



## **Impact of Industry 4.0 in Manufacturing Sector**

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**Abstract:** In this relevant research literatures have been reviewed and the findings have been presented in a concise way. Industry 4.0 is a technology that has been developed in the year 2011 during a project of high-tech strategies by German scientists. Many companies are using Industry 4.0 to enhance their productivity. Especially, the manufacturing companies use this technology for monitoring their production and related organizational operations so that they can take necessary initiatives for managing their supply chain and logistics.

**Keywords:** Industry 4.0, Automation technologies, IoT-based automation technology, Cloud-based technologies

### **1. Introduction**

Reviewing relevant research literature can help researchers to develop in-depth knowledge regarding the area of research. For this reason, it is very important to review relevant research literature before proceeding with data collection and other important research activities. The research work aims at analyzing the importance of Industry 4.0 in the manufacturing sector. For this reason, relevant research literatures like books, articles and journals have been reviewed to understand the impact of industry 4.0 in the manufacturing sector. Along with that, the reviewed literature has also helped understand the benefits and limitations of using Industry 4.0 in manufacturing organizations. The key findings from the reviewed literature have been presented concisely in this chapter.

### **2. Concept of Industry 4.0**

The concept of Industry 4.0 was evolved in the year 1960 during a project that was aimed at the enhancement of productivity of a manufacturing organization. Industry 4.0 is the current trend of automation technologies used in the manufacturing sector (Masood and Sonntag, 2020). It consists of cyber-physical systems, cloud computing, and IoT technologies for effective information sharing within different departments of the manufacturing companies in to streamline the manufacturing operations. Industry 4.0 is used for creating a smart factory.



**Figure 1: Different aspects of Industry 4.0**

(Source: Strandhagen et al. 2017)

In simple words, Industry 4.0 is the other name of digital transformation of the manufacturing operations like production, information sharing, and other value creation process. Cyber-physical systems, for example, smart machines, form the basics of Industry 4.0. Cyber-physical systems are used as control systems for tracking different business activities related to the manufacturing and other value creation process (Nikolic et al., 2017). The embedded software systems and IoT- based technologies are used for information sharing, and therefore, it becomes easier to enable new ways of production by managing the available resources effectively. In this process, it becomes easier for the manufacturing companies to create more value for their customers, investors and other stakeholders. Industry 4.0 is called the fourth industrial revolution.

### **3. Usage of Industry 4.0 in the manufacturing sector**

Industry 4.0 provides real-time information regarding the whole manufacturing process. The user can see through the value chain of the organization. The materials used in production, the supply of the materials through different stages, the origin of the materials, different activities associated with the productions. By keeping track of the total value chain and the production activities, it becomes easier for the manufacturing organization to develop strategies for managing the supply chain and improving the production rate of the organization (Ghobakhloo and Fathi, 2019). The distribution of resources and goods can be controlled effectively to manage the production activities effectively. For this reason, it has been revealed in many research that proper implementation of Industry 4.0 can help enhance the productivity of manufacturing organizations. The increase in productivity can also help an organization to fulfill the orders of the customers in different market segments.

On the other hand, the risks of surplus production and the wastage of resources for surplus production can also be avoided by using Industry 4.0 (Butt, 2020). Implementation of Industry 4.0 is very much important for managing an end-to-end digital supply chain. Mixed reality is another essential component of Industry 4.0. According to Moktadir et

al. (2018), large companies also use mixed reality devices like helmets and glasses for developing smart factories as they think that the inclusion of mixed reality in smart manufacturing process can enhance communication between employees. In this context also visualization of contextual data can improve the productivity of the workers. It has been revealed in studies that these types of mixed reality devices and technologies are used by the repair personnel in different manufacturing organizations (Machado et al. 2020).

The repair personnel can easily see through the machinery by using mixed reality devices. As a result of it, the repair personnel can find out what is wrong with the machinery. The mixed reality devices also help the repair personnel to see through the walls, through the pipelines and cables and in this process, it becomes easier for them to understand where to drill and were cut to repair those faulty machineries. Robotics is another essential feature of Industry 4.0 (Sharma et al. 2021). Robotics technologies can perform repetitive tasks in the manufacturing process and the chances of human errors also remain less. Human resources can focus on more productive and creative areas of business. Considering all these facts, it can be said that the implementation of Industry 4.0 has become essential for large manufacturing companies.

