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*Research Article*

# Revolutionizing Medical Device Implants: Unleashing the Power of Industry 5.0

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***Abstract*** *- Industry 5.0, the most recent industrial revolution, provides the potential to change the medical device implant production industry. Industry 5.0 offers a highly automated and networked production environment by merging cyber-physical systems, artificial intelligence (AI), machine learning, and the Internet of Things. This environment enables real-time data collection and analysis, enhancing manufacturing processes, cost savings, and product quality. The use of AI and machine learning improves decision-making capacities by detecting patterns in data and forecasting future trends. Incorporating Business 5.0 into the medical device implant manufacturing business can alter the industry by allowing manufacturers to develop a fully automated and linked production environment. Utilizing sophisticated technologies like AI, machine learning, the Internet of Things, and robots allows for the collection and analysis of real-time data to optimize production, cut costs, and improve product quality. The relevance of Business 5.0 in transforming the medical device implant manufacturing business is highlighted in this study, as is the transformational impact of AI and machine learning in decision-making processes.*

***Keywords*** *- Additive manufacturing, Artificial intelligence, Cyber-physical systems, Data analytics, Emerging technologies, Human-machine collaboration, Industry 4.0, Industry 5.0, Medical device implant manufacturing.*

## 1. Introduction

Industry 5.0 is the quintessential industrial revolution, where physical and digital worlds meld together in manufacturing. This latest step in industrial evolution involves integrating cyber-physical systems, AI, and the Internet of Things, all of which have the potential to revolutionize medical device implant production. This advanced technology has augmented production efficacy and accuracy, diminished costs, and optimized product quality [3]. In medical device implant manufacturing, Industry 5.0 employs AI, machine learning, the Internet of Things, and robotics to create a highly automated and interconnected manufacturing atmosphere. This atmosphere permits the gathering and examination of real-time data for improved production, cost savings, and product excellence.

The import of Industry 5.0 to the medical device implant manufacturing sector is the aptitude to fabricate a thoroughly mechanized and interconnected manufacturing milieu. This habitat allows for the assemblage and scrutiny of real-time data to refine the production system, curtail expenses, and improve the quality of the product [4]. Moreover, the application of artificial intelligence and machine learning can be used to discover designs in the data and forecast potential prospects, granting producers the ability to make more sound decisions concerning production.

The amalgamation of Industry 5.0 into the medical device implant fabrication sector may have the capacity to transform the industry. Manufacturers can construct a highly mechanized and connected manufacturing atmosphere by leveraging sophisticated technologies such as AI, machine learning, the Internet of Things, and robotics. This atmosphere permits the aggregation and assessment of real-time information to refine the production procedure, reduce expenditures, and enhance product quality [5]. Additionally, AI and machine learning can detect patterns in the data and forecast prospective tendencies, allowing manufacturers to make sounder decisions regarding production.

## 2. Objective

The aim is to construct a blueprint for amalgamating Industry 5.0 into the medical device implant manufacturing sector. This assessment will be centered around discerning the repercussions of Industry 5.0 on the medical device implant manufacturing industry, pinpointing potential advantages and obstacles, and suggesting tactics to guarantee a successful integration. The review will commence by examining the existing condition of the medical device implant manufacturing industry and its requirements for amalgamation of Industry 5.0. This exploration will investigate the prevailing technological milieu, sectorial tendencies, and market rivalries. It will also comprise an analysis of the likely openings and hindrances


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that Industry 5.0 presents for the medical device implant manufacturing industry [6].

The subsequent scrutiny will traverse the potential avails of Industry 5.0 for the medical device implant manufacturing sector. This will include an inspection of the possible cost reductions, heightened efficacy, augmented product excellence, and better consumer experience that Industry 5.0 can offer. The evaluation will then contemplate the possible perils affiliated with the amalgamation of Industry 5.0 into the medical device implant manufacturing industry. This will comprise a breakdown of the potential security vulnerabilities, data confidentiality worries, and cultural obstruction to alteration that could be encountered.

