Their concerns and the situation on the ground might not allow going into the 4IR easy as developing countries do not manufacture the technologies and do not have the resources to do so without compromising the marginalized who might require the resources more.

On the challenges theme there are three categories namely *societal consequences*, *labour issues, inequality.* On societal consequences, "there will be increased social strife and political unrest." On labour issues, "the labour market is to be changed in a quite fundamental manner, there will be realignment of the workforce and the capacity of the workforce is not sufficient to address the 4IR needs." On inequality there are concerns that the 4IR in its current form and current world will reach greater levels of inequality as there are no equal opportunities immediately available across the world's total population. To quote from CM3, "Where technology is overlaid in a system of inequality actually, those who are dominant will benefit most significantly from it and those who are marginalized are likely to benefit least from it." *The CM group believe there will be increased social strife,*

strikes and political unrest due to increased mechanization which will result in increased unemployment. On the other hand, the labour market will be changed in quite a fundamental way with the workforce being realigned. There will be incapacitation also due to insufficient workforce to address the 4IR needs.

What is coming out from Group 2 here is there will be job losses but also vacancies due to lack of skilled workers to meet the job requirements of some jobs in 4IR. Haines, & Walsh, sums the plight of workers since 1IR which is still applicable today, "Yet the coming of the machine was not an unmitigated blessing. The majority of men, the tillers of the fields and the toilers of the factories, became its chattel slaves, dependent upon its whims and fluctuating fortunes," (1941, p.652).

They also believe that 4IR in its current form will worsen inequality and that the opportunities are not available to everyone across the world. The CM group are aware of the challenges that 4IR poses.

The opportunities theme offers two categories which are *business* and *greater good. "*Opportunities for business will create new entrants into the market. Top five companies in the world are technology drivers or big technology users. Mechanisms to be a significant component of business. Gaps of bringing some of the technology into under-resourced communities shrinking quite dramatically. Opportunities to collaborate, many jobs related to 4IR yet to be created, increased mechanization, people will move out of formalized systems in terms of money, transactions, business, buying and selling markets. Profound impact on sales- you don't need money any longer if you have a smart device and there are new skills that have to be acquired." *The CM group see a number of opportunities for business that will benefit people and companies.* On the category of greater good the group believe all humanity will benefit from 4IR in time. "Technology brings a degree of POSSIBILITY for progress and advancement in the social world." An example put forward is that the understanding of bacteria produced antibiotics which then reduced death from basic infections. The use of data to improve the health and wellbeing of all South Africans. Uptake of those technologies even in under resourced environments e.g. the mobile devises are now used across the world less than 30 years since the first one was launched in 1990. Cell phone has made greater access to connectivity for many people. The marginalized can use technology in the service of liberative politics to highlight atrocities e.g. Arab Spring in Egypt, Tunisia. Technology can also be utilized in disabilities through possibilities of speech, hearing, sight, paralysis.

The CM group believe that the 4IR technologies can be used for greater good despite their shortcomings. They believe people can utilize technologies to improve their lives. They also believe the technologies will eventually become available by citing the cell phone which has taken a short period of time to be ubiquitous. The CM group clearly believe in the potential of 4IR to make life better and easier in the long run despite its glaring obvious challenges of being out of reach for many. They believe those who can access it will utilize it in a way that benefit everyone.

On the last theme in this group of education implications there are four categories, *readiness, pedagogy, inequality* and *learning.* On readiness the group cited people in leadership in the universities to having an important responsibility to prepare staff for it and we sort of doing some of that at this university. On support, Sandholtz, Ringstaff and Dwyer, (1997, p.161), "the teachers who made the most changes were those who had the greatest level of support. Support included assistance from project coordinators, other teachers who participated in the teacher development program, and school and district administrators." They went on to say that lecturers need to be more prepared and being exposed to technologies. The importance of getting teachers exposed to technology is shown from literature review, "The teacher is pivotal in determining the extent to which innovations are adopted and implemented in educational practice. Therefore, the training and regular upgrading of teachers is important for the integration of technology into daily educational practice," Howie, Muller and Paterson, (2005, p.73). On pedagogy category the group imitated to changes, "in the way we learn, the way we teach and the future of the classroom as important. Lecturers should start thinking more creatively about blending traditional models with new initiatives, tools that will change the way we do vocational training in many ways. Universities will be structured less around common disciplines but around common problems and that there will be more online learning through MOOCS." The inequality category cited the elite as going to receive the best form of higher education which will increase inequality. On learning the group cite, "the internet as making the application process easier as students can apply for a university places online at home or anywhere in the world. Practicals can be done through virtual reality which makes them appear real in a class. On the downside the internet provides students with information overload and results in less reading in depth as they read bits everywhere."

