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India, the Fourth Industrial Revolution and Government Policy

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Abstract: ***The fourth Industrial Revolution (also called Industry 4.0) has a potential to bring about changes, which could be called "revolutionary". The earlier Industrial Revolutions were in ages when time and technologies moved more slowly especially across boundaries. Now, the gap for transfer of technologies from one point of the globe to another has dropped. Technology and innovations such as artificial intelligence and 3D printing are spreading more quickly and becoming ubiquitous. The world governments, particularly in the U.S, the European Union, and China, are backing the private sector where the innovation and investments into latest, ground breaking technologies are taking place. The governments are working to provide an environment to take advantages of the developments as well as to safeguard their economies against potential misuses. The article examined some of the developments related to the Fourth Industrial Revolution in India and across the globe. The article reviewed available literature to understand what some of these benefits could be, and what some of the pitfalls are. Given the huge potential impact, the paper sought to examine what the various stakeholders can do to respond and make the India better prepared and quicker to adapt to gain the benefits. The article attempted to evaluate whether the government and stakeholders are ready to receive the latest technologies in India and what steps can be taken to create an enabling environment to ensure that the Fourth Industrial Revolution is not another missed opportunity.***

Keywords: artificial intelligence, cyber physical systems, data protection and privacy, fourth industrial revolution

1. Introduction

It is necessary to understand the term Fourth Industrial Revolution (4IR) and Industrial Revolution (I4.0) and what they have in common and where they differ. The phrase Fourth Industrial Revolution appears to have been coined by the World Economic Forum in 2016 (schwab, 2016a) and is in umbrella term used to cover the fusion on "convergence" (Cunningham, 2018) of different technologies which have emerged almost together in a number of fields such as artificial intelligence internet of things(IoT), addictive manufacturing (also called 3 D printing), and in bio-technology along with the expected coming of 5G or ultra high speed wireless technology, and many others.

The term Industry 4.0 was coined in Germany in the context of the integration of several breakthrough technologies in the manufacturing sector, including cyber-physical systems, smart manufacturing, the internet of things and cloud computing, among others (Cunningham, 2018)

Author and Technology strategist Bernard Marr stated that it does not matter which term is used and summarized that the Fourth Industrial Revolution or Industry 4.0(both) "represent the combination of cyber-physical systems, the Internet of Things, and the Internet of Systems" (Marr,2016, pare 2).

For the purpose of this article, we will use these two terms alternately and without formal demarcation unless the context so requires.

While both terms have now gained common usage, as late as June 2015, a Mckinsey article commented that, "mention Industry 4.0 to most manufacturing executives and you will get raised eyebrows" (Baur and Wee, 2015, para1)

The beneficial elements of these sets of technologies have been predicted by several scholars and practitioners, and some of these benefits are already visible and several more of these appear to be highly probable.

New technologies have always been seen as threats. We are still wary of genetically modified (GM) food, in spite of the known benefits it has brought to agriculture. Even the advent of CNC machine was seen as a threat with strikes and disruption announced by workers and unions anticipating large-scale job losses. Even today, the advantages of mechanization of the textile industry are contrasted with the loss of livelihood of skilled weavers and craftmen who have been making intricate silk sarees in India since generations.

On the other hand, there are also "jarring effects" (Johnston, Swith and Irwin, 2018,p 4). There is the availability of destructive power in the hands of a lay person (a 3 D printed rifle was available in 2013) (Greenberg, 2013a) and in the hands of governments (U. S. Army fired a 3 D printed grenade launcher in 2017) (Hodgkins, 2017).

The stakeholders to these momentous developments include the Government of India (GoI), public policy makers and elected representatives (law makers), the regulators the private sector and association of employers, the employees and Union, and society at large. The need is for all stakeholders to collaborate and create an enabling environment under the benign, but watchful eye of the government.

The President of India, Mr. Ram NathKovind put it succulently, "We live in the age of the Fourth Industrial Revolution, throwing up both opportunities and challenges which requires us to design strategies for the future" (Kovind, 2018, p.2).

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2. Objectives

The Fourth Industrial Revolutions (4IR) or the Technology Revolution as this paper calls it is predicted to have more far reaching effects than any of changes the world has seen in recorded history. From the invention of the wheel to the creation of the world wide web, most revolutionary changes have been linear, progressive, and largely singular (one major change at one time). The 4IR is special for its simultaneous focus on several different technology revolutions happening almost simultaneously, and at great speed. Nations have to be prepared for these changes. This paper focuses on what the Government of India and other stakeholders can or should do to take fuller advantage of the ongoing technologies changes.

3. Review of Literature

There exists a large volume of literature about the Fourth Industrial Revolution and industry 4.0. These are by way of books, newspapers, journals, and online articles, research papers by scholars, companies publishing their accomplishments, consulting companies preparing briefs to update clients, and by governments publishing discussion papers. Most of this literature is available in print, online, and in videos. Even as we were writing this paper, newer development have been published continually, extending the library of knowledge already available.

