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Role of Industry 4.0 In Reshaping the Future of the Industry

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Abstract

With the evolution of cutting-edge technologies, industries around the world are transforming due to the new industrial revolution, i.e., "Industry 4.0". The technologies associated with it like artificial intelligence (AI), blockchain, quantum computing, robotics, and the Industrial Internet of Things, are paving the way to smart factories, and are providing immense opportunities for organizations, to digitalize and automate their manufacturing environments. Industry 4.0 opened up enormous prospects not only in the demand for new professions, but also in the growth of new businesses, and national economies. The adoption of new innovative technologies, collectively called Industry 4.0, is transforming various sectors like factories, healthcare, automotive, supply chain, banking, agriculture, smart grid, etc. The purpose of this paper is to look into how the adoption of Industry 4.0 technologies is reshaping the future of various sectors. This paper will consider how technologies are drastically changing the nature of work in three sectors namely, agriculture, healthcare, and the supply chain. This paper attempts to analyse the scholarly work done by various researchers in the usage of Industry 4.0 technologies in various sectors. The paper tries to study how cutting-edge technologies like artificial intelligence, the Internet of Things, 3-D Printing, Stimulation, Big Data, Robots, and Cloud Computing, are transforming various sectors. The insights may provide directions to increased awareness and preparedness for future technological transformations (Rehman et al.,2019). contribution of this paper associates with an increase in usage of emerging technologies in various sectors.

Keywords

Industry 4.0, Transformation, Healthcare, Supply Chain, Agriculture

1. Introduction

Industry 4.0, popularly known as "fourth industrial revolution", "smart manufacturing," (Hofmann & Rüsch 2017), began in 2011, at the famed Hannover Messe trade exhibition, in Germany, resulting in digitization and automation of industries and transforming the way they operate (Pfeiffer, 2017 and Mubarok, 2020). Industry 4.0 is an umbrella term for the conglomerate of technologies like cyber-physical systems, the Internet of Services (IoS), the Internet of Things, big data, artificial intelligence, simulation, 3-D printing, robotics, augmented manufacturing, and cloud computing, particularly in the production processes, manufacturing, and supply chain, to digitalize, automate and track the devices in real-time (Pereira & Romero, 2017; Kang et al., 2016). The primary objective of Industry 4.0 technologies is that they reduce the time it takes to provide products to customers, respond to unforeseen events, and improve the quality of decision-making (Barreto et al., 2017). Production processes are being equipped with Industry 4.0 technologies, contributing to automation and data sharing for increased production performance (Rehman et al.,2019). Adoption of AI and IoT technologies, integrated into the manufacturing systems, is allowing the industries to optimize their industrial processes, assisting in sending

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early warnings, assisting in quality control, and the predicting machinery breakdown, thereby increasing the production, and aiding in lowering the costs.

The rapid adoption of Artificial Intelligence (AI) and the Internet of Things (IoT) in the manufacturing sector, rising demand for industrial robots in the pharmaceutical and medical device manufacturing sectors, rising government investments in 3D printing and additive manufacturing, and growing adoption of blockchain technologies in manufacturing, are all driving the industry 4.0 market (marketsandmarkets.com).

(Oztemel and Gursev,2020) emerging technologies in various fields. These innovative solutions developed in recent years are revolutionizing the way goods are being produced and transported, improving the quality and affecting the long-term viability of businesses, thereby transforming the eco-systems.

2. Literature Review

Industry 4.0, according to Christian Leyh (2016), is the move from a centralized manufacturing one to that of a highly flexible and self-contained one. Industry 4.0, (Abdirad and Krishnan, 2020). focuses on building a smart production network based on digitalization and automation, to facilitate machine to machine communication, without the need for human intervention (Gilchrist, 2016; Vladimirovich, 2016). According to Schumacher et al. (2016), industry 4.0, is a network of innovative technologies in the value chain that will transform enterprises. According to Lopes de Sousa Jabbour et al., (2018), "the essential element of Industry 4.0 is connectivity between machines, orders, employees, suppliers, and customers, electronic devices, and the Internet of Things (IoT); resulting in decentralized decision-making and autonomous systems". The main objective is the creation of smart manufacturing systems that includes smart intelligent machinery, intelligent gadgets, intelligent engineering systems, smart logistics, and smart suppliers, resulting in smart products (Abdirad et al., 2020). Smart technologies like Artificial Intelligence (AI), Industrial Internet of Things , cloud, and big data are transforming factories, in identifying, analyzing, forecasting, and recommending complex solutions, to the everyday manufacturing problems in real-time, resulting in substantial cost savings and the elimination of machine downtime, and assisting factories in becoming smart factories (Alcaser, 2019)

3. Industry 4.0 Technologies

Industry 4.0, will change the industry (Oztemel and Gursev, 2020), by allowing greater flexibility in production needs, effective resource allocation, and process integration. According to Nesma Abd El-Mawla (2019), The Internet of Things (IoT) is a network of items with a variety of sensors, software / applications, network connectivity, and computing capabilities that can connect, alter, and share data via the internet to enable smart solutions.