Group CM is aware of the implications on higher education. They believe university management should be responsible in making sure lecturers are prepared for 4IR and they were sort of doing it. They also believe that 4IR will change the way students learn and the way teachers teach and that lecturers should blend traditional models with new ones. Technology has made the application process for university places easier. They believe that the elite will continue getting quality education which increases inequality.

Themes and categories from Group 3 which will be referred as C1, C2 & C3

Themes are written in blue and categories in purple

DEFINING AN INDUSTRIAL REVOLUTION ***Innovation*** -Invention of one thing or a collection of things associated or collection of innovations ***Fundamental Transformation*** -Significant shift -Particular sector being transformed/being changed -make production more efficient -Disruption, -Basically, throws out the norms of industrial approaches -Industrial action/activity taken to a totally new level ***Economic development*** -Economic growth or economic development being fundamentally reorganized or reconfigured -to produce goods and services, ***Societal Consequences*** -need brought about by: increases in consumption, population growth,	**1IR, 2IR & 3IR** First one at the turn of the last century ***Farming*** -Agriculture revolution -Farming on a mass scale ***Economic development*** -First fundamental transformation in the -economy and society ***Technology*** -Steam engine which fundamentally transformed mobility -Printing press which fundamentally transformed communication -Computers -internet -World wide web -Mechanization	**Representing the conceptual part of the study**
4IR ***4IR Components*** -Collection of digitized innovations -Fundamentally transforming the way: the economy operates and industry operates -Fundamental impact -Unprecedented growth in technology -Unprecedented growth in digital enabling technologies	**4IR TIMELINE** ***Indeterminate*** -Already beginning or in the midst of the first block of a fundamental shift -4IR is something that has been happening gradually but now happening fast	**Representing the conceptual part of the study**

-Revolutionise the workplace and the work itself -Speed with which it is happening is now unprecedented -exponential growth -More of an evolution than a revolution ***Societal consequences*** -far reaching societal changes ***Globalisation*** -interlinked and intertwined world becomes almost one -significant overhaul ***Sophisticated Technology*** Big data Robotics Artificial intelligence Virtual reality Smart phones Cloud Mechanization The internet of things quantum computing ***Technological revolution*** New technologies emerging Digitized technologies Sophisticated technologies New forms of technology		
DEVELOPING COUNTRIES ***Dilemma*** -Real fear is that these new forms of technologies are at the behest of the rich, the empowered, the most industrialized world -danger is it might not allow the human community to come together -we are defined by the principles of human solidarity	**DEVELOPED COUNTRIES** ***Nations*** China and the United States ***Empowered*** -Rich and industrialised -Those who are able to manufacture the technologies are the ULTIMATE beneficiaries	**Representing the empirical part of the study**

so if we cannot come together, we cannot solve global problems such as climate change together and therefore we can destroy the world and ourselves as a human species ***Inequality*** -danger for the developing countries is to be bonded into perpetual servitude by countries such as China and US- we need to be equal participants in this technological revolution if we are to have freedom -Global south will get second generation or even third generation of these technologies -situation whereby the differentials between the rich nations and the poor nations are likely to be increased,		
CHALLENGES ***Societal consequences*** -Fundamentally change everyone's life -4IR must benefit us all, if it's only going to benefit the elite, then it's unlikely going to have that kind of collective impact -benefit to society is always a part of development, ultimately whoever manufactures anything wants the money, ***Inequality*** -Real danger of reconsolidating the inequalities in our society -Those who do not have resources will not make much progress ***Labour Issues***	**OPPORTUNITIES** ***Societal consequences*** More time to spend with family Use the smartphone to transact Phenomenal progress on people with resources ***Business*** -More productive means producing more wealth -Business will benefit tremendously from robots as they will be greater efficiencies, -Transforming the economy: how retail happens how production happens, how mining happens new forms of jobs	**Representing the empirical part of the study**

