

1 Summary

The executive chairman of the World Economic Forum (WEF) said that ‘The fourth industrial revolution is not merely a series of incremental technological advancements, it is an upheaval – a dramatic and wide-ranging shift in the way that value is created, exchanged, and distributed across individuals, organizations, and entire economies’ (Schwab, 2016; Ally & Wark, 2020).

The 4IR is reshaping the globe at a rate that is far quicker than earlier revolutions. It is also having a greater influence on society and industry. We are currently witnessing extraordinary technology such as self-driving cars and 3D printing, as well as robots that can follow exact instructions. And hitherto unconnected sectors are combining to achieve unfathomable effects. It is critical to comprehend this new era of technology since it will significantly alter life during the next several years in this age of technological advancement.

In particular, one of the most significant findings is that 4IR technologies must be used responsibly and to benefit people, companies, and countries as a whole; as a result, the development of artificial intelligence, the Internet of Things, blockchain, and robotics systems will be advanced most effectively by grouping a multidisciplinary team from areas such as computer science, education and social sciences, ethics, privacy, and security.

The previous industrial revolutions had significant societal ramifications. Steam power and machines, as well as other innovations, have had a tremendous impact on transportation and agriculture throughout history. The 4IR technologies are making significant improvements in business and industry, and they are also having an impact on education. The education sector must make the transition to the 4IR age, or else the business sector will step in to fill the void left by the education sector. Teachers, students, and employees must become familiar with the many types of 4IR technologies in order to be able to perform successfully in the 4IR and contribute to the attainment of Sustainable Development Goals (SDGs). Far from being science fiction, 4IR technologies, including holograms and virtual interactions, are very much a reality (Mavrikios et al., 2019; Pates, 2020).

Schwab, in his book *The Fourth Industrial Revolution* (2017), defined the 4IR as ‘a range of new technologies that are fusing the physical, digital, and biological worlds, impacting all disciplines, economies, and industries, and even challenging ideas about what it means to be Human’. The power and varieties of digital gadgets, computer devices, and networks are continuously expanding owing to breakthroughs in the newest technical developments. This facilitates access to education and other forms of knowledge. The gradual growth of technology and scientific advances is resulting in the formation of new educational fields, which,

in turn, is resulting in additional changes. The 4IR is improving the opportunities for the creation and invention of new skills. The 4IR stresses the expansion of knowledge and the desire to study. Application-oriented courses are preferred over bookish education. Online social media platforms such as Twitter, LinkedIn, and Facebook are growing increasingly popular as a result of continual technological advancement. Through these social media platforms, anyone may readily communicate and promote their thoughts on any current issue or event in front of the world.

Land is not required for the construction of marketplaces. Online shopping sites and fast delivery services make commodities more accessible at home while also enhancing economic rewards. Customers are also given informed advice via online customer support representatives. The world is becoming a global village, with billions of people and things readily available. Progress in medical sciences, neurosciences, and other fields is leading to healthier lifestyles, enhanced intellectual and mental aptitude, and longer lifespans as a result of the 4IR. The 4IR has an impact on agriculture as well. Crop yields can be increased with the use of bioengineering. Measuring crop populations and detecting weeds or plant pests are also becoming more accessible with the assistance of robots driven by artificial intelligence. Herbicide application can also be done with robotic sprayers.

Carbon emissions, road deaths, and insurance costs are being reduced as a result of breakthroughs in car safety brought about by the 4IR's increasing technology. People no longer need to stand on the side of the road waiting for transportation; instead, they may reserve automobiles or vehicles online and have them brought to their house. Autonomous or driverless cars are also accessible as a result of the 4IR and will reach their peak as technology advances. People no longer need to go to banks for transactions or other critical tasks because of online banking. The majority of bank work may be done from home.

