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The Role of Internet of Things, Cloud Computing, Artificial Intelligence and Robotics in the Fourth Industrial Revolution

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Abstract

The manufacturing industry is growing quickly, which has led to an investigation into the possibilities of Internet of Things and wireless sensor networks, which will increase production efficiency. Since the Industrial Revolution, the manufacturing sector has played a significant role in both company and national economies. One of the most important issues in the current era of Industrial Revolution 4.0 is cyber-integrated manufacturing. IoT-enabled smart manufacturing enables an interactive relationship between smart machines to exchange data and information, which is essential for complex systems to make decisions about the working environment in real time. Increasing resource and energy efficiency is the most crucial step towards achieving manufacturing sustainability on a daily basis. Business organizations nowadays face several challenges as a result of fast technology innovation and intense global rivalry. To overcome these issues and advance sustainable growth, they must innovate their procedures and goods. IoT was adopted by industries in a number of areas, from raw material purchases to customer support and service. The Industrial Revolution 4.0 is thought to have heavily relied on the Internet of Things, which presents a potential opportunity to develop manufacturing-related services and applications. Furthermore, it facilitates the interactive exchange of data and information amongst smart devices, which is necessary for complex systems to make decisions about their real-time working environments.

Major Findings: *IoT is a cutting-edge technology that greatly enhances the manufacturing industry. It enabled smart manufacturing which promotes an interactive relationship between smart machines to exchange data and information, allowing complex systems to make judgments about the real-time working environment.*

Keywords: *Automation, Fourth Industrial Revolution, Internet of Things, Smart Manufacturing*

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1.0 Introduction

The manufacturing industry has been a major contributor to national economies and business economies since the Industrial Revolution[1]. Cyber-integrated manufacturing is a critical issue in the current period of Industrial Revolution 4.0. An interactive relationship between smart machines to communicate data and information is made possible by IoT-enabled smart manufacturing, and this is crucial for complex systems to make decisions about the real-time working environment[2,3]. From a day-to-day perspective, the most important way to achieve manufacturing sustainability is to increase resource and energy efficiency[4]. Due to rapid technological innovation and fierce international competition, business organizations now face numerous obstacles. Innovation in their processes and products is essential to overcoming these problems and moving forward with sustainable development[5,6]. Companies are concentrating on IoT technology to improve the development of their products and processes[7]. IoT adoption in the industrial sector is still in its infancy, despite the technology's explosive expansion in other industries like energy management, smart retail, health care, and agriculture, among others[8,9]. As a result of this revolution, factory automation tools like robots and programmable logic controllers were developed[10]. More production in sectors with less time and resources was made possible by these provisions. But the sectors are searching for the next wave of technical innovation because of intense competition and globalization[11]. Innovation and high productivity in product development are made possible by IoT-integrated new business models for enterprises. The manufacturing sector is compelled to use less energy and less raw materials in order to manufacture more goods[12,13]. When a company links its four fundamental components- people, processes, infrastructure, and products- it can achieve informed manufacturing through a well-developed Internet of Things network[14]. This improves an organization's overall process, from raw material supply to customer service. Many other benefits of the Internet of Things for the manufacturing industry include enhanced global supply chain management, strengthened connections between manufacturers and machines, and better corporate decision-making[15].

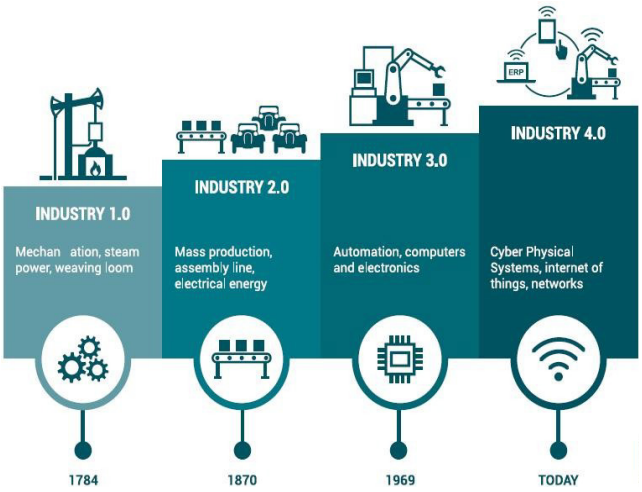


Figure 1. Demonstrates the transformation of Industry 1.0 to Industry 4.0[3].

