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The implementation of artificial intelligence in the manufacturing industry: Manufacturing execution systems and supply chain integration

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Abstract

Artificial intelligence (AI) is poised to significantly transform the manufacturing industry, with its integration into various processes such as manufacturing, decision-making, and logistics. This paper explores critical areas where AI is being and can be applied: Manufacturing Execution Systems (MES), Supply Chain Management (SCM), Challenges of AI Implementation in Manufacturing and Future Potential of AI in Manufacturing. In the context of MES, AI can optimize production processes, improve real-time monitoring, and enhance decision-making capabilities. Similarly, AI's impact on SCM is evident through improved forecasting, inventory management, and supply chain visibility. This paper aims to examine the potential applications and explore the opportunities AI offers in these domains, highlighting the ways in which it can revolutionize traditional manufacturing practices. Through a detailed analysis, we identify how AI-driven innovations could reshape manufacturing operations, enhance efficiency, and contribute to the future of the industry. However, challenges such as high implementation costs, information security concerns, and resistance from workers need to be addressed to fully realize AI's potential. By overcoming these obstacles, AI can redefine the future of manufacturing, making it smarter, more efficient, and sustainable. Reducing manufacturing costs through AI-driven innovations will be crucial for the industry in the near future.

Keywords: Artificial Intelligence; Manufacturing Execution System; Supply Chain Manufacturing; Advanced Manufacturing Systems

1. Introduction

Artificial intelligence is likely to play a pivotal role in disrupting the manufacturing industry in its future development. The integration of AI in the processes of manufacturing, decision-making, and logistics has a clear impact on the change of traditional manufacturing as an industry. There are two main approaches to implementing AI, and these are in MES and supply chain. The purpose of this paper is to determine the potential application of these domains and the possibilities that could exist when AI can be applied in those fields.

1.1. AI in Manufacturing Execution Systems (MES)

Manufacturing execution systems (MES) are operational systems that capture the happenings occurring on the production floor in real-time. AI in MES has turned these systems into intelligent systems to enable predictive and prescriptive analysis. However, when comparing all the uses of AI in MES, then it is evident that predictive maintenance is one of the most beneficial. The reliability of equipment can be predicted through AI, through the collected data from activity sensors and maintenance logs. This is a precaution that should be taken because it may preserve time, extend equipment life, and lower maintenance costs [1].

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In addition, AI also makes quality control better: real-time production line data can be analyzed. Computer vision systems can easily detect complexities, like defects, in products compared to human inspectors by operating in a machine learning approach. For instance, in the automobile industry AI systems are used to check whether the paint applied is perfect and if there are any defects that are not noticeable [2]. This leads to high-quality products with little or no scrap since the company can get back its investment in equipment within a short time due to increased efficiency. In addition, it is used to analyze large amounts of production information and to determine what changes should be made. For instance, it is possible to use AI to control the settings of a particular machine and optimize the use of energy or material, thus, making a company save money and the environment [3].

Another area of AI's importance in MES is enabling the integration of humans and machines. Cobots are integrated with artificial intelligence to accompany human operators in shared work activities, with robots performing repetitive tasks that are adjusted with input from a human operator. Efficiency is implied, and this also helps reduce employee accidents [4].

1.2. AI in Supply Chain Management

The role of artificial intelligence in the supply chain is extensive in the manufacturing industry. One of the most significant uses of AI in this context is demand forecasting. AI demands make forecasts more precise because of sales progression and such conditions as preparation, prevention, weather, or the state of the economy. This enables the manufacturers to arrange their production schedule in a way that is more advantageous to them and not have to produce stock that they never sell or sell stocks that were produced way ahead of time. [5].

In the same way, it assists in inventory management tasks such as ensuring that the appropriate and adequate stock levels are obtained from the current inventory data. Some of these systems are designed to reorder materials when a defined stock level is reached so as not to disrupt production. Moreover, it is used to filter slow-moving stocking since it will meet the requirement of stocking at the bare minimum while reducing stock pile-up [6], along with measuring buffer and safety stock calculations incorporated into the AI model.

Moreover, another facet of supply chain management is supplier relationship management in which the efficiency of suppliers and also the level of risk associated with them can be evaluated with the help of AI. Forecasting aids in identifying possible negative factors that may cause delays or compromise quality; manufacturers can minimize or even halt these negative issues [7]. This, in a way, helps to ensure a more total, reliable source of the materials needed for production. The use of Artificial intelligence in supply chain activities to improve the degree of effectiveness, cost, and flexibility in manufacturing.

1.3. Challenges of AI Implementation in Manufacturing

However, it must also be said that this development of AI manufacturing, as well as the supply chain, is not without its challenges. A problem is the high cost associated with the deployment of AI technologies. In addition, acquiring the right talent and supporting infrastructure and software is an even bigger challenge to emerging SMEs [8]. Data privacy and protection are a limitation since much of the information processed and analysed for operations and strategies is deemed sensitive along with unknown threat from data hackers or data malfunction. Concerns such as hacking and unauthorized access of the data since the AI systems work with a large volume of data can be raised. In the process of formulating the policy of the industry, the manufacturers have to ensure that adequate measures have been put in place to protect data [9] taking initiative of having self-data protection policies put in place.

There is also the workforce’s resistance to incorporating AI. Some potential challenges that may be expected in implementing the solutions include loss of jobs or inherent poor adaptability to the technologies to be implemented. Moreover, the complexity of AI systems’ implementation can hinder manufacturers from getting the most out of their capabilities [10]. To overcome these challenges, there is a need for strategic management with an emphasis on stakeholder involvement and learning [11].

1.4. Future Potential of AI in Manufacturing

The further development of AI in the manufacturing industry is expected with different technologies in its activity, such as IoT, 5G, and edge computing. These will facilitate fast real-time processing and decision-making in relation to the AI-MES and AI-SC systems [12].

Also, in Agriculture machinery manufacturing and its usage without human involvement will be achievable in near future using AI technology [14]. Further, the introduction of explainable artificial intelligence (XAI) will also mitigate problems of opaqueness, making artificial intelligence more relatable and believable [13].

2. Conclusion

The use of Artificial Intelligence in the Manufacturing Execution Systems and supply chain is becoming revolutionary in the production line. With the help of AI, trends may be easily predicted, top quality may be maintained, production processes may be optimized, and supply chains may be made smarter, less costly, and environmentally sustainable. Nevertheless, different issues, including high costs, information security, and resistance by the workers, are some of the issues that need to be resolved to unlock the potential of AI. Thus, establishing AI as a key element for defining new trends in manufacturing as smart, efficient, and sustainable. Help reduce its costs in manufacturing is very significant in near future.

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