-Lowly paid skills or manual kind of skills will lose their jobs to robots -BIG decisions to be made by governments whether to sacrifice social justice against economic progress	***Globalisation*** -Everything is interlinked and intertwined -The world becomes almost one Business can be done whilst you are anywhere in the world- male telephone calls, trade and so on -new research emerging e.g. the way we do medicine is going to fundamentally change- you could treat people in the rural areas by using a camera in a hospital in urban areas	
EDUCATIONAL IMPLICATIONS fundamentally change the face of education, the very fundamental basis of education is going to fundamentally transform ***Curriculum*** -Changing the curriculum -provide out trainee teachers with technological and technical skills required by schools ***Pedagogy*** -online education and blended education will fundamentally change the face of education	***Robots Limitations*** -Robots are going to be limited to the extent to which they can take over some jobs such as teaching ***Drawbacks*** -University do not have adequate financial resources to buy all the technologies that their student teachers encounter in some schools -Some lecturers technophobic and unwilling to train- reskilling is seen not as a bonus but task, not the easiest space to introduce new ideas	**Representing the empirical part of the study**

Summary of Themes and Categories C1,C2 &C3

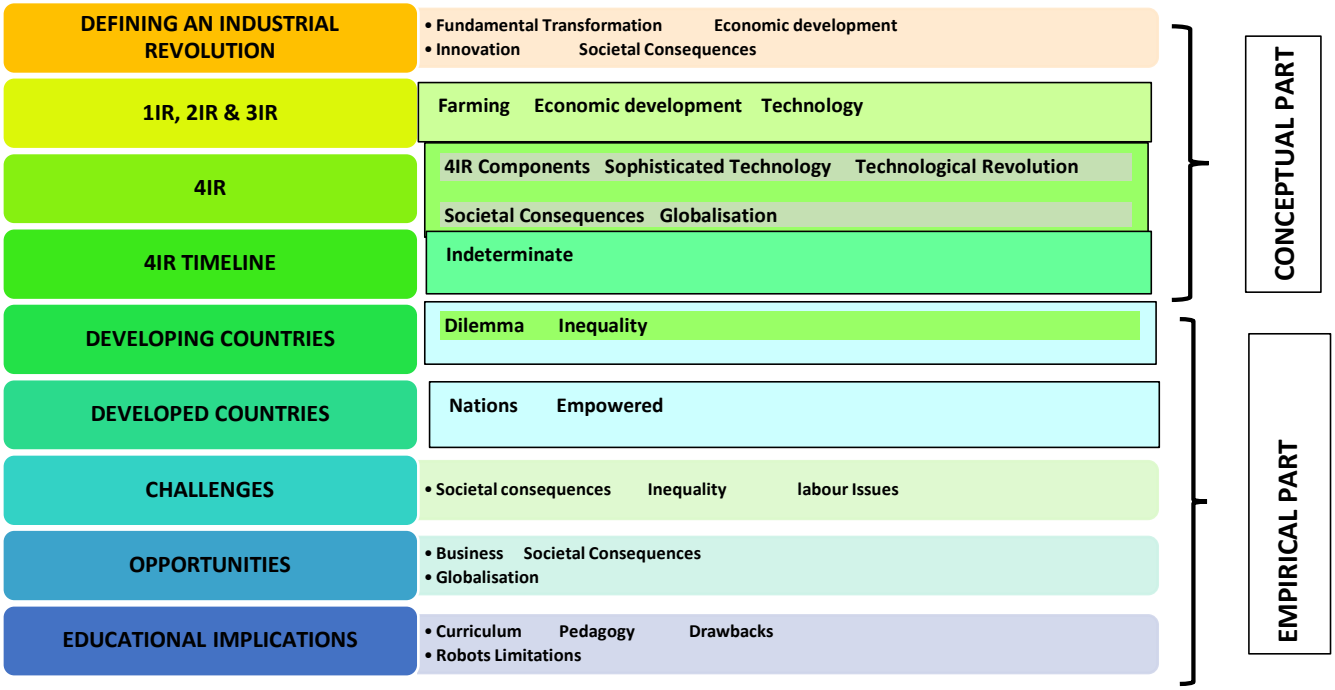


FIG 6 Themes and categories C1,2&3

FINDINGS AND DISCUSSIONS FROM GROUP 3 C1, C2 and C3

Conceptual Part: Findings and Discussions from Group 3

The categories that came out from the themes are shown in FIG 6 above. The category that came out most of the times on the conceptual part is Technology, Industry Innovation, Economic development and Societal Consequences.