## 3. Literature Review

In recent years, Industry 5.0 has emerged as a transformative concept in the realm of industrial technology and manufacturing, as shown in Figure 1. Building upon the foundations laid by Industry 4.0, this paradigm shift promises not only to revolutionize production processes but also to redefine the relationship between humans and machines. As businesses contemplate the transition from Industry 4.0 to Industry 5.0, critically examining the existing literature is essential to comprehend the evolving landscape, identify key trends, and pinpoint areas where further research is warranted.

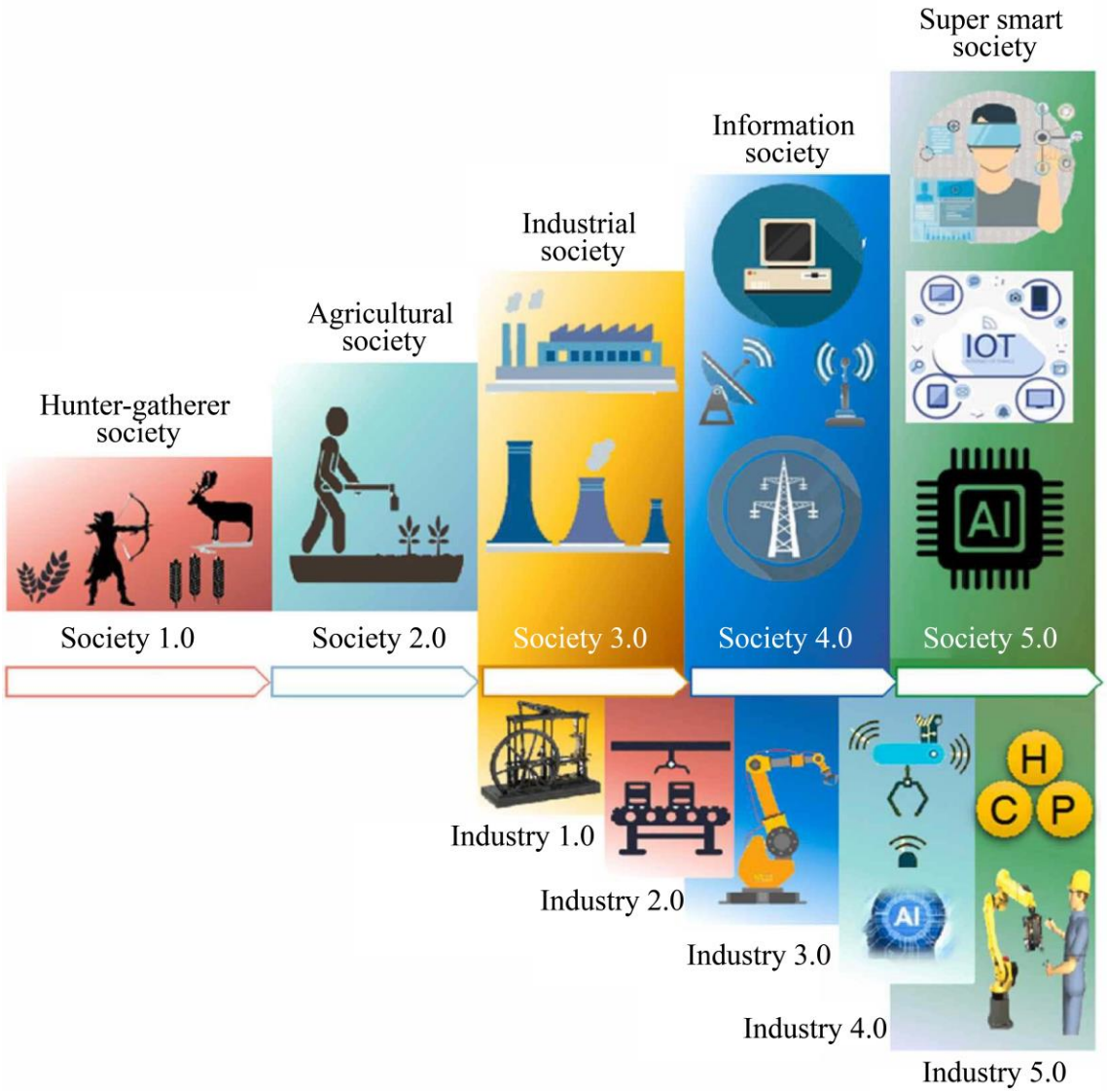


**Fig. 1 Industry evolution [42]**

The current research gaps in Industry 5.0 technologies can be categorized into four main aspects: Technological advancements, Human-centric solutions, Challenges and barriers, and Sustainability and environmental impact.