With all these positive impacts of the 4IR, there exist negative impacts as well. Human beings' willingness to use their own intelligence and physical strength is waning as a result of an over-reliance on technology. The use of social media is increasing the gap between a person and their family members, as well as between a person and the rest of society. The virtual world is becoming much more appealing than the actual world, which is causing a social rift to develop. Social media is not always beneficial since it is a platform for disseminating news, some of which may be fake. In the 4IR, individuals' privacy is no longer completely private, because of technical breakthroughs that have enabled tracking systems to be more accurate and efficient. Every action of a human being may be tracked using digital equipment

The Emerging Economies under the Dome of the 4IR

3

such as CCTV cameras, smartphones, and other similar gadgets. Social media platforms, such as Facebook, Twitter, and other similar platforms, as well as online shopping websites, such as Flipkart, Amazon, and other similar platforms, collect every piece of information about an individual, from their name and date of birth to their credit card or bank details, before allowing them to create a profile or account.

In addition to cyberbullying and hate speech, there are additional negative effects of social media that are steadily becoming more prevalent in the 4IR; because of the increasing improvement in internet connectivity, cyber assaults are also a possibility. However, it should not be forgotten that hacking is not always ethical and that it might have negative consequences for the overall security of people as well as of government institutions. Going to the market, jogging under the open sky, or visiting someone's house are examples of the activities that people find less appealing since technology advancements have allowed them to buy online, jog on treadmills, and communicate with others through social media, among other things. Because of the convenience of smart technology, children are more interested in mobile games than they are in outdoor games. This has a negative impact on human health, both physically and mentally, as the mobility of the human body and the intake of fresh air are both reduced as a result. Children's physical and mental development is being hampered by their excessive usage of smartphones and digital games.

Because of developments in automotive and robotic technologies, the breadth of work is being threatened. In the face of artificial intelligence, human abilities are becoming increasingly devalued. Machines are given preferential treatment over human beings. Constantly rising concentrations of wealth among a limited number of people are seen. Because of this, individuals are becoming economically and socially inequitable. Inevitable consequences of this include social disintegration, political division, and a loss of faith in institutions. One of the detrimental consequences of the 4IR is global climate change. Fast technological advancement, rising urbanisation, excessive deforestation, infinite resource depletion, desertification, rapid population expansion, water shortages, food insecurity, and other factors are interfering with the natural environmental balance of our planet. Population movement for greater opportunities and concentration in one location, while leaving another isolated, puts pressure on one area of the world while the other continues to grow at a slower pace than the first region. This results in environmental imbalance as well as unequal global development, which in turn results in social inequality throughout the world. Inequality is increasing, which may lead to disputes, societal tensions, and violent extremism.

The pace, size, and influence of change on the whole earth that has occurred as a result of the 4IR are unmatched in the history of humanity. The challenges and uncertainties associated with the current technological paradigm of human growth, as well as its societal costs, repercussions, and paradoxes, are all significant factors in human development. The development of new business models based on demand and supply information platforms, the strengthening of the State's control over society and individuals, a dramatic shift in the processes of the State's engagement with civil society, the growth of competition and decentralisation of power, the development of artificial intelligence – all of these can lead to considerable progress in the development and the degeneration of society. A positive trend in the development of society is achievable, provided that the State authorities are capable of adapting to the new conditions that have arisen as a result of the digital revolution.

2 Literature Review

In an increasingly technology-driven world of smart devices, quantum computing, and autonomous vehicles, significant changes are taking place which are challenging long-standing assumptions about the very nature of work and the roles that humans will play in the workforce of the future.

(Schwab, 2016)

While study into the future of work and workforce requirements is still in its infancy and evolution, available literature indicates that job activities, skill requirements, and labour pool composition will all change dramatically as a result of the present socio-economic developments. While past industrial revolutions were also marked by increased automation of job activities, the pace of change in the 4IR is unmatched.

The 4IR is a combination of emerging technologies that is shaping the way we live and work. The Internet of Things (IoT), cloud computing, big data, robotics, artificial intelligence (AI), 3D printing, augmented reality (AR), virtual reality (VR), nanotechnology, and biotechnology are the technologies that are gaining more prominence during the twenty-first century and are overlapping and fusing with one another in this age of innovation. The emerging and developing economies as compared with developed countries have been lagging behind in terms of adoption of the technologies and embracing the 4IR fully.