#### **4. Reasons behind the growing importance of using Industry 4.0**

The importance of automation technologies in manufacturing is increasing continuously because of the digital revolution in the 21<sup>st</sup> century. Large manufacturing organizations have become interested implementing automation technologies for managing their production rates. However, indeed small business organizations have not shown enough interests in adopting digital automation technologies. The pandemic of Covid-19 after 2019 has created the emergence for digitalizing all business operations (Strandhagen et al. 2017). The production activities of different organizations have been affected badly as most of the organizations have been forced to manage their productions with minimum number of workers in the factories during the lockdowns intended for controlling the spread of corona virus. The production rate of many small organizations has been decreased during the lockdown periods (Fatorachian and Kazemi, 2018). As a result of it, it has become very important to use automation technologies in the manufacturing sector to manage the production rates so that the companies can fulfill the orders of the target customers in different market segments.

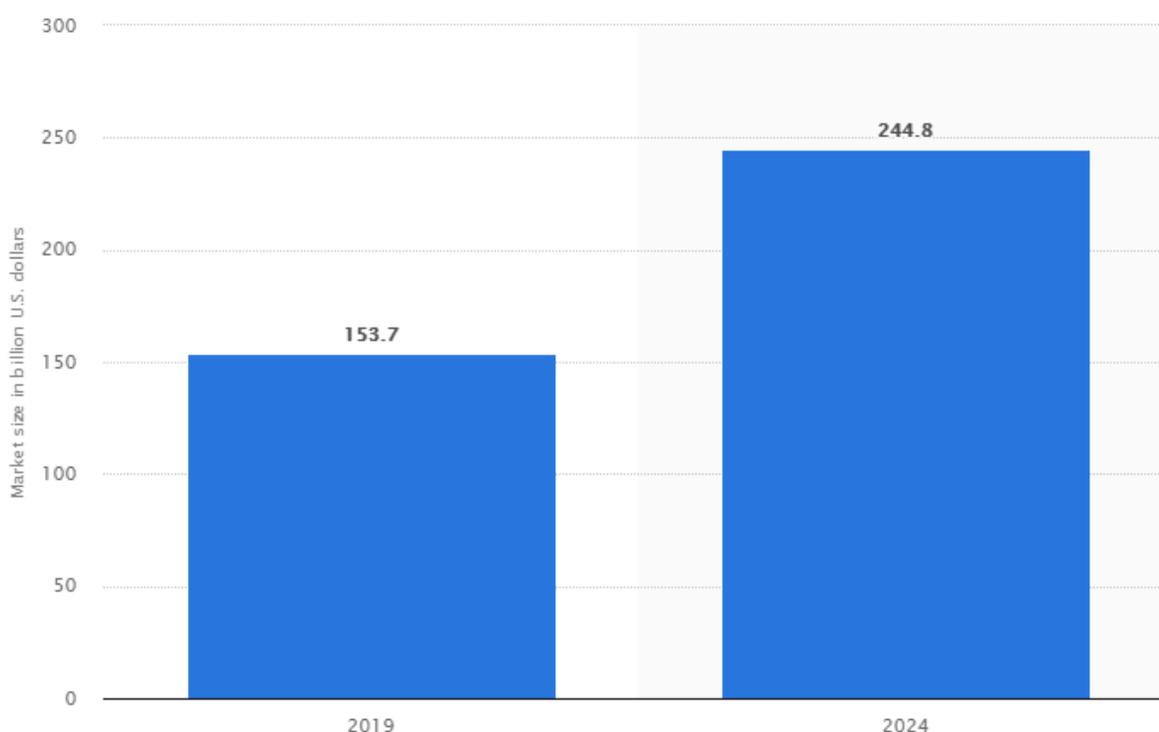
After the pandemic of Covid-19 the importance of e-commerce has been increased rapidly and therefore, it has also become important for manufacturing organizations to implement digital supply chain to keep track of the journey of the materials and goods throughout the supply chain. The combination of cyber-physical systems, cloud computing technologies and IoT-based technologies can help implement and monitor an end-to-end digital supply chain to manage it production rates (Raj et al. 2020). To implement and manage digital supply chain and e-commerce, a large number of manufacturing organizations have been adopted industry 4.0. Besides this, the implementation of Industry 4.0 also helps in tracking and managing the distribution of produced goods in different niche markets. The automation technologies and especially the use of robotics can help perform repetitive tasks effectively in the manufacturing organizations. In this process, the labor cost of the organizations reduces and the productivity of the organizations also increases (Zheng et al. 2019).

