Technologies that help in being sustainable in Industry 4.0 era

Ms. Manopriya. M, Student PSG Institute of Management, Coimbatore

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Abstract - The present business world is growing complex, intricate, and dynamic every day. There is an aggressive change in the customer requirements that have called for inevitable changes in organizations worldwide. Due to this fast-track movement, we have lost focus on knowing and doing what can sustain us for the long term. The organization needs to turn its focus in the direction of sustainability and utilize technologies for organizational goals. Industry 4.0 is transforming how companies manufacture the product and conduct distribution. The manufacturers are mixing technologies like cloud computing, Internet of Things (IoT), analytics, AI, and machine learning to aid their facilities, production, and operations. The smart factories have advanced pieces of equipment with embedded software, sensors, and robotics that gather and analyze data and pave the way for effective decision-making. This leads to creating higher value from the data set available, giving whole new insights and visibility. These technologies lead to predictive maintenance, increased automation, optimization of process improvement, and a new level of efficiency and responsiveness to the customers, which was not previously available.

Keywords: sustainability, AI, Cloud computing, Blockchain, circular economy

1. Introduction

Sustainability is about development and progress in an eco-friendly and socially equitable manner. Industry 4.0 is considered applying flexible automation, sensors, Internet of Things, cyber-physical systems, big data, cloud computing, computer modeling, cognitive robotics, simulations, 3D printing. The technologies that help in being sustainable in industry 4.0 includes Internet of Things (IoT), Artificial Intelligence, Big Data Analytics, Cloud Computing, 3-D printing, and Blockchain Technology

Technology is the way to sustainability and effectively creates vast amounts of communication and collaboration and more explicit information. All of it can aid in addressing the more significant issues of environment, sustainability, and community.

Many organizations have initiated many environmental initiatives such as Nike, Ford Motor Company, Disney, Johnson and Johnson, eBay Eco-Initiatives, Starbucks Stores Go Green, etc. Economy, society, and environment, also referred to as profit, people, and the planet, are the three pillars of sustainability.

1.1 Literature Review

Manavalan et al.; states that the supply chain is essential for business functions and has a significant influence on the expenditure and profits of the business. SCM operations include manufacturing process, infrastructure, wholesale, the flow of information, raw materials, and retail services to the consumer from the supplier. Industrial technology advances aids in maximizing the efficiency of operations all across the organization and the supply chain.

Kamble et al. proposed a framework on sustainability and Industry 4.0. It is the analysis and conclusions from literature based on various technologies of Industry 4.0. The critical components of this framework are process integration and sustainable results. He also states that future studies on this topic will primarily focus on the influence of these smart manufacturing on different levels of process integration. This study considers the sustainable outcomes of Industry 4.0 to be process automation, environmental protection, safety, and economic sustainability.

Etzion et al. consider that sustainability reporting is becoming vastly data-driven, using arrays of real-time data to analyze organizational sustainability performance. There are firms like Bloomberg and Thomson Reuters who have started showing interest in offering specific sustainability-oriented metrics. Big data is gaining more precision and time opportunity using more social and environmental data collected from firms, which eventually will generate opportunities.

De Sousa Jabbour et al.; states that the technological change that industry 4.0 brings in will revolutionize manufacturing processes to make them more environmentally sustainable. Through cloud computing manufacturing in the manufacturing plants, it can help in linking the demand and supply. Cloud computing can support organizations to remodel their business model in finding customers to acquire refurbished elements.

Zhao et al.; state that the incorporation of 3-d printing impacts the performance of a new product designed by the firm and will report the triple bottom line property. This study educates us on how 3-d printing alters how new products can be manufactured and how their performance is studied by looking into intermediate stages by developed and developing countries.

Esmaeilian et al.; states that Blockchain possesses the capacity to implement sustainability through a circular economy successfully. These capacities will navigate the circular economy in addressing solutions like emission reduction, increasing product lifecycle, and resource utilization to the fullest. He categorizes them as special token designing to promote green behavior, improve product visibility and lifecycle, increase system efficiency, reduce operational expenses, and improve sustainability monitoring.