The first theme of defining an industrial revolution has three categories namely *innovation, fundamental transformation, economic development and societal consequences.* On innovation the group cited invention of one thing or a collection of innovations. On fundamental transformation the group cited things like Industrial action/activity taken to a totally new level, basically throws out the norms of industrial approaches, a significant shift, particular sector being transformed/being changed, make production more efficient. On economic development the category indicates how economic growth or economic development is being, "fundamentally reorganized or reconfigured to produce goods and services. On societal consequences industry transformation was brought about by, "increases in consumption and population growth. *What is coming out is that an industrial revolution is a collection of innovation or invention of one thing or other which leads to a fundamental transformation of the economy through industry activity taken to a whole new level in producing goods and services to meet the needs of a growing population which spurs on economic growth. Their definition sounds similar to* Mathias, (1983, p.2) who defines an industrial revolution as,

> the onset of a fundamental change in the structure of an economy; a fundamental redeployment of resources away from agriculture, becoming self-evident over time…

growth in production, investment and the labour force grows more rapidly in other sectors of the economy, which therefore becomes more differentiated. The concept involves also the assumption that industrial production begins to expand at a higher and sustained rate – speaking of output as a whole."

Group C1, C2 & C3 seem to know what an industrial revolution is from their categories and some of the features of an industrial revolution from the conceptual framework which are technological innovation, economic development societal consequences, industry transformation.

The next theme on 1IR, 2IR & 3IR shows the following categories *farming, economic development and technology.* The first industrial revolution was shown to have started at the turn of the last century. The category on farming indicates there was a revolution in agriculture and farming on a mass scale. It was the first fundamental transformation in the economy and society. The technology involved in the revolutions were steam which transformed mobility in the 1IR, printing press which transformed communication, computers, world wide web. *The group C1. C2 & C3 are aware of the inventions of the industrial revolutions although they seemed to mix some of the inventions according to their appropriate period*.

On 4IR all three agreed that they had heard of the term though C3 said for him it was an evolution instead of a revolution. 4IR timeline is *indeterminate* also as no one could actually say when it started. The group gave varied explanations such as, "already beginning or in the midst of the first block of a fundamental shift. 4IR is something that has been happening gradually but now happening fast." On 4IR theme the categories are *4IR components, sophisticated technology societal consequences*, *globalization* and *technological revolution.* 4IR components cited are, "a collection of digitized innovations, fundamentally transforming the way the economy and industry operates. Fundamental impact, unprecedented growth in technology, unprecedented growth in digital enabling technologies, revolutionise the workplace and the work itself, speed with which it is happening is now unprecedented, exponential growth." Societal consequences indicates how these technologies have far reaching societal changes. Globalisation category indicates how interlinked and intertwined the world has become. On sophisticated technology the Group indicated the following, "big data, robotics, Artificial Intelligence (AI), Virtual Reality (VR) smart phones, cloud, Internet of things (IoT). Technological revolution alludes to new technologies emerging, digitized technologies, sophisticated technologies and new forms of technology."

The 4IR components indicates how they are viewed by Group 3 as digitized innovations that surpasses any other innovations before them. This resonates with Schwab's assertion "Digital technologies that have computer hardware, software and networks at their core are not new but in a break with the third industrial revolution, they are becoming more sophisticated," (Schwab, 2016, p.7). *Group 3 are aware of 4IR and they seem to know the technologies that are in the 4IR and they described what 4IR entails with phrases such as digitized innovations, fundamentally transforming, unprecedented growth, exponential growth and sophisticated technologies. This signifies that they believe these technologies are way too advanced from the previous ones which differentiates the eras.*

Empirical Part: Findings and Discussions from Group 3

Two categories of Inequality and Societal consequences were noted more than once.

On developing countries there are two categories namely dilemma and inequality. On the category dilemma Group 3 mentioned that there is real fear that these new forms of technologies are at the behest of the rich, the empowered, the most industrialised world. The danger is it might not allow the human community to come together. "We are defined by the principles of human solidarity so if we cannot come together, we cannot solve global problems such as climate change together and therefore we can destroy the world and ourselves as a human species." On inequality "there is the danger of developing countries being bonded into perpetual servitude by countries such as China and US. We need to be equal participants in this technological revolution if we are to have freedom. Global south will get second generation or even third generation of these technologies. The differentials between the rich nations and the poor nations are likely to be increased."