*Category 1: Technological Advancement shown in Table 1.*

**Table 5. Research gap in technological advancement**

| Research Gap | Description |
|---|---|
| Adoption of Industry 5.0 | The transition from Industry 4.0 to Industry 5.0 poses a challenge as companies need to adapt to new technologies like big data, IoT, and digital twins while integrating a human-centric approach [1]. |
| Enabling Technologies | Investigate the role of key technologies such as big data, IoT, cloud computing, 6G networks, and Blockchain in enabling Industry 5.0 and how these technologies can be effectively implemented [31]. |
| Integration Challenges | Explore the challenges manufacturers face when integrating new Industry 5.0 technologies into their existing operations and supply chain [32]. |
| Implementation Strategies | Study how companies can effectively implement Industry 5.0 technologies, given the complexity of introducing these innovations into manufacturing processes [1]. |

*Category 2: Human-centric Solutions shown in Table 2.*

**Table 2. Research gap in human-centric solutions**

| Research Gap | Description |
|---|---|
| Human-Machine Collaboration | Investigate methods to enhance human-machine collaboration, emphasizing robots as collaborators rather than competitors in Industry 5.0 settings [33]. |
| Workforce Realignment | Explore how the Industry 5.0 workforce combines human and digital resources, leveraging AI, big data, machine learning, cloud computing, and IoT to create smart factories [34]. |
| Standardization and Legalization | Research the need for standardized regulations to prevent potential conflicts between technology, society, and businesses as Industry 5.0 evolves [33]. |
| Societal Impact | Analyze the societal implications of Industry 5.0, addressing concerns related to technological unemployment and ensuring technology alignment with societal values [35]. |

*Category 3: Challenges and Barriers shown in Table 3.*

**Table 3. Research gap in challenges & barriers for Industry 5.0**

| Research Gap | Description |
|---|---|
| Human-Centric Processes | Explore ways to make Industry 5.0 processes more human-centric and address resistance to automation from labor unions and policymakers [1]. |
| Investment and Training | Investigate the financial challenges of adopting Industry 5.0, including the costs associated with upgrading production lines and training the workforce for new roles [36]. |
| Pace of Adoption | Study the pace of technological change in Industry 5.0 and how it may lead to disparities, leaving some companies behind due to their inability to afford or adapt to new technologies [34]. |
| Security Challenges | Examine the stringent security requirements posed by Industry 5.0 applications, ensuring the protection of critical systems and data from potential threats [37]. |

*Category 4: Sustainability and Environmental Impact shown in Table 4.*

**Table 4. Research Gap in Sustainability & Environmental Impact**

| Research Gap | Description |
|---|---|
| Circular Economy Integration | Investigate how Industry 5.0 can promote a circular economy by preserving ecological and resource integrity through sustainable manufacturing processes and waste reduction strategies [38]. |
| Social and Environmental Prioritization | Study integrating social and environmental concerns alongside technological innovation in Industry 5.0 to ensure sustainability remains a central goal [39]. |
| Sustainable Development | Explore strategies for achieving sustainable development within the context of Industry 5.0, considering environmental, economic, and social dimensions [40, 41]. |

## 4. Industry 4.0 and Medical Device Manufacturing

Industry 4.0 is the fourth industrial revolution, otherwise dubbed the "smart factory" revolution. This industrial transformation amalgamates the physical production process with the digital world, allowing machinery and systems to be linked, governed, and tracked through the web. It incorporates innovative technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), Big Data, and cloud computing to mechanize and refine production procedures [3]. Industry 4.0 is a thorough idea encompassing the digital metamorphosis of all aspects of the production process, from product conception to production and service. It is a comprehensive system that permits data-driven production processes, providing real-time information on production performance and enabling more efficient decision-making.

