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The Fourth Industrial Revolution (I4.0) in India: Challenges & Opportunities

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1. INTRODUCTION

The fourth industrial revolution as it is called, is emerging globally as a powerful force and is being touted as the next industrial revolution. It is characterized by the increasing digitization and interconnection of products, value chains and business models. Industry 4.0 is driven by an amalgamation of emerging technologies like data volumes, computational power, Internet of Things (IoT), business analytics, augmented reality, artificial intelligence, elemental design, simulation, advanced robotics, additive manufacturing, sensor based technologies and cyber-physical systems. Industry 4.0 would mean the convergence of real and virtual worlds - the next phase in bringing together conventional and modern technologies in manufacturing. This will result in the "Smart Factory", which is characterized by versatility, resource efficiency, ergonomic design and direct integration with business partners for manufacturing.

As manufacturing today is cutting edge and requires a high level of skill. Today, the global manufacturing sector is undergoing a structural transformation. Though India banks heavily on its Service Sector for growth, the Manufacturing Sector needs to play a significant role in the Indian economy. Manufacturing now needs to fuel the high growth in India. Government of India launched the 'Make in India' program to place India on the world map as a manufacturing hub. The Manufacturing Sector especially MSMEs play a pivotal role in the Indian economy and provide the largest share of employment after agriculture. In order to converge the aims of growth with employment it is important to increase the share of manufacturing in the country's Gross Domestic Product from 16% to 25% and to create 100 million additional jobs by 2022. Digital connectivity forms the backbone for adoption of advanced technologies required for industrial revolution. With increasing penetration of the internet in India and emergence of e-Commerce, presence of enterprises on the internet has become inevitable. Ensuring comprehensive broadband connectivity in industrial clusters, Government of India has launched Digital India Program with a vision to transform India into a digitally empowered society and knowledge economy by adopting I4.0.

2. From I1.0 To I4.0 - The Evolution of The Connected Ecosystem:

The first industrial revolution was triggered by water and steam power to move from human labor to mechanical manufacturing. The second industrial revolution built on electric power to create mass production. After seeing constant progress on the back of mechanisation, electrification and the advent of the assembly line over two centuries, the global manufacturing industry adopted information technology in the 1960s, when computers came into the forefront of development, simplifying human effort. The third industrial revolution used electronics and information technology to automate manufacturing. The fourth is the current trend of automation and data exchange in manufacturing technologies. From then to now, both operational technology and information technology have come a long way, unleashing a vast plethora of possibilities on the factory floor through I4.0.

1st Industrial Revolution (mid- 1780s) Mechanisation: Mechanisation driven by steam engines and water. The first mechanical loom was invented in 1784.

2nd Industrial Revolution (mid 1870s) Electrification: Assembly line led mass production with the use of electrical

energy. The first conveyor belt was set-up by Cincinnati slaughterhouse in 1870.

3rd Industrial Revolution (mid 1960s) Automation: Information technology led automation as computers were developed to simplify various tasks. The first programmable logic controller was invented in 1969.

4th Industrial Revolution (2011) Cyber Physical Systems: While Industry 3.0 focused on the automation of single machines and processes, Industry 4.0 focuses on the end-to-end digitisation of all physical assets and integration into digital ecosystems with value chain partners. Generating, analysing and communicating data seamlessly underpins the gains promised by Industry 4.0, which networks a wide range of new technologies to create value.

3. Industry 4.0 is Driven By:

3.1 Digitisation and Integration of Vertical and Horizontal Value Chains:

Industry 4.0 digitises and integrates processes vertically across the entire organisation, from product development and purchasing, through manufacturing, logistics and service. All data about operations processes, process efficiency and quality management, as well as operations planning are available real-time, supported by augmented reality and optimised in an integrated network. Horizontal integration stretches beyond the internal operations from suppliers to customers and all key value chain partners. It includes technologies from track and trace devices to real-time integrated planning with execution.

3.2 Digitisation of Product and Service Offerings:

Digitisation of products includes the expansion of existing products, e.g. by adding smart sensors or communication devices that can be used with data analytics tools, as well as the creation of new digitised products which focus on completely integrated solutions. By integrating new methods of data collection and analysis, companies are able to generate data on product use and refine products to meet the increasing needs of end-customers.