"Industry 4.0" was first unveiled by German researcher at the Hannover Fair in 2011 to herald the revolution to come wherein different advanced technologies would come together in industrial production by integrating and optimizing all the stages of production for improved efficiency (Schwab, 2016b).

These sets of technologies include artificial intelligence (AI), the Internet of Things (IoT) additive manufacturing or 3 D printing, big data, cloud computing, smart manufacturing, wearable devises, cyber physical systems, autonomous cars, amongst others (Schwab, 2016b).

The First Industrial Revolution got underway with steam power, stem engines, and railways moving activities from muscular power to mechanical power. The Second Industrial Revolution saw the boost towards large factories and mass production with the wider availability of electricity. The Third Industrial Revolution saw the world benefit from computational power and the subsequent creation of the World Wide Web.

There is evidence that India was probable the world's largest economy and contributed almost 25% of the world's GDP around the 17^{th} – 18^{th} century, thereafter rapidly decreasing (World Economic Forum, 2017). Today the gap between the nominal GDP of the first ranked U.S. ($19.42 trillion) and India at sixth rank ($2.45 trillion) is almost eight times and this is huge considering that India's population is about three and a half times that of the U.S. (Chakravarty, 2010).

Now the 4 IR is here, and as Klaus Schwab, the then President of the World Economic Forum said, "In its scale, scope and complexity … the Fourth Industrial Revolution is unlike anything humankind has experienced before." (Schwab, 2016b,p.7). He goes on to predict that the 4IR would change the way people live, work, and interact with one another.

The current Industrial Revolution is not about one specific new invention, say, the wheel or steam power. It is about a set of technologies simultaneously evolving and becoming available and with each technology building on the power of the others. This is the new "Technology Revolution", with the innovations developing in parallel. Along with massive increases in computational power and the imminent launch of 5G wireless technologies, we are poised to witness a profound change. Probably, the most powerful of these technologies is artificial intelligence (AI). The expression was first coined in 1956 by John McCarthy of MIT, the father of the discipline (Childs, 2011). Artificial Intelligence (AI) applies advanced analysis and logic-based techniques (Garter 2017a) to perform tasks commonly associated with intelligent beings (Copeland, 2019).

Just a few year back in 2006, AI was called a "nebulous" subject and there were question marks on what it had achieved. According to Smith (2006), significant AI breakthroughs have been promised in 10 years for the past 60 years. However, with increased computing power, advanced algorithms and increased data volumes, artificial intelligence has finally come into its own. Today, AI is considered the "alpha" of all technology trends (Aggarwal, 2018). A Wharton- World Economic Forum joint study called this the golden age of artificial intelligence (Knowledge@Wharton, 2017). Today AI is already all around us with Amazon's Echo and Google's Home bringing these technologies to the drawing room. By its nature, AI is data intensive. We now have "dataists" whose world view is that data is everything and harnessing that through AI or machine learning is the only way forward (Harari, 2016).

Some examples shows the power of AI

- Diagnostic equipment can spot skin cancer as accurately as a human doctor, artificial intelligence was trained using an image database of 129,000 images (Burgess, 2017).
- "Drishti" is an AI based solution to help the visually challenged enhance their productivity (Accenture, 2017)
- 3D printing (also known as additive manufacturing) is being used with great benefit to customize medicine prosthetics and implants and fabricate living tissues (Ventola, 2014)
- India's first smart factory, where machines communicate amongst themselves, is coming up in Bengaluru at the Indian Institute of Science (IISc) Centre for Product Design and Manufacturing (CPDM) in collaboration with Boeing (Kumar, 2016)
- Wipro, one of the pioneering Indian software companies, has developed its own AI system and named it Holmes and is in competition with IBM's AI system, Watson. (IBM's Watson is named after its founder Thomas Watson, and Wipro's Holmes stands for "Heuristics and Ontology- based Learning Machines and Experiential system"; so neither is considered a reference to the fictional characters) (John, 2014). Holmes is aimed at

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applications like insurance claim frauds to improving productivity in engineering drawing (Wipro, 2018).

- U.S. giant General Electric's India operations have invested USD 200 million to create digitally interlinked supply chains, distribution networks and servicing units as a par of an intelligent ecosystem (GoI,2017)
- 3D printing is giving customizable footwear for our athletes with their names being factory printed (Nike, 2017)
- Deep learning experts at Siemens Corporate Technology are developing an intelligent traffic management solution based on artificial intelligence around the Electronics City in Bengaluru. The processing takes place at the intersections itself (Siemens, 2018).
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The need for caution

Scientists and technologist (this paper call them "technology intellectuals") have at the same time sounded a note of caution. Artificial intelligence is also often cited for potential of its misuse.

Legendary physicist Professor Stephen Hawking stated that, "Success in creating effective artificial intelligence could be the biggest event in the history of our civilisation. Or the worst. We just don't know"

Microsoft founder Bill Gates added that we should be "very careful about artificial intelligence… if I had to guess at what our biggest existential threat is, it's probably that. With artificial intelligence, we're summoning the demon" (Should we be worried about artificial intelligence?, 2017, para 6).