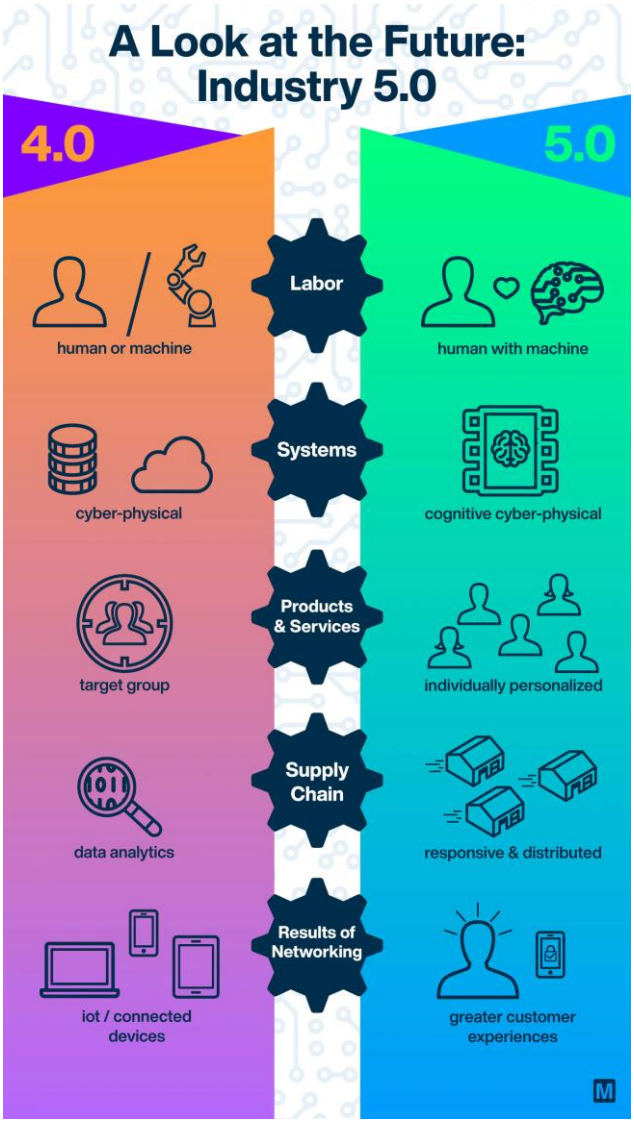


**Fig. 2 Industry 4.0 v/s Industry 5.0**

The manifold advantages of Industry 4.0 are apparent. It augments productivity and efficacy, minimizes waste and idle time, and bolsters quality control. It also furnishes access to data-driven intelligence, which can help producers optimize their production operations. The adoption of Industry 4.0 in medical device implant fabrication is becoming progressively popular due to its capability to streamline production and refine quality control [6]. It can assist in shortening the time and cost of production by automating processes, abating manual labor, and intensifying efficiency. It can also assist in reducing the hazard of human mistakes and enhancing the accuracy of medical implants. Furthermore, Industry 4.0 can help to improve traceability and furnish data-driven intelligence, which can help to recognize and resolve problems quickly.

Industry 4.0 has the potential to transform the medical device implant fabrication industry. Real-time data and intelligence can help augment efficiency, cut costs, and ensure quality control. As more producers adopt Industry 4.0, it will likely become integral to the medical device implant fabrication process. Take a look at Figure 2.

Industry 4.0 is a name given to the fourth industrial revolution, where daily manufacturing operations are mechanized and connected through the Internet of Things (IoT). The primary aim of Industry 4.0 is to assemble a unified system of production in which machines, procedures, and personnel are interconnected through the web and utilize big data analytics to amplify production proficiency and item excellence. In the medical device implant fabrication sector, Industry 4.0 has the potential to upend the production process [7]. It can aid manufacturers in boosting the accuracy, efficiency, and quality of their goods. Implementing Industry 4.0 in this industry can also reduce the cost of production, better customer gratification, and shorten the time to market.

