

# Industry 4.0: History, Concept & Components

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**ABSTRACT:** The application of new technologies in the manufacturing environment is ushering a new era referred to as the 4<sup>th</sup> industrial revolutions, and this digital transformation appeals to companies due to various competitive advantages it provides. By promising huge benefits for industries and new opportunities for multitude of applications, Industry 4.0 is currently one of the major and most discussed topic in the academia and practice. Industry 4.0 combines the strengths of traditional industries with edge internet technologies. In the era of industrial digitalization companies are increasingly investing in their own data collection, data analysis and tools or solutions that can integrate their processes, machines, employees and their own products into a single integrated network to evaluate and improve company growth. Accordingly, there is fundamental need for assisting companies in the transition to Industry 4.0 technologies/practices, and guiding them for improving their capabilities in a standardized, objective, and repeatable way. The purpose of this research is to explain how companies are operating and to describe the events of Industry 4.0. The paper presents the result of a study on the potential of the industry 4.0.

**KEYWORDS:** Industry 4.0, Cyber physical systems, IOT, big data, automation

## I. INTRODUCTION

Industry 4.0 is the term first introduced at the Hannover Fair in 2011 in Germany. Industry 4.0 is the ongoing transformation of traditional manufacturing and industrial practices combined with latest smart technologies. Combining the strengths of optimized industrial manufacturing with cutting edge internet technologies is the core of Industry 4.0. Therefore it does not surprise that Industry 4.0 is experiencing an increasingly growing attention especially in Europe, but also all over the globe, coined as industrial internet. The Industry 4.0 is based on data. It can be analyzed collectively and the way it used to make and explore the right decisions has become competitive factor. The main objective of Industry 4.0 is to improve automation and operational efficiency, as well as effectiveness. Some of the key factors of this industrial revolution are technologies like Internet of Things (IOT), Artificial Intelligence (AI), Cloud computing, Data science, smart machines, etc..The idea of the 4<sup>th</sup> industrial revolution, represented by terms such as Industry 4.0 and Smart Manufacturing, has attracted considerable attention namely as a result of a proposal by the German government and other initiatives from USA, Korea and other countries. The initial notion primarily pointed to a merging of the physical and virtual worlds—Cyber Physical System (CPS), thus leading to a CPS based industry. Soon the idea evolved to a symbiosis of the CPS with Internet of Things and Internet of Services, justifying the view that it represents an evaluation towards digitalization.

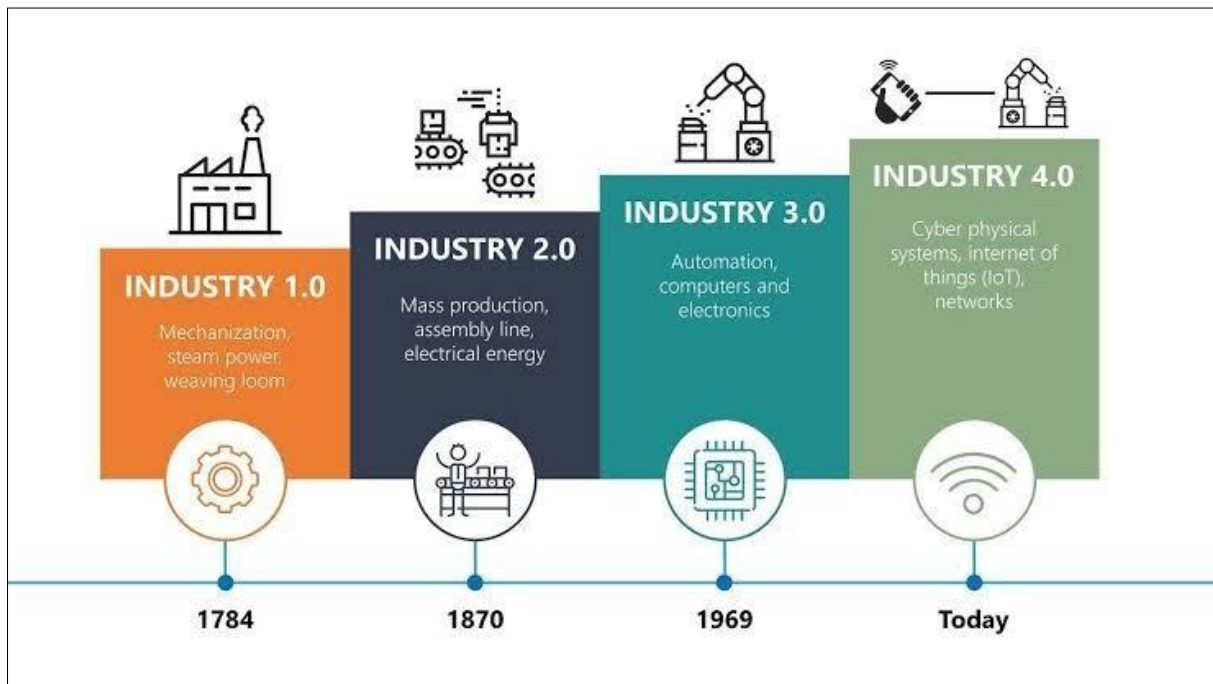
Industry 4.0 is expected to have a significant impact on supply chains, business models and processes. Fundamental changes, which are likely to be enabled by transformation to Industry 4.0, are as follows: Meeting personalized customer requests; flexibility; optimized decision-making; resource productivity and efficiency; creating value opportunities through new services; responding to demographic change in the workplace; improved work-life balance. More recently, Industry 4.0 has turned into a buzzword and became a –integration factor! for various new technologies and manufacturing concepts following the –me too effect. As a result, its scope has increased – a kind of –everything fits! – making this concept even more difficult to grasp, while every technology related company also tries to this concept its own description.