3.3 Digital Business Models and Customer Access:

Leading industrial companies also expand their offering by providing disruptive digital solutions such as complete, data-driven services and integrated platform solutions. Disruptive digital business models are often focused on generating additional digital revenues and optimising customer interaction and access. Digital products and services frequently look to serve customers with complete solutions in a distinct digital ecosystem.

4. Industry 4.0 Key Technologies:

I4.0 brings together technology forces such as Internet of Things (IoT), cloud computing, big data analytics, additive manufacturing, Augmented Reality (AR), robotics, cyber security and Machine-to-Machine (M2M) communication. While some of these digital technologies are already in use in industrial applications, some others are still not ready for application at scale. Manufacturers need to carefully pick the right mix of technologies that would maximize returns on investment.

4.1 Internet of Things (IoT): IoT enables real-time machine–machine interaction by connecting them over a network and help establish a connected value chain

4.2 Big Data Analytics: Data analytic capabilities to support intelligent and real time decision making

4.3 Augmented Reality: AR could enhance business operations by leveraging mathematical modeling, AI and virtual reality

4.4 Cyber Security: Cyber security helps establish secured communication protocols to ensure data security

4.5 Cloud Computing: Cloud computing offers a platform equipped with vast computational, storage and networking capabilities, which would facilitate the interaction amongst various technologies

4.6 Additive Manufacturing: Additive manufacturing helps production in small-batches in a cost-and-time-effective way, by reducing the lead time from product designing to product release and improves customization

4.7 Robotics: Inter-connected robots to facilitate the automation of manufacturing processes, helping improve efficiency

4.8 M2M: Machine-to-Machine involves the use of industrial instrumentation and sensors to record and communicate data directly with software.

5. Current Status of Industry 4.0 in India:

Globally, the I4.0 market is expected to reach INR 13,90,647 crore by 2023.1 Countries such as the U.S., China, Japan and European nations like U.K., Ireland, Sweden and Austria all have started adopting I4.0. In India, the sixth-largest manufacturing country, the manufacturing sector forms an integral part of the country's long-term vision as seen by the government's strong focus on the 'Make in India' campaign. The government aims to augment the share of manufacturing in GDP to 25 per cent from the current 17 per cent, by 2022. A number of initiatives and policy reforms, such as implementation of the GST (Goods and Services Tax) and easing FDI policy have been taken by the government.

At present, India lags its global peers in I4.0 adoption. A significant portion of the Indian manufacturing sector is still in the post-electrification phase with use of technology limited to systems that function independently of each other. The integration of physical systems on cyber platforms, the basic premise of I4.0, is still at its infancy. Furthermore, the Micro, Small & Medium Enterprises (MSME) segment has very little access to automation technology due to the high cost barrier. The current scenario of I4.0 implication in India can be summoned by following way:

1. Non-awareness of the technology
2. Systematic approach towards modernization.
3. Non-Willingness to adopt the new technologies
4. Availability of Cheap labor initiates reluctance to adopt automation
5. Volume of products is not very high so as to adopt the automation increases ROI for the investments.
6. Non availability of skill set to adopt the Automation.

6. Role of Government:

The Indian government assumes the role of a critical stakeholder in Industry 4.0 revolution. Putting the Indian MSME sector at the forefront of the fourth Industrial revolution will need significant push in terms of funds, infrastructure, technical knowhow and exposure- areas

where the government's intervention can make a significant impact and make the benefits of Industry 4.0 accessible to the bottom of the pyramid. Furthermore, the government's role in India's Industry 4.0 story goes much beyond just enabling the MSME segment. Given the strong role of advanced technology in Industry 4.0, there is also a need to demystify the core skill requirements of Industry 4.0 through education and enablement. Best practices from nations that have succeeded with Industry 4.0, such as Germany, show that the government has a strong role to play here too by mandating relevant curriculum in educational institutes as well as in the vocational training infrastructure. Partnering with the industry, the government can use its vast research infrastructure to encourage innovation and learning around Industry 4.0.

The role of the government as a facilitator is not only to extend support to the manufacturing sector, but also take reformative steps to encourage wider adoption of technologies. Taking cues from countries such as Germany, the government could propose a proper regulatory framework, develop competitiveness and form conducive policy environment for an enabling I4.0 ecosystem in the country. The government can also play a crucial role to encourage employment and bridge the skill gaps for successful implementation of I4.0. There is a heightened for the government in making sure that I4.0 is accessible to the MSME segment – the segment of India Inc. that comprises some 60 million enterprises and contributes to 45 per cent of the country's total manufacturing output.