To begin the introduction of Industry 4.0 into the manufacturing of medical device implants, the primary objective is to identify those regions that require betterment. This can be accomplished by conducting a survey of the current production process and finding the locations where automation can be utilized to increase productivity. After the deficient areas have been identified, it is necessary to construct a cohesive system of production where machines, procedures, and personnel are linked via the Internet. This arrangement permits companies to observe and govern production from one platform. The subsequent action is to deploy big data analytics, which allows businesses to collect information from various sources, such as production machines, sensors, and consumer reviews, and apply this data to refine the production procedure. Through analysis of this information, companies can discover patterns, detect flaws, and make judgments based on current data.

Manufacturers must finally resort to sophisticated technologies such as 3D printing, robotics, and AI to increase their output's exactitude, efficiency, and excellence. These mechanisms can be utilized to automate activities, lower the cost of production, and better customer contentment. Introducing Industry 4.0 in the medical device implant manufacturing sector can potentially revolutionize the manufacturing procedure [7]. By incorporating these state-of-the-art technologies into their production process, manufacturers can augment their output's accuracy, effectiveness, and quality, lessen production costs, and heighten customer gratification.

The medical device implant manufacturing industry benefits from adopting Industry 4.0, which facilitates enhanced traceability and quality control through real-time data tracking. Additionally, it enables swifter and more efficient production cycles with automated processes, leading to more incredible velocity and cost savings. Despite the clear advantages, there are drawbacks to be reckoned with, such as the hefty capital outlay for implementing new technologies and systems and the potential for human job displacement and security issues due to cyber-attacks [8]. However, with prudent strategies and investments, these constraints can be mitigated, and the perks of Industry 4.0 can be thoroughly enjoyed.

## 5. Evolution of Industry 4.0 to Industry 5.0

Industry 5.0 denotes the fifth industrial revolution, a fusion of the physical and virtual realms of production. Figure 3 shows this is an advancement in Industry 4.0, which concentrates on digitalization and automation of production. Industry 5.0 takes this to a higher level by assimilating Artificial Intelligence (AI) and robotics into the fabrication system, producing a "smart factory" that is more effective and cost-efficient. The basis of Industry 5.0 is digitalization, automation, and intelligence. Digitalization involves transforming tangible items into digital data [9]. Automation is the application of machines and robots to complete tasks with limited human involvement. Intelligence involves employing AI to refine processes and identify issues before their emergence.