2.0 Obstacles in the Way of Intelligent Manufacturing

Although the quality of products and the efficiency of the manufacturing process are improved by IoT, the sectors still confront significant implementation-related uncertainty. Three major obstacles have been noted[16]. The first is the typical reluctance of equipment manufacturers and end users to really implement this technology. The second is security; in order to truly transform an organization into one with an IoT culture, the knowledge gathered about the industry must be transformed into big data and shared with other partners. Lastly, collaborating with other industries is crucial, as only a select few enable the integration of all supporting businesses into a single, cohesive whole[17]. The largest obstacle to IoT implementation and connected manufacturing development is system integration. In order to gather data from a variety of sensors with varying degrees of sensitivity, each vertical sector in the manufacturing industry has a unique procedure and requires a variety of gateways and platforms. One of the biggest challenges in IoT is connecting all the gadgets, which will change the underlying technology and the entire communication protocol. Data collection from various network nodes now takes place using the centralized paradigm[18]. If billions more devices are to be connected in the future, however, it will be difficult to continue using the same approach. Moreover, cloud computing will have very

expensive maintenance costs to keep up with this massive amount of data. The many network nodes will eventually need to be connected *via* a decentralized network. Cloud storage is the best place for stakeholders to access data gleaned from smart manufacturing[19]. This allows them to monitor all manufacturing processes, maintain strict control, and adjust diligent measures based on up-to-date information. When creating smart factories, security is a key consideration. The researchers investigate various frameworks to guarantee network security and privacy. Hackers are now better able to pinpoint the vulnerabilities and weak points of "Smart Businesses" thanks to the abundance of information available online[20,21]. Complete security should be maintained during the data transfer from the industrial unit to the cloud server. One of the biggest obstacles to implementing the IoT is connectivity and utility standards. The producers use a wide range of unique integration solutions and exclusive techniques. Standardization makes it possible for assets and robots to interact transparently. In order for the devices to communicate with one another, standard mechanisms must be created. The development of the sustainable IoT standard is an ongoing research endeavour[22,23].

3.0 Objectives of the Research Work

1. To get familiar with the key role of IOT in smart manufacturing.
2. To aware the different kinds of obstacles in the way of intelligent manufacturing.
3. To depicts IOT enabled smart manufacturing system.
4. To get the various advantages of IOT based smart manufacturing system.

4.0 IOT Enabled Smart Manufacturing System

Sensing nodes are the first component. The applications that determine which sensing devices are employed in an IoT environment can vary greatly[24]. A thermocouple can be used to measure temperature, or an RFID reader can be used to detect the presence of an object or person[25]. A camera can be utilized for image monitoring. A microcontroller or microprocessor that is hybrid and

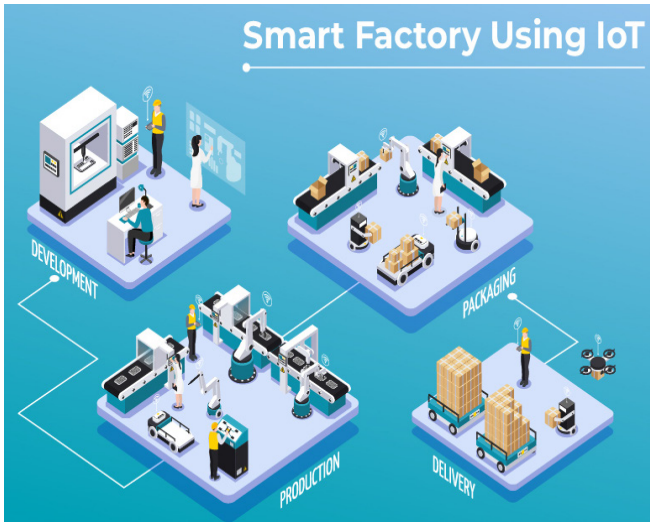


Figure 2. Represents the smart factory using IoT[7].

allows for real-time embedded processing is the second building block, known as the embedded processing nodes[26]. To complete a task, the third building block is a wired or wireless communication node, which relays information between the two previous building blocks. Usually, it involves two parties[27,28].