It also becomes easier to manage the production rate with minimum number of workers in the factory. For this reason, the relevance of Industry 4.0 has been increased in the post- Covid business world. According to Kolla et al. (2019), high population growth rate is another reason behind the increasing importance of industry 4.0. Because of the increasing population rate in most of the developing countries, the demand of different products, especially food, delevverages, clothes and health care products have been increased rapidly. To produce these goods in bulk, it has become important to implement industry 4.0 so that the manufacturing organizations can fulfill the orders of target

customers properly by managing the supply of products in different markets. On the other hand, a large number of organizations have also implemented industry 4.0 to reduce manual errors in manufacturing operations (Luthra and Mangla, 2018). Along with that, effective information sharing through cloud-based technologies, Internet of Things and mixed reality technologies can also help the productivity of the workers and facilitates effective strategic management for managing the value creation process. Considering all the above-mentioned facts, it can be said that the importance of Industry 4.0 has been increased in the manufacturing sector for different reasons, but the pandemic of Covid-19 is a major factor which has influenced manufacturing organizations to implement industry 4.0.

## **5. Adoption of Industry 4.0 and IoT-based automation technology in the manufacturing sector**

Since the 21<sup>st</sup> century, large manufacturing organizations have shown interest to implement Industry 4.0. However, after the pandemic of covid-19, it has become very important for manufacturing companies to implement automation technologies to manage their production rate.



**Figure 2: Smart factory market growth**

(Source: Statista, 2021)

The figure shows that smart factory market is increasing rapidly since 2019, after the pandemic of Covid-19. The value of smart factory market in 2019 was 153.7 billion which is expected to grow to 244.8 billion by 2024. SMEs in different countries also showing interests to adopt IoT-based technologies and smart machines to achieve their production targets (Bibby and Dehe, 2018). However, SMEs face different types of challenges in the implementation of Industry 4.0. The common issues that prevent SMEs from implementing advanced technologies are lack of talent and technical skills and the lack of resources and funds for implementing those automation technologies. Therefore, the SMEs are failing to enjoy the full benefits from the implementation of Industry 4.0. On the other hand, the concept of industry 4.0 is also unknown to many small companies (Mohamed, 2018). For these reasons, Industry 4.0 has been

increased rapidly among the industry leaders in the global manufacturing sector. Still, its popularity is less in the SME sectors of the world.

## **6. Benefits of using Industry 4.0**

### **6.1 Increase of productivity**

It has been revealed in studies that the implementation of industry 4.0 can help enhance the productivity of the manufacturing organizations. Proper information sharing using IoT and cloud-based technology help an organization to review each step of the supply chain effectively. In this process, it becomes easier for the organizations to develop strategies for managing the supply chain and production (Bibby and Dehe, 2018). Repetitive tasks of the organizations can also be performed by smart machines. As a result of it, more goods can be produced within the limited time and production rate of the organization increases.

### **6.2 Remaining competitive**

Industry 4.0 has become essential for managing production rates in manufacturing industry. Proper management of production rates and supply chain can help an organization to fulfill the orders of the customers in different market segments. On the other hand, the implementation of Industry 4.0 can help avoid the issue of surplus production. Surplus production indicates the wastage of materials and valuable resources (Castelo-Branco et al. 2018). Proper management of production, effective distribution strategies helps an organization to remain competitive in highly competitive manufacturing industries.

### **6.3 Increased knowledge sharing and collaborative working**

Industry 4.0 comprises IoT-based and cloud-based information to share technologies that help sharing relevant information within different departments so that they can manage their works accordingly. Proper flow of information between departments also helps enhance team collaboration, and it becomes easier for the organization to achieve the organizational targets. For example, the information regarding the supply chain, production rate and sales can help the production department and sales department to work collaboratively for developing strategies that can enhance the product quality and the sales of the company.

