



## Industry 4.0: The revolutionary wave of digital transformation

Shyam Kishor Yadav

Guest Teacher, Department of Commerce, R. K. College, Madhubani, Maharashtra, India

### Abstract

The rise of new digital industrial technology, known as Industry 4.0, is a transformation that makes it possible to gather and analyse data across machines, enabling faster, more flexible, and more efficient processes to produce higher-quality goods at reduced costs. This manufacturing revolution will increase productivity, shift economics, foster industrial growth and modify the profile of the workforce, ultimately changing the competitiveness of companies and regions. India has been gearing up for Industry 4.0, surpassing another industrial revolution and lunging unwaveringly into the Internet of Things. India is now the hotspot of most industrial activities made possible by our IT stronghold. India today is prepared for connectivity, since it is very well known as IT-hub for the world. Indian IT-companies and India based subsidiaries of global IT-players produce smart software solutions for the world. A great challenge for the future lies in the transfer of Industry 4.0 concepts and new technologies. None of the companies in India are fully industry 4.0 ready. However, the companies that have adopted Industry 4.0 are making considerable improvements both in process as well as in structures.

**Keywords:** Augmented reality, big data analytics, cloud computing, intelligent manufacturing system, simulation

### Introduction

The invention of the steam engine in 1760 marked the beginning of the first industrial revolution. Coal was the main source of energy and trains were the main means of transportation. The most dominant industries were textile and steel in terms of employment, value of output, and capital invested. The invention of the internal combustion in 1900 marked the beginning of the second industrial revolution. Rapid industrialization happened during this period using oil and electricity to power mass production. The implementation of electronics and information technology to automate production in 1960 led to the third industrial revolution. The fourth industrial revolution now involves computer generated product design and three dimensional (3D) printing, which can create solids object by building up successive layers of materials. The Industry 4 or the 4th industrial revolution marks its beginning from 2014 with real time, self optimising connected systems (Xu, David and Kim, 2018) <sup>[1]</sup>.

World-renowned economist Klaus Schwab (2017) <sup>[4]</sup>, Founder and Executive Chairman of the World Economic Forum, explains that we have an opportunity to shape the fourth industrial revolution, which will fundamentally alter how we live and work.

Blanchet, Rinn and, Dujin (2016) conclude that Germany is the only country where the transition to Industry 4.0 has been accompanied by significant improvements in the return on capital employed (ROCE) over the last 15 years. Despite a slight drop in employment (9 per cent), value added grew by 80 per cent between 2000 and 2014, while profits increased by 158 per cent. Investments and depreciation remained stable over the same period, with a more efficient use of assets. The rate of use of production equipment grew from 85 per cent in 1998 to 95 per cent in 2014. As a result, Germany's ROCE climbed from 12 per cent in 2000 to over 30 per cent in 2014.

### Industry 4.0- A German Initiative

Industry 4 is a German initiative aimed at creating smart factories. The concept is very similar to the Japanese e-@ Factory. Industry 4 or the fourth industrial revolution is defined by digitally-enabled smart factories. It has highly connected systems that create a fully automated value chain. The nine technologies that are transforming industrial production under Industry 4 are Big Data Analytics (BDA), autonomous robots, Internet of Things, horizontal and vertical system integration, the cloud, cyber security, simulation, additive manufacturing and augmented reality. Industry 4 marks an Intelligent Manufacturing System (IMS) and uses service-oriented architecture (SOA). It may be mentioned that while Industry 3 focused on automation of single machine and process, Industry 4 concentrates on end-to-end digitisation of all physical assets and their integration into the digital eco system with value chain partners.

The objective of Industry 4 is to bring about highly integrated human-machine cooperation in the industrial ecosystem through cyber physical production system integrating communications, IT, data and physical elements. The main components of Industry 4 includes strategy and organisation, smart factory, smart operations, smart products, data driven services and employees. Industry 4 offers an opportunity to develop new business models as well as improving the current models by using digital technologies. Smart products are the basis of smart factory and smart operations. These products are capable of collecting data on their environment and their own status with the help of sensors, Radio Frequency Identification (RFID), communication interface, etc. Data driven services call for equipping physical products with physical IT so that they can send, receive, or process the information needed for the operational processes.