Group 3 believe developing countries are in a dilemma as these new technologies are controlled by rich and powerful countries so they fear that it might not make people work together as one. If people do not work together then they will not be able to solve global problems such as climate change together. Group 3 fears that 4IR might further divide the world. The Group also believe that inequality might even make developing countries to be dominated endlessly by China and America who are the producers of 4IR technologies but this can be solved if developing countries become equal partners in the technological revolution. The Group also are worried by the digital divide between developing nations and the developed nations which might make them receive outdated technologies which might worsen their situation. Group 3 are aware of the predicament that developing nations are as compared to the developed nations. They highlight these as a precautionary measure to what might happen if governments in developing countries are not careful. Group 3 attitude is negative as they are fearful of being dominated by developed nations which might create tensions and as a result divide nations instead of bringing them together

Developed countries nations cited are America and China and they are *empowered*. "They are rich and industrialised and they are the ULTIMATE beneficiaries of 4IR." The Group showed the two countries as being the ultimate beneficiaries of 4IR inventions.

Moving on to the theme challenges with categories *societal consequences, inequality and labour issues*. On societal consequences, "4IR will fundamentally change everyone's life by changing the way humans spend their day. 4IR must benefit all in order to make that collective impact, if it benefits only the elite then it is unlikely to achieve that. Benefit to society has always been a part of development, ultimately whoever manufactures anything wants the money." On inequality, "those who do not have resources will not make much progress. There is a real danger of reconsolidating the inequalities in our society. We inherited a whole series of inequalities because of our past and the real fear is that these new forms of technologies instead of addressing the historical disparities might consolidate those same historical disparities. If we are divided, we cannot create the platform to address human challenges." On labour issues, "lowly paid skills or manual kind of skills will

lose their jobs to automation and robots e.g. people working in service stations. Big decisions need to be made by governments whether to sacrifice social justice against economic progress."

What is coming out of the challenges theme is that there will be social consequences on society in that life will fundamentally change in the way we spend our day as there might be a lot of spare time. 4IR should benefit all because if it does not it will not have the results that it should in making people work together. Any development that happens is supposed to benefit society so those who manufacture anything are doing it for the money. Inequality keeps popping up as a challenge on 4IR. Here in SA where it was inherited from the past, the Group believe it might worsen if it is not addressed properly. There are labour issues also that will pose challenges for people and it is up to governments to decide what is best for their people.

Moving on to opportunities there are three categories on *societal consequences*, *business* and *globalization.* On societal consequences, Group 3 believe, "the working day will be shortened due to automation and robotics. It might mean that men will now spend more time at home doing other things such as cultural and intellectual decisions, spend more time looking after the household and lesson the burden on women. People will now use their smartphone to shop online, do banking online and other things. Business will benefit tremendously from robots as they will be greater efficiencies. Retail, mining and production will be transformed and there will be new forms of jobs." On globalization, "everything is interlinked and intertwined. The world becomes almost one. Business can be done whilst you are anywhere in the world- make telephone calls, trade and so on."

What is coming out of Group 3 on opportunities is that with automation and robotics humans can have fewer hours at work which will allow them time to be with family. Again, the smartphone has made life easier for people as they can use it to shop, bank and contact business anywhere. Globalisation has made the world become one and you can work or contact your business whilst you are anywhere in the world and anyone is just a phone call away. Bonciu reiterates on globalisation, (2017, p. 11),

> …new technologies and a new level of knowledge are available simultaneously to almost all the population of the globe while at the same time all these new technologies and knowledge can connect, communicate and inter-act with each other and, in the process, further generate new technologies and new knowledge… **Ubiquity**, **availability** and **interaction** at a global scale are the three main characteristics of the 4th industrial revolution.

The Group identified some opportunities for the 4IR and were able to show how these will be an opportunity in the 4IR.

Lastly moving on to education implications which has *curriculum, pedagogy*, *robots' limitations* and *drawbacks* as identified categories. On curriculum the implications are that the curriculum should change to meet the needs of the 4IR. Universities should provide trainee teachers with technological and technical skills required by schools. On pedagogy, blended learning and online education will change the face of education. On robots'

limitations, Group 3 thought robots are going to be limited to the extent to which they can take over some jobs such as teaching. On drawbacks, “University do not have adequate financial resources to buy and teach the students all the technologies that their students encounter in some schools. Some lecturers are technophobic and unwilling to train-reskilling is seen not as a bonus but a task, the university is not the easiest space to introduce new ideas. Making sure that schools do not lose focus on the social justice principle.”

What is coming out from Group 3 is that education should be ready to change the curriculum to suit 4IR needs. Education should be prepared to change their modes of delivery to blended and online as this is now the future. An interesting observation came out of this Group that robots are limited and will not be able to take over some jobs especially the teachers’ job as there is the AFFECT side of things that machines cannot provide. The group found out some drawbacks such as financial limitations in acquiring technologies in universities and schools. Another drawback was that some lecturers were technophobic and it was difficult to have them trained as they offer resistance as they come from a different era. Advice was offered for schools not to lose focus on what is important that is the social justice principle. Group 3 was able to articulate what is needed in order to meet the 4IR requirements but at the same time pointed out the things that stand in the way of moving forward.