The remainder of the paper is structured as follows: First, a history of Industry 4.0 is given, followed by the brief explanation of the Industry 4.0 concept. Then components of the Industry 4.0 are discussed along with the advantages and challenges of Industry 4.0 and the conclusion of study is presented.

## II.HISTORY

Term “Industry 4.0”, shortened to I4.0 originated in 2011 from a project in the high-tech strategy of the German government, which promotes the computerization of manufacturing. The term –Industry 4.0| was publicly introduced in the same year at the Hannover Fair. In October 2012 the working group on industry 4.0 presented a set of Industry 4.0 implementation recommendations to the German federal government. Industry 4.0 is fourth major reset in the history of the factory automation. The following figure gives the brief idea about the history of industrial automation

Fig.: History of Industrial revolutions.



The late 18<sup>th</sup> industries introduced mechanical production facilities to the world. As shown in above figure, Industry 1.0 was the combination of mechanical and production engineering systems. The systems were powered using steam and water energy to help the workers in the mass production of goods. Industry 4.0 was equally based on the mechanization and humans. In the late 19<sup>'s</sup>, industries marked the start of the second revolution. The main contributor to this revolution was the development of machine running on electric energy. This was more efficient to operate and maintain in term of cost and effort unlike water and steam based machines which were comparatively inefficient and resource hungry. Basically, Industry 2.0 was all about assembly line, mass production and electrical energy. The next industrial revolution resulting in Industry 3.0 was spurred by the advancement in the electronics industry. Industry 3.0 was the first use of computers and automation systems in the industries. Industry 3.0 resulted in less human efforts due to the automation. During the third industrial revolution advent of computers and automation ruled the industries alone. The recent industrial revolution that is Industry 4.0 is more about centralizing and computerizing the processes. It is simply a term for the trend of automation and data exchange in manufacturing. Industry 4.0 is the intelligent production in cooperated with IOT, cloud technology, big data and cyber physical system Industry 4.0 is also called ‘smart factory’. Term ‘smart factory’ is used more in USA region but these are same things. Productivity and output are improved in Industry 4.0 as compare to Industry 3.0. The resource hunger is decreased in the Industry 4.0 by using more robots to perform human tasks such as programmable logic controllers, automatic robot arms.

### III. CONCEPT

Industry 4.0 and smart manufacturing are always describing the intersection of operational technology and information technology to monitor physical processes within the manufacturing and use that data to make productive, adaptive and corrective decisions to improve operation cost.

Industry 4.0 refers to the fourth industrial revolution and specifically moves towards smart manufacturing. The National Institute of Standard Technology defined smart manufacturing as, fully integrated collaborative manufacturing system. This responds in real time and meets changing demands and conditions in the factory, in the supply network and in the customer need. Industry 4.0 is about connectivity as an opportunity to radically change the way industry responds to the needs of society. The advancement of the Industry 4.0 will be driven by the smart interconnected provenance environment. Industry 4.0 has connected Internet of Things (IOT) with the manufacturing techniques to enable system to share the information, analyze it and use it to guide intelligent action.

Industry 4.0 is mainly characterized by an increasing digitalization and interconnection of manufacturing systems, products, value chains and business models. The interconnection between the physical and the virtual/cyber worlds – Cyber Physical Systems and Internet of Things is a central feature. Adopting Industry 4.0 requires horizontal and vertical data integration. Across the businesses vertical data integration may include design, manufacturing, supply chain, product life cycle management, logistics, operation and quality. Whereas the horizontal data integration mainly consists of suppliers, distributors, customers and key persons.