Cornelius Baur and Dominik Wee (2015) of McKinsey have brought out the following compass which consists of eight basic value drivers and 26 practical Industry 4.0 levers. This provides a benchmark of bouquet of offerings that Industry 4.0 can offer.

**Industry 4.0 levers**



Source: www.mckinsey.com

**Technological Pillars of Industry 4.0**

Many of the nice advance in technology that form the foundation for Industry 4.0 are already used in manufacturing, but with Industry 4.0, they will transform production: isolated, optimized cells will come together as a fully integrated, automated, and optimized production flow, leading to greater efficiencies and changing traditional production relationships among suppliers, producers and customers – as well as between human and machine. (Rubmann et. al. 2015) [6].

**Technological pillars of Industry 4.0 are**

▪ **Big Data Analytics**

Big Data is voluminous data, originated from countless different sources, such as business transaction systems, customer databases, medical records, internet click stream logs, mobile applications, social networks, the collected results of scientific experiments, machine-generated data and real-time data sensors used in industrial Internet of Things (IoT) environment. Data Analytics tools along with Artificial Intelligence (AI) applications like Machine Learning and Deep Learning can be embedded into smart factories for absolute automation.

▪ **Autonomous Robots**

Robots can perform tedious jobs consistently and tirelessly. Autonomous technology allows for machinery and robots, to act and behave autonomously after being programmed to

do so. This technology allows for systems to think, act and react autonomously which also allows for decisions to be made remotely if control systems allow you to determine these behaviours from afar.

▪ **Simulation**

Simulation helps in imitating a situation, process or environment. Manufacturers could utilise simulation based virtual realities for training of employees and resembling the real-life accidental scenarios without having to be in the actual dangerous physical environment.

▪ **Vertical and Horizontal Integration**

Interactions between implemented systems based on highly specialized software and specialized user interface, which are integrated in digital networks create an entire new world of the systems functionality for the horizontal and vertical integration (Chukalov 2017) [1]. While horizontal integration is integration of information technology systems in the production and automated equipment for various stages of the production and planning process, vertical integration is at various hierarchy levels in production and automation equipment.

▪ **Industrial Internet of Things**

Under industrial IoT, interconnected autonomous machines are fitted with sensors for collection of realtime data for analysis and quick responses resulting in optimisation of production processes.

### ▪ **Cyber Security**

Industry 4.0 relies on interconnectivity of all devices and one of the derivatives of interconnectivity is increased cyber threat. Thus, protecting information systems and manufacturing lines from cybercrime threats is becoming a critical issue.

### ▪ **Cloud Computing**

Storing of data in a central server is the pre-requisite of interconnectivity and sharing of information among all devices. Cloud computing allows seamless flow of information from one connected device to another resulting in data sharing across sites and companies in order to achieve response times of mere milliseconds.

### ▪ **Additive Manufacturing**

Digital 3D design and 3D printing for prototyping and unit production helps in creation of decentralized systems resulting not only in production of customised products but also in reduction of transportation and inventory management costs.

### ▪ **Augmented Reality**

It helps in creation of visual imagery in the real-world. Manufacturers showcase their products to the customers without even going for the actual production. This technology can be able to demonstrate physical feel of the product without the expense of actual physical trial.

### **Industry 4.0: Initiatives and Practices**

India has already begun its transition to Industry 4. World Economic Forum opened a Centre for the Fourth Industrial Revolution in Maharashtra, India in 2018. The focus area of the Centre will be block chain and artificial intelligence (AI).