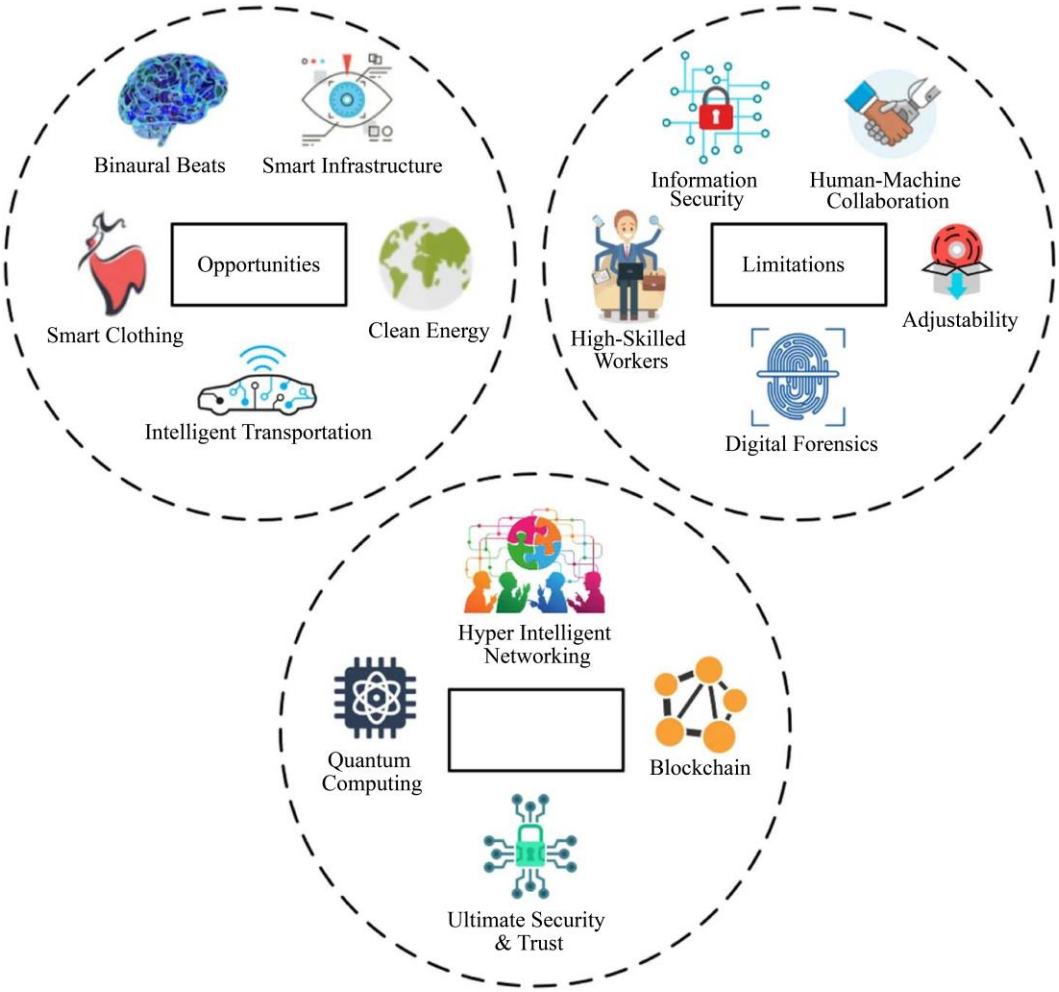


**Fig. 3 Opportunities, Limitations, & Future Research [1]**

**Table 5. Technologies used in Industry 4.0 & Industry 5.0**

| Industry 4.0 | Industry 5.0 |
|---|---|
| Smart Manufacturing | Autonomous Manufacturing |
| Data-driven Automation | Autonomous Systems and Process |
| Cyber-physical System | Artificial Intelligence (AI) and Robotics |
| Internet of Things (IoT) | Augmented Reality (AR) and Virtual Reality (VR) |
| Cloud Computing | Autonomous Supply Chains |
| Predictive Maintenance | Cognitive Maintenance |

Industry 5.0 is projected to bring countless advantages to producers, such as enhanced output, financial savings, and enhanced quality control. Manufacturers can boost effectiveness and minimize mistakes by capitalizing on AI and robotics. Additionally, data analytics can help uncover latent issues and optimize operations. The objective of Industry 5.0 is to build a "smart factory" where machines and robots can collaborate to create an effortless and efficient production process. By integrating digitalization, automation, and intellect, manufacturers can reach higher efficacy and cost savings [10]. Ultimately, Industry 5.0 will help bring forth a more sustainable and profitable manufacturing landscape.

The mutation of Industry 4.0 to Industry 5.0 is metamorphosing the medical device implant fabrication method. With the advent of Industry 5.0, producers can now generate more effective, dependable, and inexpensive items, resulting in a surge in demand for these products and empowering medical device implant manufacturers to be more aggressive in the global market. Incorporating Industry 5.0 into medical device implant production has perils and prospects. One of the primary difficulties is the expenditure related to the amalgamation of new technologies and operations [11]. The technology is relatively novel, so the requisite hardware and software expenses can be excessive. Additionally, educating personnel to work with the new technology and processes can be costly and laborious.

## 6. Relevance of Industry 5.0 with Medical Device Implant Manufacturing

### *6.1. Human-Machine Collaboration*

Medical device implant manufacturing in Industry 5.0 requires close collaboration between humans and machines, which is vital to this concept. Optimization of the manufacturing process and compliance with rigorous industry regulations is achievable through the human-machine partnership for medical device implant manufacturers [12]. The production process may benefit from integrating robotic automation to enhance efficiency while assuring accuracy and quality through human oversight.