### **6.4 Cost effectiveness**

Cost effectiveness is another benefit offered by Industry 4.0. Industry 4.0 is to automate production activities. Smart technologies can be used to perform repetitive tasks without any error (Bibby and Dehe, 2018). The chances of human errors also remain less in this process. On the other hand, it also becomes possible for the organizations to manage their production rates with limited number of workers on the premises of the organization. As a result, the labor cost of the company also decreases.

### **6.5 Flexibility and agility**

The implementation of Industry 4.0 also helps maintain flexibility and agility in manufacturing system. By implementing Industry 4.0, it becomes easier to scale production up and down or to include new products lines (Kolla et al. 2019). Along with that, Industry 4.0 also opens opportunities for one-off manufacturing systems and high-mix manufacturing systems.

### **6.6 Better customer experience**

The use of smart machines and automation technologies in production can help improve the quality of the products as the chances of human errors in producing goods can be avoided. The chances of damaged products also remain less and a huge number of products can be manufactured within the limited time. The improvement of product quality helps enhance the satisfaction level of the customers. Along with that, the increase of production rates helps an organization

to manage the availability of the products in different markets so that the customers do not face issues in availing those products.

## **7. Challenges of using Industry 4.0**

### **7.1 Cyber security issues**

The use of IoT-based technologies and cloud-based technologies can lead to cyber security issues. Cloud-based databases are prone to cyber-attacks. However, cyber-attacks performed on the servers and databases of the companies might lead to issues like data losses and data manipulation (Dean and Spoehr, 2018). Along with that, confidential information regarding the companies can also be leaked because of the cyber-attacks performed on the servers of the company.

### **7.2 Technical issues**

Industry 4.0 is combined system of smart cyber-physical machines, cloud-based databases, IoT technologies for information sharing and mixed reality technologies. Improper maintenance of these technologies or inefficient handling of the machines can lead to technical issues. Such technical issues can also create inconveniences in managing operations. Because of the technical issues, it might become difficult for the managers of the manufacturing organizations to make decisions regarding implementing any change in the manufacturing system or supply chain (Bellandi et al. ,2019). Therefore, technical issues always need to be paid attention to and need to be solved as soon as possible by taking help from expert technicians.

### **7.3 Increase of technology maintenance cost**

It is true that the proper implementation of Industry 4.0 can help reduce the labor cost of an organization and can also help increase the production rate of the organization. However, it cannot be denied that the implementation of industry 4.0 can lead to the increase of technology maintenance cost of an organization (Luthra and Mangla, 2018). The maintenance costs of servers, cloud-based and IoT- base databases and information sharing technologies are high enough. The wages of expert technicians who are appointed for resolving technical issues and cyber security issues are also high. Therefore, small and medium-sized organizations face difficulties in implementing industry 4.0.

### **7.4 Challenges related to employee training**

After implementing industry 4.0, it is very important for the manufacturing organizations to train their employees properly for using digital technologies and smart machines in the production activities. Without proper training, they cannot handle those technologies properly and, it would lead to technical issues. Without proper training to employees, it might not be possible to enhance the productivity of the organization even after the implementation of Industry 4.0 (Luthra and Mangla, 2018). However, organizations often cannot afford spending a lot of money in the training of the employees. As a result of it, they fail to get proper benefit from the implementation of Industry 4.0.