CHAPTER 5

CONCLUSIONS

Chapter 4 dealt with findings and discussions of the research. Chapter 5 will make conclusions based on the findings.

Conclusions on the Conceptual part of the research

According to the findings all members in the three groups were able to conceptualise an industrial revolution. According to all participants an industrial revolution involves technological advancement, industry innovation and changes in society. Most of the categories that came out of the definition are also on the conceptual framework as shown on FIG 2. This definition goes with what Marx and Engels, (2008, p.6) also said, "The bourgeoisie cannot exist without constantly revolutionizing the instruments of production, thereby the relations of production, and with them the whole relations of society." All the respondents know what an industrial revolution is. This answers the first research question, *what constitute an Industrial Revolution?*

On the theme of 1IR, 2IR & 3IR the conclusion is that all participants mentioned that there is technological development, industry development and societal consequences in the three industrial revolutions. The only differences were that Group 1 TL and Group 2 CM were able to identify the major inventions in 1st, 2nd and 3rd industrial revolutions whereas Group 3 C had the inventions all muddled up. Basically, they all knew that the three industrial revolutions involved technological invention with the rise and growth of industry which affected society in one way or the other. One member from Group 2 pointed out that they did not believe in naming these as industrial revolutions but rather significant shifts and one from Group 3 called them industrial evolutions as a revolution was a violent and sudden event. On 2IR, Greenwood, (1999, p. 9), states, "By around 1910 it was apparent that machines could be driven with individual electric motors. The realization had a great impact on the workplace productivity. Furthermore, the production process became more flexible…" and on the revolutions, Castells, (2000, p.35), "They were indeed revolutions in the sense that a sudden, unexpected surge of technological applications transformed the processes of production and distribution…" On 3IR, Toffler, (1980) posits,

> the rise of dynamic new industries based on scientific breakthroughs: quantum electronics, information theory, molecular biology, oceanic nucleonic and the space sciences. Enhanced manipulative abilities via computers, data processing, aerospace, sophisticated petrochemicals, semiconductors, advanced communications, solid state physics, systems engineering, artificial intelligence, fuzzy logic, polymer chemistry."

On consequences to society, "In terms of economic productivity this social transformation was an immense success, in terms of human suffering, a tragedy… which reduced the rural poor to demoralized destitution," (Hobsbawm, 1962,48).

Conclusions on 4IR were that all participants have heard and are aware of the 4th industrial revolution, but they were not sure of when it actually started. They were answers such as, "already in the midst of the first block"," it has been happening gradually", "slowly been creeping in the 10-15 years". So, the research concluded that the time was indeterminate. On the categories all participants had technology, digital innovation and societal consequences which means they all believe that it is an industrial revolution. All interviewees including the two who do not want to use the term industrial revolution believe we are in a significant shift which means we are in a new era. This means it is a matter of terminology but there is a difference from the previous era. Phrases used were sophisticated technologies, collection of digitized innovations, fundamentally transforming the way the economy and industry operates, fundamental impact, unprecedented growth in technology, exponentially increasing capacity based on previous technology, make decisions beyond our capability, understanding credibly complex mechanism, smartphones, big data, powerful computing infrastructure. Though most of the technologies started in 3IR, they believe that there is a difference in the way they are now used. Their growth is unprecedented and they are changing the business, political,economic and societal landscapes. This is cited from literature review "Digital technologies that have computer hardware, software and networks at their core are not new but in a break with the third industrial revolution, they are becoming more sophisticated," (Schwab, 2016, p.7). I would then conclude that the participants believe that we are in the 4IR. The conclusions on 4IR answers the question on *why is the 4IR deemed an Industrial Revolution?*

Conclusions on the empirical part of the study

The conclusions in this section reflects the attitudes, conceptions and beliefs of the interviewees on 4IR.