Specifically, the 4IR proposes a technique to generate a change from machine-dominated to digital production contingent primarily on the overlapping of a plethora of technologies. Because the implementation and applications of related theorems and definitions outlined for the 4IR are not yet mature

The Emerging Economies under the Dome of the 4IR

5

enough for the majority of real-life implementations, a systematic approach for conducting appropriate assessments and evaluations appears to be urgently required for those countries, industries, societies, establishments, and institutions that wish to accelerate this transformation and adopt it in a significant manner to be fruitful and gainful.

The 4IR scenarios that are well defined, as well as technical infrastructures which include physical systems and management models, are now the primary responsibility of the research community in order to simplify the lives of practitioners. The following seven areas are believed to be vital for the improvement of the industrial sector around the world:

- digital technology, virtualisation, and the IoT
- additive manufacturing (3D printing)
- automation, robotics, AR, VR
- composites, novel materials, and assembly
- controlling and monitoring situations
- human aspect in manufacturing facilities
- efficient and sustainable use of energy.

Despite the fact that many of these breakthroughs are still in their infancy, they are already approaching a critical juncture in their evolution as they build on and magnify one another through the integration of technologies from the physical, digital, and biological worlds. Securing the full economic and social advantages of innovation will be critical to re-establishing a more stable economy and stimulating economic growth and productivity in the future. Unleashing innovation will also help us to address some of the most important issues facing the world today, such as climate change, cybersecurity, and public health, among other things. To achieve these goals, it will be necessary to establish policy frameworks that are fit for purpose and in which innovation may flourish while also ensuring safety, quality, and efficiency. While the profound uncertainty surrounding the development and adoption of emerging technologies means that we do not yet know how the transformations driven by the 4IR will unfold, their complexity and interconnectedness across sectors imply that all stakeholders of global society – governments, business, academia, and civil society – have a responsibility to collaborate to better understand the emerging trends.

Klaus Schwab said,

The world is experiencing an economic and political upheaval that will continue for the foreseeable future. The forces of the Fourth Industrial Revolution have ushered in a new economy and a new form of globalization,

both of which demand new forms of governance to safeguard the public good. Whether it will improve the human condition will depend on whether corporate, local, national and international governance can adapt in time.
(Schwab, 2018b)

Shared understanding is especially important if we are to construct a collaborative future that reflects shared goals and values. We need a comprehensive and internationally shared understanding of how technology is affecting our lives and the lives of future generations, as well as how it is redefining the economic, social, cultural, and human context in which we live.

3 Introduction

The rise of the 4IR in the emerging economies will profoundly transform the nature of competition and how a country's performance will be measured (Schwab, 2016). Faced with the challenge of becoming data colonies and not data giants, emerging economies stand on a unique cornerstone of opportunity to bypass the conventional laws of competitiveness and leapfrog into the twenty-first century, leading the way to a more equitable form of economic development, under the dome of the 4IR.

The term *Fourth Industrial Revolution*, abbreviated as 4IR or *Industry 4.0*, was coined by Klaus Schwab, founder and executive chairman of the WEF. He describes those individuals in the 4IR who move between digital domains and offline reality with the use of connected technology to enable and manage their lives (Miller, 2016). The adoption of the digital world has created a fusion of technologies, which makes it difficult to achieve clear-cut segregation of physical, digital, and biological spheres (Schwab, 2015).

As we speak, the 4IR is already underway, one that will be unlike any other that has come before. The 4IR or Industry 4.0 is an amalgamation of various cutting-edge technologies, disruptive in nature and trends, which are transforming the current and developing the new living and work environment that will, in turn, shape the world. The speed of technological breakthroughs, the rate at which the fusion of technologies is taking place, the pervasiveness of the scope of the 4IR, and the cascading impact on the living and work environment will impact the future of work and businesses. As with the previous industrial revolutions, along with economic growth it brings upheavals in the work environment, societal denials and apprehensions, challenges of governance and policies, and a sense of despair in low-skilled workers.

The 4IR opens up windows of opportunity for the emerging countries and it is yet to be seen how effectively this is embraced by the developing and emerging

The Emerging Economies under the Dome of the 4IR

7

nations – who do not want to lag behind their counterparts, the developed nations, on the path of growth – to reap the benefits of this industrial revolution and foster their economic growth as well as leapfrogging ahead on the trajectory of development.