It may be mentioned that none of the companies in India are fully Industry 4 ready. However, the companies that have adopted Industry 4 and are making considerable improvements both in processes, structures and routines are not few. Some of the notable ones are as follows:

Asian Paints with the help of ABB has set up a Greenfield plant for decorative paints at Khandala. Asian Paints selected ABB for the Manufacturing Execution Systems (MES) and Decision Control Systems (DCS) solutions for its new plant. The plant has almost 42000 input and output devices (I/ Os) that controls and integrates plant processes from raw material receipt, storage and transportation to paint manufacture and packing. ABB solutions not only reduced manpower required to operate the plant and production cycle time, but also significantly cut the downtime.

In order expand industrial IoT in the country, L&T subsidiary L&T Technology Services Limited (LTTS) and US- based computer software company PTC unveiled a Centre of Excellence in Bengaluru. The Centre will demonstrate digital transformations for companies globally. Its areas will include application lifecycle management (ALM), product lifecycle management (PLM), service lifecycle management (SLM), manufacturing operations management (MOM) and connected manufacturing. L&T heavy engineering facilities at Hazira, Powai, Ranoli, Talegaon and Coimbatore for defence, aerospace and nuclear industries conform to Industry 4 specifications. L&T uses real time data of plant and machinery from its

construction site to improve performance. The smallest of data, such as the amount of electricity consumed by machines or the weight hauled by a crane at a construction site, are put together and analysed, helping L&T take big decisions to improve performance. L&T-Nxt is a strategic initiative taken by L&T that will focus on AI, virtual reality, augmented reality, geo spatial solutions and cyber security to offer automation solutions to industrial clients.

Bosch's Bidadi Plant in Bengaluru uses 'Cobots' which work alongside humans. They can sense when a human comes near them and stop functioning. One of the very successful projects of Bosch's Bidadi Plant has been the spindle monitoring system. Vibrational sensors can now predict when the spindles are likely to fail. This helps the company to schedule maintenance without disrupting the workflow. Bidadi is a Greenfield factory.

The Tata Group's power utility has developed its own digital platform, helping customers better manage consumption with real-time information and improving efficiency at its own plants. It is now offering this service to other utilities. Voltas is working with Tata Consultancy Services (TCS) to offer IoT based solutions to offer better chiller maintenance services to customers.

Axis Bank has entered into a partnership agreement with Active.Ai leading to a smooth seamless fund transfer experience for its customers through conversation.

Mondalez India's plant at Sri City, Andhra Pradesh packs almost 6300 chocolate bars a minute. Mondalez India calls its Sri City plant an integrated digital factory.

Bajaj Auto commenced automation in 2010 and today uses 100-120 'Cobots' (Collaborative Robots) in its production facilities. Ford, in the Sanand plant, manages to operate the assembly lines and body shop with the help of 437 robots. Tata motors, in its Sanand plant, manufacture Nano with the help of 100 robots. Maruti Suzuki uses around 1700 robots to manage 7 process shops and 5 assembly lines. Renault uses automation of business process to prevent accidents. Siemens worked with Mahindra & Mahindra to set up a digitalised platform that quickly translates market requirements into a viable vehicle platform, including reducing the time taken for new product launches (Thornton, 2017). All major automotive manufacturers are now developing self-driving autonomous vehicles and plan to release partly, if not fully, automated cars in the mid 2020's. This will be made possible only through AI.

The Siemens factory at Kalwa, Mumbai introduced PLM software. This helped the company to be interconnected with a portal and a manufacturing execution system (MES). Machines are connected via sensors and a cloud computing based IoT operating system.

General Electric's (GE's) Chakan plant near Pune has its Enterprise Resource Planning (ERP) linked to MES. The machines in GE plant also uses sensor to send early signals of machine breakdown.

Swiggy, restaurant aggregator uses AI to help its systems keep pace with rapid growth. The firm has intensified its focus on building a strong data repository. This acts as a catalyst towards the adoption of AI.

### **The Challenges of Industry 4.0**

India has welcomed the idea of Industry 4.0. Not only manufacturing industry, but trading firms (logistics and distribution majorly) as well as service industry is expected to be impacted by industry 4.0. Beyond the changes in

processes, major changes are also expected in the workforce roles as new skills are required.