Noted technology investor Elon Musk agrees, "I'm increasingly inclined to think that there should be some regulatory oversight, may be at the national and international level, just to make sure that we don't do something very foolish" (Gibbs, 2014, para3).

Technology writer Katharine Dempsey is more specific when he says, "A healthy modern democracy requires ordinary citizens to participate in public discussions about rapidly advancing technologies"(Dempsey, 2017, para 3).

Some examples of the potential misuse or malicious use of AI are given below:

- The first 3D printed gun was available from2013, with designs freely available on a website (Greenberg, 2013b). Aided by the availability of Open Source software, 3D printer costs have come down (Ventola, 2014).
- We know that soldiers sitting in one location can remotely fly an unmanned drone over an "enemy" location and release a bomb with pinpoint accuracy using AI technology, which is only a generation or two removed from that of an advanced video game (Betz, 2017).
- The news from China is that advanced technology is being used to harvest data and contracts from phones for action against suspected terrorists (Johnston, 2018; Li and Cadell, 2018)
- In a major collaborative work, researchers from several universities put together a comprehensive report on "Malicious use of Artificial Intelligence". The report pointed out that less attention has been paid to the potential malicious use of AI and listed security threats from three domains, namely digital security, physical security, and political security. For example, they predicted that changing a few pixels at a traffic signal could cause autonomous cars to crash (Brundage et al,. 2018). While autonomous cars may not be a reality, the technology to disrupt the car already exists.
- In an experiment, researchers hacked into and tampered with a few lines of code and then using 3D printing installed the faulty part on a drone, which then malfunctioned and crashed. The experiment was designed to show how malicious manipulation of 3D blueprints can lead to mechanical failure (Johnson, 2018).

The fear of jobs

The one scare most often quoted is of artificial intelligence taking over jobs. There is large body of research on what jobs have been or will be lost to automation of artificial intelligence.

An OECD study predicted that 50% of all jobs are vulnerable (A study finds nearly half of jobs are vulnerable to automation, 2018). Other research studies have shown that these fears may be overblown. Garter's latest study predicted that AI will create 2.3 million jobs and eliminate only 1.8 million jobs (Garter, 2017b).

Take one example. The world is moving toward electric vehicles (EV) and so is India, where the government at one time proposed to switch over To EVs from 2030 (India to sell only electronic vehicles by 2030; Piyush Goyal,2017). Practical difficulties may have pushed the deadline. Now, research by German institute for industrial engineering predicted that the EV push threatens 75000 German auto industry jobs since EV power trains have only a sixth of the components when compared to combustion-engine variants, which means EVs can be assemble more quickly (Wissenbach, 2018)

4. Global and Indian Responses

The role of the government is both proactive in keeping the legal framework updated and prevent loop holes from being exploited and reactive (enforcing the law) (Johnston et al., 2018). While professing a market economy and benefiting from private sector investments and successes in high technology areas, the U.S. and European countries have also adopted policies which provide opportunities to the private sector. Government such as Germany have been pioneers, for example, in nudging 4.0 (or "Industry 4.0" in German) forward (UNIDO, 2018).

China appears to be aggressively investing AI and "has called for an AI industry worth hundreds of billions over the next few years and the government has challenged Chinese

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AI researchers to surpass their international counterparts by 2030" (Knight, 2018, para 10).

Governments of countries like U.S., France, China, the UK, and Japan have released policy and strategy papers on artificial intelligence. Some governments already have dedicated departments such as the UAE Council for Artificial Intelligence (Zacharias, 2018); the United Kingdom has set up an AI council with some distinguished members (UK Government, 2018). India too announced the development of a National Strategy for Artificial Intelligence, where the goal has been articulated as the optimization of social goods rather than maximization to top-line growth (NitiAayog, Government of India, 2018).

India's draft of Personal Data Protection Act is in circulation to regulate the way data can be accessed and used be technology companies and make it possible to analyze data in a responsible way to boost artificial intelligence based innovations. Against, what is equally important as good policy and regulations is the speed of action. With countries like the U.S., European Union, and China surging ahead, India cannot afford the postponement of these initiatives.

Countries have realizes that the largest amount or raw data lies in government records or within government control. In the U.S., a senior official said that the government is looking for ways to open up data with the federal government to researchers in artificial intelligence."Anything that we can do to unlock government data, we're committed to" MS Mash, 2018, para 2).

5. Conclusion

This study is a generalized and conceptual study on what government of India and other stakeholder can undertake in a wider variety of area. The current Industrial Revolution is not about one specific new invention, say, the wheel or steam power. It is about a set of technologies simultaneously evolving and becoming available and with each technology building on the power of the others. This is the new "Technology Revolution", with the innovations developing in parallel. Along with massive increases in computational power and the imminent launch of 5G wireless technologies, we are poised to witness a profound change. The world governments, particularly in the U.S, the European Union, and China, are backing the private sector where the innovation and investments into latest, ground breaking technologies are taking place. The governments are working to provide an environment to take advantages of the developments as well as to safeguard their economies against potential misuses.

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