A products movement can be tracked by several supply chain parties[29]. Additionally, the product becomes completely independent, allowing readers to make different judgments based on the knowledge they have learned[30]. This results in end-to-end visibility in warehouse management and the supply chain, guaranteeing that the product is where it should be at the correct moment[31]. When fleet downtime is significantly decreased, optimal fleet management is also achievable. The installation of IoT technology in factories opens up the possibility of effective collaboration and real-time information access[32]. The ability to monitor machine and production status from any place can greatly minimize decision-making and action-taking downtime for a plant management[33]. When the issue is understood ahead of time and product waste has been completely removed, stopping the production process can successfully achieve quality control. Third-party participants and suppliers also benefit from factory visibility[34,35]. Several business networks are connected to one another through the Internet of Things and IP network, which also enables communication and information sharing[36]. Enabling flexible and compliant automation requires a thorough understanding of



Figure 3. Demonstrates the essential elements to smart manufacturing[13].

industrial IoT, covering business, technology, and facility aspects[37,38]. This is necessary to: (i) Provide real-time control for optimization and improved uptime (ii) Enable horizontal device association (iii) Provide expected and protected service feature inclusion[39]. Energy is a crucial component of production and frequently the second-highest operational expense[40]. However, a lot of sectors are behind in terms of modeling or management technologies that might help them optimize how much energy they use in their operations[41]. A few IoT-enabled facilities provide integrated energy data and forecast analysis. Three levels make up the energy management system for smart factories developed[42]. The first layer is called the sensor layer, which gathers data and forwards it to the second layer for analysis and context inference. The third layer is where energy management is accomplished by tracking and managing the state of energy consumption[43].

5.0 Advantages of IoT for Intelligent Manufacturing

The cost of energy is a major factor in manufacturing industry expenses. Businesses use the generated bill to calculate their energy-related costs. Identifying the inefficient power concept with the provided data is either extremely difficult or impossible[44]. Although the amount of data accessible is restricted, around 77% of enterprises obtain their energy consumption statistics from either their monthly electricity bills or energy use monitoring facilities[45]. By using IoT, data at the device level may be accessed, and underperforming devices can be identified. Managers can compare underperforming devices with top performers by monitoring the power consumption of individual devices[46]. By using actual data to determine the maintenance needs of the equipment at that precise moment, IoT entirely replaces the traditional approach of maintenance, which relies on conjecture based on historical data. Each components status is shown by the sensor, and if it doesn't require maintenance, there's no need to replace it-saving both money and time[47]. These oblique perceptions reduce the possibility of expensive downtime and maintain the equipment in good operating order. Profits are mostly determined by timely, accurate, and high-quality manufacturing. In addition to the usual downtime costs, a mid-machine malfunction results in a massive loss. For manufacturers, unplanned downtime is the worst possible scenario. Predictive maintenance, a popular Internet of Things strategy, helps industries avoid downtime by utilizing zero downtime[48]. ZDT bases the necessary maintenance on how the machine is used in real time. ZDT has many additional uses, but proactive failure forecasting is its most well-known use. Its capacity to remotely monitor the health of the machine, enabling optimal production through, for instance, lowering energy consumption, increasing output, and prolonging the mechanical life of machines[49,50].

6.0 Conclusion

Internet of Things is widely acknowledged as a novel technology that significantly contributes to the improvement of the manufacturing sector. Since the Industrial Revolution, the manufacturing sector has played a significant role in both enterprise and national economies. In the era of Industrial Revolution 4.0, cyber-integrated manufacturing is a crucial concern. In order for complex systems to make decisions regarding the real-time working environment, IoT-enabled smart manufacturing enables an interactive relationship amongst smart machines to share data and information. From a daily standpoint, improving resource and energy efficiency is the most crucial step towards achieving manufacturing sustainability. Business organizations now face several challenges as a result of intense global rivalry

and rapid technology innovation. Overcoming these issues and advancing sustainable development require innovation in their operations and output. It is capable of integrating any component found in the industrial sector, such as sensors, CPUs, communication devices, and actuators. This new Industrial Revolution 4.0 is made possible by these highly integrated smart cyber-physical systems, which also bring up new business and market potential in the manufacturing sector. It offers the industrial industry a great chance to improve system performance in distributed and multinational situations. Furthermore, IoT deployment in manufacturing is still in its early stages, and extensive research is needed to make IoT technologies dependable and safe.

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