The major challenges being faced by the Indian Industries in implementing Industry 4.0 include

- **Lack of skilled manpower:** As this fourth revolution seeps in; it requires a different type of manpower to handle the technological literature which is different from the conventional methods, but industries in India face a skilled labour crunch. Decision makers must do a gap analysis- what is the existing criteria of labour requirement and what will be the same in the future.
- **Lack of awareness:** Apart from a few top notch companies, there are other medium and small scale enterprises that are not yet aware or willing to adopt the technological shift. Some firms are of the idea that any form of investment in technology is risky as a result of which they are not motivated to invest (Suresh N. *et al.*, 2018). Though the government has taken initiatives to promote innovation in the art of making profits, but often it has faced resistance from a good number of industries. Lack of eagerness in these firms to accept change can be a factor under this head.
- **Lack of scale:** The Indian automotive industry lacks the volume or scale of production. Industry 4.0 will be inherently advantageous to the industries which participate in large scale production rather than the firms which compete for a smaller market share (Rojko, 2017).
- **Lack of design/infrastructure:** The elements of Industry 4.0 demand a considerable amount of structural investment to function smoothly. Most of the firms lack the appropriate design to support I 4.0 tools. The factories must have the structure to ensure seamless transportation of data in between machines, processing them and churning the best results from the process.
- **Lack of pervasiveness:** The Indian industrial scenario comprises mostly of MSMEs. As the idea of Industry 4.0 is still germinating in India, it will take a considerable amount of time to reach them because the cost of investment is high and these enterprises are skeptic most of the times to accept something new. The `success of Industry 4.0 lies in its pervasiveness, in the context of India. The more it penetrates down the corporate pyramid (MSME's), the more Indian industries become proactive to change.

### Conclusion

Industry 4.0, is the current trend of automation and data exchange in manufacturing technologies. It is the future of manufacturing. Its enhanced technology, digital systems and automated processes make it optimum for manufacturing of quality products.

Industry 4.0 is an approach that uses advanced technologies to reinvent products and services from design and engineering to manufacturing and support, accelerating operational efficiency and enterprise-wide growth. The Fourth Industrial Revolution characterised by the increasing digitization and interconnection of products, value chains and business models has arrived in the industrial sector.

Companies face formidable challenges in the adoption of these new technologies. To build and sustain a lead in the race to full implementation, they need to broaden and deepen their practical knowledge about digital technologies and then develop and implement tailored digital manufacturing strategies.

A great challenge for the future lies in the transfer of Industry 4.0 concepts and technologies to small and medium sized enterprises. Industry 4.0 technologies offer great opportunities for the SME sector to enhance its competitiveness. SMEs will only achieve Industry 4.0 by following SME-customized implementation strategies and approaches and realizing SME-adapted concepts and technological solutions.

The global manufacturing landscape is being transformed by digital technologies and huge efficiency and productivity gains are being realized through cost reductions, quality improvements, customization and a quantum leap in performance.

The fourth Industrial Revolution is already on its way. Industry 4.0 will be a challenge and may also have answers for India's continued advantage in the global manufacturing industry. Industry 4.0 emphasizes the idea of consistent digitization and linking all productive units in an economy.

Industry 4 brings along with it many challenges, which if not taken care of can cause severe disruptions both for the organisation as well as for the entire economy. The causes of concern are massive job displacement; replacement of low skilled and low wage jobs by computers and digitisation; possible threats from dissatisfied employees, human error, hackers and cyber threats; vulnerability of being connected to anything and everything through IoT and finally fixing moral values to artificial systems.

The early adopters of Industry 4 will have the first mover advantages and those who fail to take it will be left behind. Failure to adapt may have severe consequences on organisations. The new wave of industrial revolution will set new norms, standards, practices and procedures. The competitive landscape will alter for industries and the survival of the fittest will be the order of the future.

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