## **8. Application of relevant theories and models**

### **8.1 Diffusion of Innovation theory**

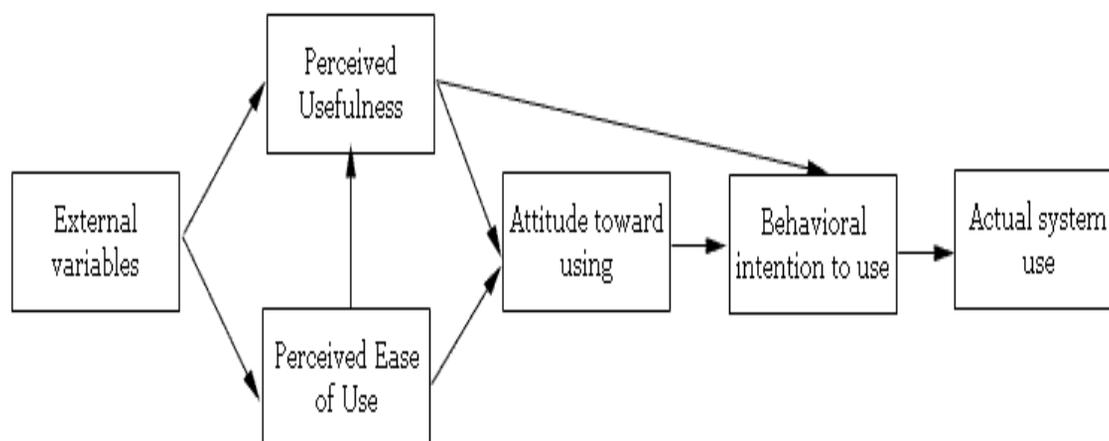
Diffusion of innovation (DOI) is one of the oldest theories of innovation that are used by organizations for managing technology implementation and organizational change management. The implementation of Industry 4.0 has can be considered as an innovation in the working style of any manufacturing organization. Therefore, the manufacturing companies that want from implementing industry 4.0 can apply this theory to manage the massive change. Per the theory of diffusion of innovation, a company that is implementing a change idea or an innovation needs to analyze the categories of the people who need to adopt the change and respond to the change effectively. According to Al-Rahmi et al. (2019), there are mainly five categories of people who adopt the change differently. As per the adopter categories of

this theory, five categories are innovators, early adopters, early majority, late majority and laggards. Innovators are those people who implement the innovative idea or the change initiative. Early adopters are those people who enjoy leadership roles and easily embrace changes. Early majority people are not leaders, but they adopt changes when the leaders adopt the changes. Late majority are those people who adopt the changes and respond to it lately.

On the other hand, laggards are those people who are always resistant to change. In case, the percentage of laggards is very high in an organization, it becomes difficult for the organization to implement new technologies. Therefore, it is very much important for an organization to promote a culture of continuous improvement and innovation and develop the mentality of the employees to adopt change and new technologies to successfully implement Industry 4.0 in their organization (Choe and Noh, 2018). The leaders of the organization need to make the employees aware of the importance of implementing those smart technologies for enhancing the production rates. In this context, it is also important for the organization to take necessary initiatives for providing proper training to the employees of the organization for using digital technologies in their work so that they can respond to the change initiative positively.

## 8.2 Technology acceptance model (TAM)

According to the model of technology acceptance, the success of new technology implementation depends mainly on two factors. Those are perceived usefulness and perceived ease of use. These factors determine how the people will use the technologies or how they will respond to the change.



**Figure 3: Technology acceptance model**

(Source: Granić and Marangunić, 2019)

Therefore, it is very important to make the people analyze that the technologies are useful so that they can accept digital technologies easily. Besides this, it is also important to make them understand that they can use those technologies easily (Al-Emran et al. 2018). The ease of use will help them accept those technologies easily. In this process, it can become easier for the organization to successfully implement Industry 4.0.

## 9. Literature gap

The existing literature provides enough importance regarding the benefits and limitations of using Industry 4.0. The reviewed literatures also provide enough information regarding the challenges faced by the SMEs to implement Industry 4.0. However, there are no such specific suggestions in the reviewed literature for resolving the issues related to the implementation and use of Industry 4.0. Therefore, the current research is trying to find out new ways of resolving the issues related to the use and implementation of industry 4.0.

## 10. Conclusion

The research reviews relevant literature to analyze the impact of implementing Industry 4.0. From the above discussions, it can be concluded that Industry 4.0 can help increase the productivity and competitiveness of manufacturing companies. However, the high cost of implementation, maintenance costs and, training costs are major barriers to the implementation of Industry 4.0. However, if the companies can make the employees aware of the benefits of digital technologies and can make them believe that the employees can use those technologies easily, it will become easier for the organizations to implement Industry 4.0 successfully.

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