### *6.2. Cyber-Physical Systems*

Cyber-physical technology is a fundamental requirement for medical device implant manufacturing within the framework of Industry 5.0. By incorporating cyber-physical systems in their operations, medical device implant manufacturers can improve their ability to supervise the entire production cycle, which includes identifying potential concerns early while enhancing productivity.

### *6.3. Data Analytics and Artificial Intelligence*

Industry 5.0 strongly emphasises data analytics and artificial intelligence, critical medical device implant manufacturing concepts. Data analytics and artificial intelligence can aid medical device implant manufacturers identify improvement opportunities within the production process [13]. Additionally, forecasting potential issues with the help of predictive analytics can assist in refining manufacturing procedures.

### *6.4. Additive Manufacturing and Emerging Technologies*

Medical device implant manufacturers must leverage the benefits offered by additive manufacturing and other emerging technologies under Industry 5.0. Optimizing the production process while maintaining high-quality standards is possible for medical device implant manufacturers through emerging technologies like additive manufacturing [14]. Incorporating 3D printing for fast, complex part production and using augmented reality to offer immediate feedback to employees could be beneficial.

### *6.5. Personalization and Customization*

Personalization and customization play a critical role in medical device implant manufacturing as they align with fundamental concepts of Industry 5.0. Personalization and customization allow medical device implant manufacturers to create products that better align with the unique requirements of each patient [15]. Custom-made implants can be produced using advanced techniques such as 3D printing, and utilizing AI algorithms is also an option.

## 7. Conclusion Framework for Industry 5.0 Integration in Medical Device Implant Manufacturing

Adel (2022) illuminates the prospects of Industry 5.0 to overhaul society and offers an appraisal of its current state and foreseeable future. The author perceives several difficulties that could impede the effective execution of Industry 5.0, including a need for more public cognizance, proper infrastructure, and the demand for new technical solutions [1]. In addition, the article reflects on the possibility of Industry 5.0 to refine the quality of life for citizens by offering enhanced access to healthcare,

education, and transportation services. Additionally, the article alludes to the requirement for new research and development to ensure the effective implementation of Industry 5.0 in medical device implant fabrication.