Big data, as defined by the US Congress in August 2012, is "large volumes of high velocity, complex, and variable data that necessitate advanced techniques and technologies, to enable the capture, storage, distribution, management, and analysis of the data" (Raghupathi, 2014).Big data analytics helps in identifying cost-effective solutions by using modern analytical algorithms for forecasting, detecting, analyzing, and in prevention (Gallelo et al., 2021).

Cyber-Physical Systems (CPS) are the integration of computational and physical processes that are required for Industry 4.0 implementations (Oztemel & Gursev, 2020). Cyber-physical sensor systems, are a type of embedded systems, based on sophisticated software systems, that enables for integration in digital networks and the creation of entirely new system. (Berger et al., 2016) and (Oztemel and Gursev, 2020). IoT (Internet of Things) applications have the potential to reduce carbon emissions, thereby delay global warming.

Virtual Manufacturing, (VM) is the use of computers to model, simulate and optimize critical operations and entities in a manufacturing plant (Oztemel & Gursev, 2020). Virtual manufacturing, according to (Dépincé, 2007) allows a company, to study the manufacturability of a part or a product, as well as review and validate production processes and machines, and train managers, operators, and technicians on production systems (Bharat, 2015). It can also be used to evaluate business risks and detect possible breakdowns in machine tools and equipment problems. Virtual Manufacturing gives firms the assurance that will give high-quality products on schedule and within budget (Oztemel & Gursev, 2020). Artificial Intelligence (AI) and related technologies are transforming the healthcare industry, showing the indispensable role of Industry 4.0 technologies in healthcare (Davenport, 2019). It is being used in a variety of clinical settings to diagnose, treat, and forecast outcomes, and detect abnormalities in a data set.

Robots are used in manufacturing, to protect workers from doing repetitive, mundane, and dangerous tasks, in engineering, and equipment maintenance jobs. Robots perform difficult or large tasks and work in hazardous or undesirable environments (Oztemel & Gursev, 2020) or for routine operations. Mohammed and Wang (2018) talked about how robots are being used in car manufacturing, to aid the operator in the coordination in the building up of automotive car engines. (Oztmel & Gursev, 2020) and (Lavazzo and Gkegkes, 2017) emphasized the increased usage of robots, in assisting the doctor to (Abdirad & Krishnan, 2020) and (Chou et al., 2019). hysterectomies, lung and brain surgeries in the healthcare industry. In the mining industry, they are being used to compile important information about the interior of a mine, Azmoodeh et al. (Berger et al., 2016) and (Oztemel and Gursev, 2020). and drones, in the defense industry to give battlefield support, and, (Lee 2014) talked about how collaborative robots called COBOTS are being used in warehousing, logistics, shipbuilding process, etc. Using computer vision technology, Xu et al. (2015) created a real-time tracking capability (Oztemel, & Gursev, 2020) for robots. Villani et al. (2018) explored the benefits of robots (Oztemel & Gursev, 2020) by emphasing how collaborative solutions are designed to increase system efficiency with minimal human intervention. (Franciso and Valero, 2015) investigated the design of efficient mobile robots (Oztemel & Gursev, 2020), capable of performing scientific and educational activities.

Bechtold (2015) noted that Augmented Manufacturing (AM) technologies "...could have a transformative impact not only across a large number of different industries but also on how products, are produced, distributed and consumed". He conducted an extensive study of Intellectual Property Rights in AM and (Lavoie et al 2018), concluded that, "in the industrial 3D printing sector, patent protection seems to have played an important role".

4. Concept and Role of Industry 4.0 Technologies in Various Sectors

Industry 4.0 trend is seen as transforming force, that is deeply impacting various sectors across the industry. The trend is built on an array of digital technologies: like cyber-physical systems, Internet of Services (IoS), Internet of Things, AI, robotics (Abdirad & Krishnan,2020). Industry 4.0 technologies are being used in advanced manufacturing, connected with devices, equipment's, production modules, and goods, and applied in a variety of industries such as the supply chain management (Abdirad & Krishnan, 2020) and (Chou et al., 2019). logistics (Kang et al., 2016), manufacturing (Pereira & Romero, 2017) etc., to respond in real-time.