The participants on the theme developing countries, believe that these countries are in a dilemma as they do not manufacture many of the technologies. They are also afraid that these technologies are being manufactured without any consideration of the developing world's needs. This might make developing countries a dumping ground of 2nd and 3rd generation technologies. Kennedy from literature review exposes the dangers facing the developing world "there are indications that some of the "First" World's new technologies, far from rescuing the booming populations of the developing world, may harm poorer countries, by making redundant certain economic activities…" (1993, p.13). These technologies might also be out of context with developing countries' realities as shown also by Wilson and Heeks, (2004, p. 406), who share the same sentiments, "technology is embedded in social, cultural and economic relations of particular societies. In this view, technology both reflects and influences the society that produces it." The participants also see inequality as another problematic area. They believe developing nations can end up being bonded into "perpetual servitude" to countries such as China and America and also that there is a possibility of a new wave of imperialism. The danger as aptly put by the participants being that, "if inequality is allowed to continue, then the world will not come together as one and work together to solve global problems such as climate change." On the other hand, Thought Leaders believe weak policies and poor leadership are the major

drawbacks in the developing world so if these are addressed developing countries can move forward into 4IR without many problems. Group 1 is more optimistic. China and America were cited as the developed countries that are the major developers of the 4IR technologies that might abuse developing countries.

On Challenges all participants believe inequality will worsen in 4IR. Those who are 'digitally disempowered' are at risk of being further marginalized so the digital divide might widen. All participants also believe unemployment will be a major problem but they believe new jobs might be created but literature review poses otherwise, "The fourth industrial revolution seems to be creating fewer jobs in new industries than previous revolutions," (Schwab, 2016, p. 37). There will be societal consequences such as social strife, strikes, political unrest and so on as cited by some of the participants. These challenges were also a major issue in 1IR, as Falkus, (1987, pp. 85-86) explains,

> Periodic bouts of unemployment were a feature of industrial work from the beginning of the nineteenth century. Family ties were also changed by the industrial revolution as factories destroyed the family economies which had been part and parcel of the domestic system.

The participants believe lives will be changed but governments must find a way of managing the transition as those who are not part of it might be left behind. Group 1 TL seem to have some advice on how to be prepared for 4IR despite the challenges that society faces. All participants are aware of the challenges but they choose to be optimistic that they can be overcome.

On opportunities all participants believe business will be the major beneficiary in 4IR. Robots will make production more efficient as they do not get tired like human beings. New businesses will be created. Group 2 drew attention to opportunities that can be used for the greater good in 4IR that will benefit everyone like the use of technologies in medicine to find cures that benefit all, the uptake of some technologies even in marginalized societies such as the cellphone and the use of technologies to expose oppressive environments. They believe the challenges in 4IR can be utilized as opportunities eventually. Group 3 believe that if machines take over some of the work, it might shorten the working day which will allow men to go home early and help their wives with family responsibilities and also that they will be more time to engage in cultural activities. The Group also concluded that globalization has made the world to become almost one as now everything is interlinked and intertwined. The smartphone has made life easier for the people as they can do many transactions from anywhere.

Lastly on education implications, the participants believe universities and institutions of higher learning should invest in infrastructure for education to be in 4IR and should determine the resources needed to support students accordingly. Thought leaders further suggested that the curriculum should be evolved to ensure students are prepared with the skills and knowledge necessary to succeed by supplementing the old stuff with a lot of material that is more relevant. On pedagogy they believe 4IR will have a significant impact on both what is taught and how it is taught. They believe technology allows to tailor modes

of delivery. The participants also believe university management should be responsible in making sure lecturers are prepared for 4IR and they were sort of doing it at their university. Schwab, (2016, p.40), iterates, "…leaders need to prepare workforces and develop education models to work with, and alongside increasingly capable, connected and intelligent machines." They also believe that 4IR will change the way students learn and the way teachers teach and that lecturers should blend traditional models with new ones. The participants also believe technology has made the application process for university places easier as students could now apply for university places without setting foot on campus. The participants also said that Universities need to provide trainee teachers with technological and technical skills required by schools. On pedagogy they believe blended learning and online education will change the face of education and that robots will not be able to replace teachers .

They also concluded that there are certain drawbacks as universities do not have adequate financial resources to buy all the technologies required and also that some lecturers are technophobic and are unwilling to train. They also believe that the elite will continue getting quality education which will continue to increase inequality.

The main educational implications which came out were investing in infrastructure which will allow universities to tailor their modes of delivery accordingly. Changing the curriculum and implementing pedagogies that blend the old and the new. What came out also was that it was the responsibility of the university management to make sure lecturers are prepared to teach in 4IR. Students could now apply online for university places which made life easier. Drawbacks were inadequate funding for 4IR infrastructure, technophobia among some lecturers and an unwillingness to move with the times. *This answers the research question on implications for university practices*

Attitudes of academic leaders (University leaders and lecturers) at the University are that we are in the 4IR and it is a reality. They believe 4IR technologies should be viewed as opportunities to change people's lives. Although the technologies in 4IR are manufactured elsewhere, government should put measures in place to make the country move into 4IR. Despite all the challenges that confronts the country as a developing nation they believe visionary leadership and strong policies will mitigate the challenges. They fear that the country will be left behind if it does not move into the 4IR.