Technological breakthroughs are being made at a rate that has never been seen before and are touching every industry all over the world (Ægisdóttir, 2016). This technological journey will surely raise red flags about the challenges likely to be encountered in embracing the technologies and impact on societal levels, including work environment, jobs security, and the interaction between pivotal players like policymakers, technocrats, corporate and business houses, and employees.

For the first time, unlike in previous industrial revolutions where technology worked alongside people to improve human activities and make them more productive, ‘Industry 4.0 represents a paradigm shift that, albeit partially, is not limited to working alongside but in certain activities replaces human beings’ (Senate of the Italian Republic, 2017).

We are on the cusp of a technology revolution that will drastically transform the way we live, work, and interact with one another in the coming years and decades. This transition is unprecedented in terms of its extent, scale, and complexity, and it is unlike anything else humankind has ever witnessed. No one knows exactly how it will evolve, but one thing is certain: the reaction must be coordinated and comprehensive, bringing together all players in the global political system, from the public and corporate sectors to academia and civil society.

The 4IR possesses three characteristics that distinguish it from all preceding revolutions. These traits are as follows:

- i. *Rate*. The rate at which contemporary innovations are occurring has never been seen before in history. In contrast to earlier revolutions, the 4IR is growing at an exponential rather than a linear rate. To put things in perspective, it took 119 years for the spindle, a symbol of the First Industrial Revolution, to reach Europe, but the Internet reached every corner of the globe in less than a decade. Aside from that, 1.3 billion people, or 17 per cent of the world’s population, are still without access to electricity, which was the cornerstone of the Second Industrial Revolution, and 4 billion people, or a whopping 52 per cent of the world’s population, are still without access to the Internet, which is a major concern. The 4IR, on the other hand, took only a little more than three years to successfully infiltrate every element of our daily lives.
- ii. *Fusion*. The 4IR builds on the digital revolution and brings together a variety of technologies, creating a fusion that is causing enormous paradigm transformations in the economy, industry, society, and governance. It is not only altering

the ‘what’ and ‘how’ of things, but it is also altering ‘who’ we are. Infinite possibilities exist as a result of billions of people being linked through mobile devices that have unparalleled computing power, storage capacity, and access to information. And new technological developments in disciplines like AI, robots, the IoT, autonomous cars, 3D printing, nanotechnology, biotechnology, materials science, energy storage, and quantum computing will multiply these possibilities even further.

- iii. *Penetration.* In contrast to its predecessors, the 4IR is not only affecting specific sectors of industry or commerce, but is also affecting entire systems, both across and within countries, industries, and society as a whole. The 4IR is penetrating all the domains – physical, digital, and biological – and all the sectors. Artificial intelligence is already all around us, in everything from self-driving vehicles and drones to virtual assistants and software that translates or invests in foreign currencies. In recent years, significant advances in AI have been achieved, fuelled by exponential growth in processing power and the availability of large amounts of data. These advancements range from software used to identify new pharmaceuticals to algorithms used to forecast our cultural preferences. The biological environment is always engaging with digital manufacturing technologies, which are in a constant state of flux. The fields of computational design, additive manufacturing, materials engineering, and synthetic biology are being combined to create a symbiotic relationship between microorganisms, our bodies, the products we eat, and even the buildings we live in, according to engineers, designers, and architects.

This Element is the result of a research project that has used largely qualitative data from a review of relevant literature. The research study was used because the focus of the study is more on description and explanation rather than prediction (Merriam, 1988).

4 Evolution of Industrial Revolutions and Fusion of Technologies in the 4IR

The term ‘revolution’ refers to a period of sudden and drastic change. History has witnessed revolutions when new technology and fresh ways of viewing the world caused a significant shift in the functioning of economic systems and social structures. Industry 4.0 was coined for the first time publicly in 2011 by a group of professionals from diverse professions. The German federal government endorsed the concept of a ‘High-Tech Strategy for 2020’. A working group of specialists was organised to give more guidance on the concept’s applicability, functioning, and implementation.