This paper tries to analyze the usage of emergent technologies in three sectors like agriculture, healthcare, and supply chain.

4.1 Agriculture 4.0

Usage of an array of digital technologies has

increased a lot in the agriculture sector with increasing connectivity and IoT devices . The use of IoT in agriculture allows the optimization of resources, the reduction of production costs, and the avoidance of crop losses. In agriculture, smart autonomous systems are being used in rural environments, in advanced countries to work along with technological developments, like object detection capabilities, robotic milking machines, harvesting of horticultural crops and fruits, where there is a shortage of farm labor, which can improve sustainability, productivity, and reduce the cost of developing autonomous agricultural machinery. Agriculture 4.0 is directly related to emerging technologies, like Machine Learning algorithms for water management (Scott, 2020; Zaidi et al., 2019) and automation of grain and defective coffee bean selection (Chou et al., 2019), complex systems for identifying and monitoring pests and diseases (Sott, 2020 ; Lasso et al., 2017), and artificial intelligence for soil analysis (Kouadio et al., 2018).

4.2 Supply Chain 4.0

Supply Chain 4.0 also known as E-Supply Chain, E-logistics, or Logistics 4.0, is expected to have a significant impact on supply chains, business models, and operations in the supply chain network. According to (Abdirad, & Krishnan, 2020), the modern and agile supply chain networks are being connected with sensors to vehicles, radio frequency identification (RFID)s (Abdirad and Krishnan, 2020) to deliver packages, and cloud technology to store / retrieve the data. These technologies are assisting the managers, in taking timely decisions, reducing risk and increasing productivity. (Abdirad & Krishnan,2020 and Saucedo-Martínez et al., 2018). Industry 4.0 has the potential to enhance logistics processes, leading to improved operations, (Hazarika, 2020). (Santos et al.,2017). 4.0 technologies in supply chain systems, can assist in integration, operations, purchasing, and distribution activities, thereby boosting company's productivity (Kayikci, 2018); (Abdirad & Krishnan, 2020).The key advantages of Industry 4.0 in the Supply Chain is that, they reduce the time taken to supply items to clients, and also to respond to unexpected events (Barreto et al., 2017) which will result in considerable improvement in decision-making quality. (Armengaud et al., 2017) looked into the effects of Industry 4.0 on the product life cycle across the whole automotive supply chain. Based on the integration of blockchain and Industry 4.0 technologies. Korpela et al. (2017), developed a framework between digital supply chain (DSC) and multi-stakeholders.

4.3 Healthcare 4.0

The healthcare sector has undergone numerous technological transformations, in the last two decades (Hathaliya et al. 2019), Beginning with Healthcare 1.0, where doctors kept patient records manually, to Healthcare 2.0, electronic data storage, and advent of wearable gadgets like smartwatches and fitness trackers paved way to Healthcare3.0 (Hathaliya et al. 2019). With the development of Internet of Things (IoT) and Cyber-Physical Systems, a great number of devices are being interconnected with one another, to track a patient's health and do other health-related activities, leading to Healthcare 4.0 (Hathaliya et al., 2019).

(Sommer, 2015) stressed that Industry 4.0 technologies, provide essential direction for the development of personalized devices.

(Globalkhloo, 2018) talked about the popularization of Industry 4.0 technologies, leading to the customization of patient-specific medical implants or models as per the requirement, reducing the cost of inventory, and minimizing the mismatch of the model. According to Raghupati (2014), the rapid expansion of the healthcare sector has created new opportunities, while posing several challenges. (Hazarika,2020). pointed out that Artificial intelligence (AI) has the potential to revolutionize healthcare and help in addressing the challenges faced. AI can *'Engineering Management Journal'* developing diagnostic tests and vaccine

(Altoibi,2020) anomalies by using AI, thereby saving huge amounts of precious time and money (Bhattacharya, 2021). The remote patient monitoring system allows for observation of patients, outside the clinical settings (e.g., at home), and improves the quality of life of a patient (Alotabibi, 2020).

5. Conclusion

The fast-emerging technologies are changing the eco-systems in which the industries operate. The industry 4.0 technologies are improving sustainability, productivity, and reducing the cost of developing autonomous ones. The global demand for analytics and AI skills, is increasing, affecting the future of every sector, as industries and companies are expanding the use of digital technologies. Robots are used in assisting manufacturing, and protecting workers from doing repetitive, mundane, and dangerous tasks. The agricultural industry is being modernized and equipped with fourth industrial revolution, aiding in increased supply of food products. The working conditions of farmer/ workers is improving with the utilization of automation and hi-tech technologies which reduce the environmental effects.

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