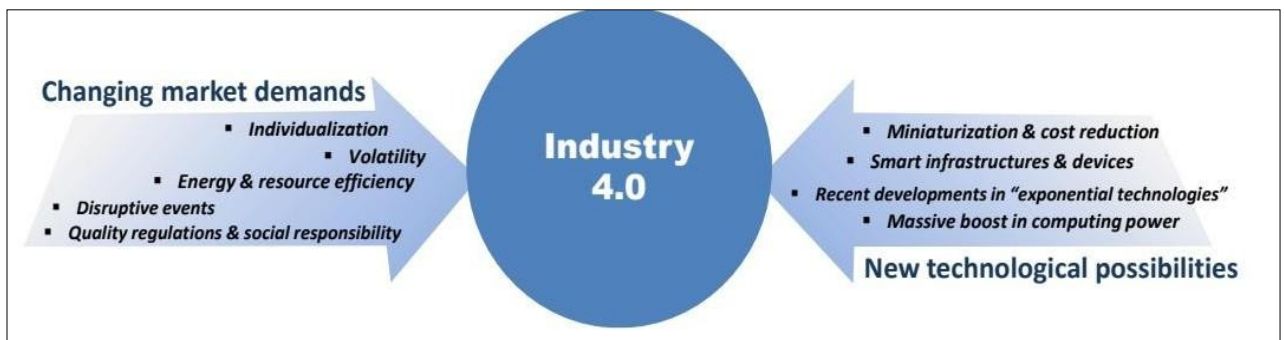


Fig.: Driving Forces of Industry 4.0

Above shown figure describes the driving forces of the Industry 4.0. This industrial transformation momentum towards Industry 4.0 is driven by two major forces – the new technological possibilities, and the fast changing market demands. From the technological perspective, Industry 4.0 is in fact characterized by the combination of large variety of enabling technologies. Furthermore, the role of data - available in fast growing amounts - is becoming central not only challenging the redesign of past systems and solutions, but also motivating new services and products.

The fundamentals of Industry 4.0 are highlighted by many researchers. Since Industry 4.0 covers many technologies, some of them overlap in terms of the functionalities and capabilities they offer. Industry 4.0 targets the implementation of interconnecting, smart, and self-controlled structures of processes and systems. Therefore, business processes based on the technologies underlying Industry 4.0 provide innovative value-added processes, providing more flexible, reliable and efficient operations. In general, the latest developments in technology by itself offer new business opportunities and create new business models; while Industry is seen as a disruptive technological development that brings new business model innovation in the manufacturing sector. Because it is still in initial stage of development, it is essential to define the structure and methodology of the implementation guidelines for Industry 4.0 for successful implementation in the industry.

### IV. COMPONENTS OF INDUSTRY 4.0

Industry 4.0 is an abstract and complex term consisting of many components when looking closely into our society and current digital trends. To understand how extensive these components are, here are some contributing digital technologies as example:

- Cyber Security
- Cloud computing

- 3D Printing
- Advanced robotics
- Internet of things



Fig.: Components of Industry 4.0

- a. Cyber Security:** The fourth industrial revolution is closely associated with the topic of cyber security. A rapidly increasing number of Industry 4.0 cyber security incidents emerge, additionally stressing the need to strengthen cyber resilience. In Industry 4.0, cyber security is springboard for a safer and more resilient connected world. Cyber security provides the security to the digital data and this is the reason Industry 4.0 is being collaborative with the IT experts.
- b. Cloud Computing:** No matter which segment of industry you are associated with, cloud computing is playing the part of a critical enabler boosting the next industrial revolution, by offering the means for business to innovate around these technologies. The true potential of cloud in support of the fourth industrial revolution can only be determined via the integration of compute services with a cloud platform.
- c. 3D Printing:** 3D printing is a vital part of Industry 4.0. Leading corporate and consultants across the world are making significant investments in 3D printing knowledge and capabilities so that they can advise and join their clients in Industry 4.0 wave and revolutionize supply chains, product portfolios, and business models in the process.
- d. Advanced Robotics:** Robotic systems can already proactively monitor and adapt to changes in a production line. By networking multiple machines, each robot will increasingly be able to adapt dynamically not just to its work, but that of other robots and humans in the smart factory. Major companies are investing in machine learning powered approaches to improve all aspects of manufacturing.
- e. Internet of Things:** The Internet of Things involves adding digital sensors and networking technologies to the devices and systems we use every day in the analog world. The Internet of Things extends well into commercial and municipal uses as well and can include everything from building temperature control systems to sensor enabled trucks to digital manufacturing control systems

## V. CONCLUSION

The vision behind Industry 4.0 and alternative terms such as Smart manufacturing is having a strong catalyzing effect, reflected in the convergence of various new technologies and mobilization of efforts toward reorganization of industry. To some authors this effect is triggering a new industrial revolution.

From an analysis of literature on Industry 4.0, a great number of results and empirical knowledge gathered which constitute a rich contribution to the identified needs of Industry 4.0. Complementarily, this analysis shows that this revolution also raises new research challenges or re-enforces ongoing focus topics in Industry 4.0 community

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