6.1 As Enabler:

- Encourage, promote and support original research aimed at developing technologies in emerging areas
- Mandate an industry-oriented curriculum in state-driven education boards at a graduation level
- Introduction of PBL (Problem or project based Learning at the institutions.
- Interdisciplinary curriculum at the undergraduate level.
- Restructuring the Skill sets imparted during the undergraduate levels.
- Bolster the vocational training infrastructure in partnership with the private sector and include elements of I4.0 in vocational training
- Involving the Industries for building the necessary infrastructure
- VET introduction at the school levels, thereby creating awareness for the Vocations and need based education systems

6.2 As Facilitator:

- Set up a dedicated wing in the Industry Ministry to oversee and promote Industry 4.0 adoption
- Establish a network of 'test labs' that will work with enterprises, industry bodies, government, academia, labour organizations, and the wider community to advance I4.0. Also connect with similar labs and I4.0 initiatives worldwide

6.3 As Policy-Maker:

- Provide financial incentives and aid for MSMEs – e.g. tax breaks, subsidies – to make I4.0 affordable to them
- Continue push with initiatives such as Smart cites, Digital India and Make in India
- Improve telecommunications infrastructure to ensure seamless IoT implementation
- Formulate adequate cyber security policies
- Encourage FDI and improve ease of doing business
- Involvement of stake holders is very much needed. And this responsibility is to be taken by the Institutes as well as socio political mediums.

7. Government Initiatives:

In 2015, the Indian government launched an IoT Policy that aimed at skill development, technological upgrades, and building IoT products specific to Indian demands, thereby occupying a considerable share in the global IoT market15. In addition, the government is formulating a National Policy for Advanced Manufacturing to enhance India's global manufacturing competitiveness. The government has recently announced the launch of a mission on Cyber–Physical Systems (CPS) and allotted an initial corpus of INR100 crore for commencement. Once fully implemented, these plans would be key tools to enhance the contribution of manufacturing output.

- **National Manufacturing Policy, 2017:** In July 2017, the government rolled out a new policy to push the manufacturing share to 25 per cent of the GDP by consolidating Make in India initiative, with focus on adoption of digital platforms for I4.0
- **Centre of Excellence (CoE) on IT for Industry 4.0:** This CoE would act as a knowledge centre for entrepreneurs and startups, propagating the concept of IT and its application in I4.0
- **National Program on Artificial Intelligence:** In the Union Budget 2018-19, the government announced that NITI Aayog will create a road map for national AI programme focusing on developing new AI applications
- **Mission on Cyber-Physical Systems:** As per the Union Budget 2018-19, the Department of Science and Technology will launch CPS mission to support establishment of CoE for training in robotics, AI, digital manufacturing, etc.

8. Role of Organizations:

The industry, particularly the large and multinational manufacturing companies, will adopt 4.0 if they see returns on investment.

8.1 As Adopter (Manufacturing Sector):

- Include MSMEs in their supply chain
- Embrace disruption in business model
- Invest in Leadership 4.0

8.2 As Supplier (Technology Sector):

- Invest in research on I4.0 technologies and innovation to improve output quality
- Continue developing verticalised technology solutions for industry 4.0

It is essential to prepare the roadmap for adoption at various levels of technology appropriate for different scales of operations especially for MSMEs. It is proposed that the institute/organization may undertake the following policies and reap the benefit of Industry 4.0 advancements:

- **Leadership:** Have a long-term strategic vision to lead an organizational transformation in the I4.0 era

- **Talent Pool:** Focus on talent retention and re-skilling; enable timely up-skilling of workforce, relevant to I4.0 trends
- **Innovations:** Foster a culture of innovation and trust in the organization; provide a conducive environment for humans and bots to work together
- **Cyber Security:** Focus on strengthening organizational data privacy and cyber security protocols, as threats may arise due to connected ecosystem.

9. Role of Academia:

- Enhance quality of teachers and modernize learning infrastructure
- Align course curricula in tandem with I4.0 requirements, with well-regulated and industry-relevant updated content
- Focus more on practical, result oriented knowledge, over theoretical content
- Promote a culture of research in upcoming areas like I4.0 and act as the test beds for innovation and new learning
- Participate actively in the development of MOOCs (Massive Open Online Courses)
- Collaborate with industry players.