The Emerging Economies under the Dome of the 4IR 9

Industry 4.0 is also referred to as the Fourth Industrial Revolution, and it is built on the ‘Internet of Things and services’, following mechanisation (Industry 1.0), mass production (Industry 2.0), and automation (Industry 3.0). The IoT is already ingrained in manufacturing in developed countries, particularly in sophisticated manufacturing and service industries such as automobile manufacturing, aircraft manufacturing, insurance, logistics, and also the communications industry (Haller et al., 2008; Bandyopadhyay & Sen, 2011; Rüßmann et al., 2015; Trappey et al., 2017; Hofmann & Rüsç, 2017; Witkowski, 2017).

4.1 Evolution of Industrial Revolutions

The *First Industrial Revolution* was characterised by the transition of hand production methods to mechanised factory systems leading to mass production of goods, textile manufacturing, and the development of roads and canals for transport. It was fuelled primarily by the use of steam engines in locomotives, ships, and machines in factories. It is James Watt who holds the credit for improvements in the development of the steam engine during this period. The First Industrial Revolution began in the late eighteenth century in Britain, soon spreading to continental Europe and the USA, and ended in the mid-nineteenth century. Following the introduction of the steam machine into industries, labour transitioned from being entirely manual to being primarily machine-based. Cotton spinning machines were introduced into textile mills. It wasn’t until 1819, when the Cotton Mills and Factories Act was passed, that things began to calm down significantly. Many factory acts followed, giving workers more rights.

The *Second Industrial Revolution* was characterised by massive steel production, electrification allowing assembly line and mass production in manufacturing methods, and large-scale laying of railroads leading to cheap and fast transportation. The primary focus was on steel production, automobiles, electrification, chemicals, and petroleum. In a nutshell, the second revolution was the outburst of steel, chemicals, electricity, and petroleum. The Second Industrial Revolution began in the late nineteenth century and the beginning of World War I marked its end. In this period of history, Henry Ford, the founder of Ford Motors, is credited with being the first to introduce the assembly line to the globe. As a result, there was a significant rise in output, and assembly lines were soon found in practically every industry.

The *Third Industrial Revolution* started in the mid-twentieth century and was characterised by the use of electronics, computers, and digital machines, leading to the world of automation and digitisation, the discovery and use of nuclear energy, explorations in outer space, and the invention of the Internet,

marking the breakthrough of a new era of industrialisation. It brought forth the digital revolution and significant advancements in telecommunication, biotechnology, outer space, and automobiles. This is where the automated assembly line became a reality and machines increasingly started replacing people on the factory floor (Ægisdóttir, 2016).

The *Fourth Industrial Revolution (4IR or Industry 4.0)* already started emerging at the turn of the twenty-first century, overlapping with the Third Industrial Revolution and building upon it with advancements in several domains. The 4IR is a fusion, an amalgamation of technological breakthroughs in AI, AR, VR, nanotechnology, robotics, 3D printing, ADP (Advanced Digital Production), and the IoT. As it has been put aptly by someone, ‘The 4IR is a way of describing the blurring of boundaries between the physical, digital and biological worlds’ (McGinnis, 2020). The 4IR or Industry 4.0 is rewriting the rules of manufacturing, infrastructure developments, domestic reforms, and trade liberalisation in order to keep pace with the changing times.

4.2 Fusion of Technologies in the 4IR

The 4IR is not a single technology driving the revolution but is a cluster of different technologies that are de facto agglomerated by technological leaders, pivotal users, system integrators, and government policymakers (Martinelli et al., 2019). It is clearly a complex fusion of technologies all connected by cloud-based internet (see Figure 1).

Under the overall domain of the 4IR are some of the cutting-edge technologies that will shape the future impacting tremendously the way of functioning of businesses and the governments and how the individuals and the societies live, work, and interact with each other and the environment. A few such high-end technologies are AI, big data, the IoT, robotics, VR, AR, 5G, and deep learning (DL). The relevance of these technologies in the 4IR is touched on very briefly below:

- i. *Internet of Things (IoT)*. One of the most important developments in the 4IR, the IoT is a natural extension of prior levels of connectivity achieved by the Internet to include physical objects and systems. The IoT consists of digital technologies, sensors, communication modules, and software applications which enable everyone to integrate digitally and bring everyone onto the digital platform. It delivers readily available information at your fingertips, which saves uptime and provides the most accurate information. The IoT entails devices with self-identification capabilities, localisation status, data acquisition, and implementation, which are connected via standard