On education they believe the university should invest in infrastructure, change the curriculum and teaching models and offer adequate training to lecturers so that they are better trained for 4IR. From literature review, Rushby and Surry (2016, p.480) also advised on how schools can help, "Schools must consider the knowledge and efficacy needs of teachers and plan for training impact by providing appropriate technological, pedagogical and content professional development along with providing adequate time for teachers to plan, experiment and develop fluency with technology."

To sum up what came out from all the themes were five categories that kept recurring which are technology, societal consequences, inequality, industry innovation and labour issues. These categories led the research to conclude that 4IR is definitely an industrial

revolution as most of its features are on the analytical framework on FIG 2 in the research. The conclusion is technological advancement leads to industry innovation which creates labour issues that impacts society and exacerbates inequalities. The same happened in 1IR. Harteis, (2018, p.1) posits,

> The history of industrial development is also a history of technological, economic and societal changes which at each of their phases had crucial impacts on work-places and work practices. Most important driver always had been technological development that ended up in the invention of new machines that improved industrial production.

As pointed out by the author we cannot separate industrial development from technological development hence the reason why inventions of new machines made an impact on industrial production and the work-place. On the new invention that has driven 3IR into 4IR, Schwab, (2016, p. 3) specifies, “Three reasons, however, underpin my conviction that a fourth and distinct revolution is under way.” And he points out that the velocity, breadth, depth and the systems impact of the current technologies are unprecedented. (Schwab, 2016). Lastly, Psotka, (2018) points, “…we confront the future of this fourth industrial revolution with 3rd industrial mindset and 2nd industrial institutions.” This could be the reason why 4IR is in dispute and its timeline indeterminate.

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APPENDIX

In this section are the permission letters sent to academics and the interview questions.

Appendix 1

Interview Schedule

1. What do you understand by the term Industrial Revolution?
2. Are you familiar with the idea of the 4th Industrial Revolution? What is the 4th industrial revolution?

(Prompts: Technological aspects? Social aspects? Global aspects?)

3. (Assuming that the interviewee accepts that we are now in the midst of a 4th Industrial Revolution)

In brief what are the major technological inventions associated with each industrial revolution (1st – 4th).

4. When did the 4IR start and why do you think we are in the 4th industrial revolution?
5. Who stands to benefit most from the 4th Industrial Revolution?
6. Who has been affected or is going to be the most and still being affected by 4IR?
7. What are the implications of the 4th Industrial Revolution for the following?
    - People
    - Business
    - Developing countries
    - Education, esp. Higher Education

Appendix 2

Dear Registrar

My name is Barbara Maisiri. I am a student in the School of Education at the University of the Witwatersrand.

I am doing research on the idea of the 4th Industrial Revolution in the context of Higher Education in South Africa.

My research involves doing interviews on the understanding of the term 4th Industrial Revolution among selected academic leaders of the University. Each interview will take about 30 minutes.

Participants will be selected on the strength of previously articulated statements on the Fourth Industrial Revolution.

The research participants will not be advantaged or disadvantaged in any way. They will be reassured that they can withdraw from participation in this project at any time. There are no foreseeable risks in participating in this study.

The names of the research participants and their level of seniority, and the identity of the University division or department, will be kept confidential at all times and in all academic writing about the study. The individual privacy of participants will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

SIGNATURE

Appendix 3

INFORMATION SHEET FOR HEAD OF SCHOOL/LECTURER/MANAGEMENT

DATE:29/04/2019

Dear Participant

My name is……Barbara Maisiri and I am a student in the School of Education at the University of the Witwatersrand.

I am doing research on the term 4th Industrial Revolution.

My research involves doing interviews with academics (lecturers and university management)

The reason why I have chosen your school is because it is suitable for I what I am looking for
Would you mind if interview you and audiotape the interview?

Your name and identity will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-5 years after completion of the project.

You will not be advantaged or disadvantaged in any way. Your participation is voluntary, so you can withdraw your permission at any time during this project without any penalty. There are no foreseeable risks in participating and you will not be paid for this study.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

SIGNATURE