10. Challenges Faced for Execution of I4.0:

There are many challenges which have to be addressed in order to successful adoption of advanced technologies and realization of Industry 4.0 potential. Few key challenges are given below**:**

- Lack of a clear digital vision
- Lack of data analytical capabilities
- Fostering a strong digital culture
- Level of digitization
- Data Security
- The major risk with recording, storage and analysis of large volumes of customer data is the inappropriate use of said data.
- Lack of standardization

10.1 Cost and Technical Issues:

- **Lack of Adequate Infrastructure:** physical and digital: Despite continuous effort of the government, India still lacks basic infrastructure such as roads and electricity. Additionally, India's telecommunication network still suffers from low data speeds and unstable connection.
- **Cyber Security:** According to KPMG in India's Cybercrime Survey Report 2017, 79 per cent of corporations in India have acknowledged cyber security as one of the top-five business risks. Apart from cyber security, the regulatory environment pertaining to data privacy would also need to be strengthened.
- **High Cost of Digital Technologies:** Building the factory of the future having an entirely connected system could require significant capital outlay. Getting access to digital technologies for MSMEs, that forms the base of Indian manufacturing sector, remains a challenge due to the high cost of these technologies.

10.2 Skill and Talent Issue:

- **Leadership Skill Gap:** India faces a lack of business leaders ready for the Industry 4.0 era, which could hinder the country's attempts for widespread adoption. Although, India Inc. has a strong traditional leadership, there are deficiencies of digital CXOs with a strong vision for Industry 4.0 adoption. The need of the hour is agile leadership and mitigating this challenge should be India's foremost priority. Although, most CXOs acknowledge the need for Industry 4.0, their execution capabilities are still untested.
- **Workforce Skill Gap:** India's current workforce lacks skill and expertise in new age technologies such as data analytics, additive manufacturing and IoT. The government, industry and academia needs to collaborate to enable an Industry 4.0-ready workforce.

11. Opportunities Need to be Grabbed:

One of the key strengths in favour of India's foray into the I4.0 era is the country's INR10,85,224 crore IT services industry.18 India is one of the most sought-after IT outsourcing destinations in the world and houses some of the world's largest IT companies. India's IT expertise along with infrastructure can now be leveraged locally to catalyse I4.0 adoption in India. The IT sector is expected to play a defining role in the I4.0 era. As a result of this, Indian IT companies are already on the look out to bolster their I4.0 capabilities through R&D in order to seize the latent opportunity. For instance, an IT major recently announced the setting up of a 'Factory of Future' lab in Bengaluru. The lab is reported to be working on new-age technology solutions to create a deep convergence of cyber and physical systems. Apart from this, Indian IT majors have also started exploring organizational tie-ups and collaborations to develop their I4.0 capabilities and offerings. Companies have started increasing their focus in partnering with companies from other sectors and countries to develop new IoT and M2M solutions relevant for I4.0. For instance, a Bengaluru-based IT major has announced collaboration with a Germany-based global leader in automation for an I4.0 cloud platform. In another development, another Indian IT major is looking to work with a major Japanese IT company in the area of smart factories. The experts believe that by fourth industrial revolution, the manufacturing base will become modernized by 4.0 solutions, allowing capital to be used more gainfully. In making better use of its base, industry will draw less on capital employed. Profitability and Return on Capital Employed will rise and create new investment opportunities - a key aspect in the funding of new projects and in creating new jobs. The use of industry 4.0 technologies will result in an increase in labor productivity and in the quality of the products manufactured. As a result, the demand for quality products manufactured will increase, rendering companies with no option but to increase capacity to meet the demand. There is no doubt that certain low-skilled jobs will be eliminated. However, it is expected that an increase in capacity will have a positive effect on the creation of jobs.

12. Conclusion:

Industry associations could take a lead in I4.0 adoption in India. Overall, widespread adoption of I4.0 would require collaborative efforts of industry associations. These associations can take initiatives to identify technological developments, find infrastructure and political needs, assess impact on sectors and plan a workforce up-skilling road map. The associations could also work closely with the government to facilitate faster adoption of I4.0 in India. Industry 4.0 adoption could position India as the leader on the global manufacturing map. Demand and volume growth, driven by consumerism trend in India, would create jobs, which is expected to offset some of the job losses due to I4.0.

Government can focus on improving the ease of doing business and attracting FDI investments in the space through policy reforms. Collaboration between countries, corporations as well as academia would catalyse I4.0 adoption.

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