2. TECHNOLOGIES OF INDUSTRY 4.0

2.1. Internet of Things (IoT)

IoT is a combination of intelligent and autonomous machines with human collaboration. It also uses predictive analysis to improve reliability, productivity, and efficiency. IoT not just helps in the fast transfer of data but also in real-time sensing. It simplifies the partnership between stakeholders and the operation of the manufacturing unit remotely. The combination of Cloud computing manufacturing and IoT has helped capture and process the data and effectively communicate to humans and systems.

IoT products have a unique system in identifying information linked to the origin and utility of a product. This technology, along with RFID systems, aids in data collection and analytics in many manufacturing units. They also help in syncing and coordination of information flow and product flow.

Smart manufacturing uses CPS-based IoT in accessing manufacturing resources to facilitate innovation by linking many parties through social networks, to provide more process flexibility with the help of RFID, to improve productivity and manage logistics processes.

2.2 Artificial Intelligence

In the industry 4.0 era, with the remote connection of AI and machine learning algorithms equipped in computer systems, the AI can operate almost with no human intervention. Decentralization of decision-making and observation of production processes using cyber-physical systems is possible in smart plants with the help of AI.

AI can help in transforming sustainability technically, socially, and on political aspects also. AI can work on multilevel, which can represent from citizens to even the country. It can analyze a multilevel that can help researchers and other vital representatives better understand nature's complexity and sustainability issues.

With multilevel modeling, researchers can examine the integration of socio-economic sustainability along with environmental sustainability. Thus, AI can help understand the impact of human activities and how unintentional actions have consequences, and how to overcome these limitations.

2.3 Big Data & Analytics

Data analytics can transform manufacturing industries. For this digital transformation, the industry must have various skills to develop algorithms and interpret the data. Big data analytics work with large data sets, structured or unstructured, with overflowing data about the process and manufacturing. Predictive maintenance can support decision-making, improve product quality, increase flexibility and energy efficiency.

2.4 Cloud computing

Cloud computing and technology enhance the sharing of data across many industries, increase flexibility and agility, improve performance, reduce prices by taking systems online, and present a framework for the smart factory. Cloud-based big data can aid in self-assembled physical systems and decision-making. Cloud computing and smart manufacturing in Industry 4.0 has great potential in the upcoming era of industrial development.

2.5 3-D printing

3-D printing innovation will conceivably permit clients to contribute to item plans and impact the item's impact choices. The assembling offices may draw nearer to the last clients. The options on plant areas can be reconsidered with the diminished expense because of automated frameworks in assembling. The reduced time and the expense productivity will influence significantly on carbon effects had by the development business. 3-D printing will clear the route towards sustainability.

2.6 Blockchain Technology

Blockchain can help increase tracking and visibility of the product, reducing the reworking of a product. It also helps trace the product's carbon footprint and improve the recycling process due to the increased connectivity between different sectors. It can also increase the transparency of the system, which can keep a check on

the system. Blockchain will increase product lifecycle, operations efficiency, and monitoring sustainability. There are limitations to the Blockchain, but it can ease sustainability issues and promote a circular economy.

3. Findings

This paper is descriptive research. The technologies such as IoT, AI, cloud computing, 3-D printing, big data analytics, blockchain technology, etc., are the giant leap to incorporate sustainability in the industry 4.0 era. Though most of these technologies are in the development phase, they exhibit the tremendous potential to pave the way for a sustainable world. More jobs are to be created across industries to employ these technologies. These technologies can support concepts like closed-loop systems, circular economy, etc. An elaborate study of research papers was conducted to learn about the aid of these technologies to promote sustainability in the industry 4.0 era.

4. Conclusions

Sustainability and climate change are real issues, and every industry should take a stand to tackle them. These technologies are a great solution to accelerate the transition towards sustainability. Many big companies have already transitioned towards zero carbon emission, and these technologies have helped through this transition very much. These technologies lead to predictive maintenance, increased automation, optimization of improvement of process, and a new level of efficiency and responsiveness to the customers that were not previously available. In Industry 4.0, sustainability should be kept centric to better the people, society, and world.

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