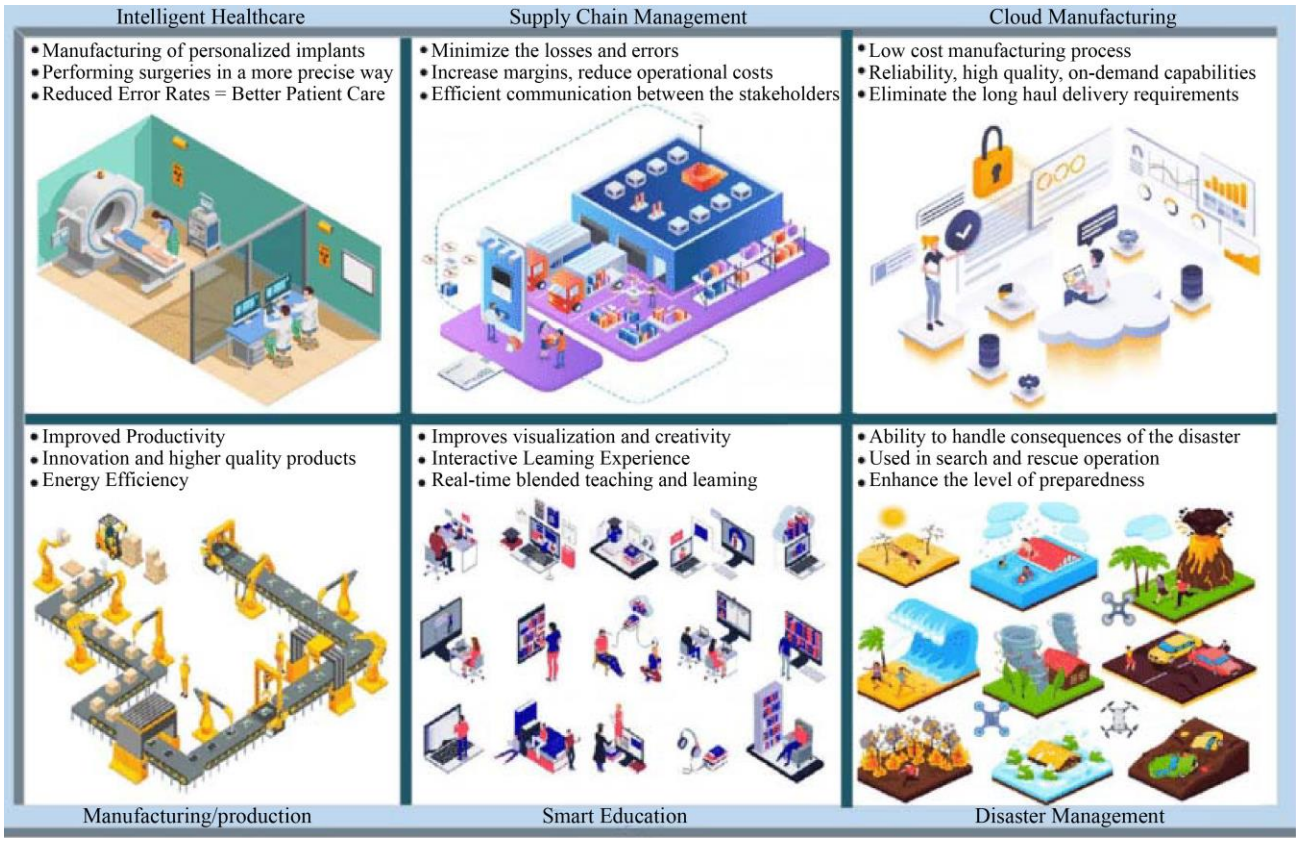


**Fig. 4 Industry 5.0 applications [38]**

Expressly, Adel intimates that research should be directed towards establishing technologies that can deliver exact and dependable data, as well as technologies that can improve the efficacy and safety of the manufacturing process [1]. Moreover, Adel proposes that research be conducted to pinpoint the most productive methods for combining Industry 5.0 into existing manufacturing processes. In summation, this article provides a perspicacious synopsis of the potential of Industry 5.0 to revolutionize medical device implant fabrication and the potential challenges and research opportunities associated with its successful implementation.

I. Santos' paper deliberates on the significance of product development protocols in the medical device industry. The writer investigates the prevailing methods employed in the industry and how they can be adjusted to assimilate Industry 5.0 inclusion. Moreover, the paper examines the influence of Industry 5.0 on the product development course, from pattern to fabrication and distribution [2]. It reveals that Industry 5.0 has brought the notion of 'intelligent' production and digital transformation, which has revolutionized how products are formulated and produced. It also insinuates that medical device producers must include the new technology to remain competitive. The paper further explores the likely problems related to amalgamating Industry 5.0 in medical device implant production, such as the requirement for high-grade data, high degrees of mechanization, and a transition from manual to automated operations. All in all, I. Santos' paper thoroughly overviews the current product development procedures used in the medical device industry and how they can be adjusted to embrace Industry 5.0 inclusion. It likewise provides a valuable system for medical device producers to ponder when forming their Industry 5.0 strategies.

## 8. Case Studies of Industry 5.0 Integration in Medical Device Implant Manufacturing

The significance of Industry 5.0 is becoming more and more palpable in the realm of medical device implant fabrication. This is because of the necessity for more competent, thrifty, and quality-driven manufacturing systems. Industry 5.0 emphasizes the amalgamation of cyber-physical systems, the Internet of Things (IoT), artificial intelligence (AI), and cloud computing. This coalescence helps producers to elevate the exactitude and expediency of production procedures [16]. Intelligence sensors are a specimen of triumphant Industry 5.0 integration in medical

device implant fabrication. Savvy sensors are utilized to monitor the temperature, pressure, and other parameters of the manufacturing system [30]. This assists manufacturers in detecting and tackling any issues that arise promptly and precisely. This permits enhanced quality control and faster production.

Integrating Industry 5.0 in manufacturing medical device implants has yielded beneficial outcomes, including leveraging AI-driven analytics to enable manufacturers to survey the production process in real time and pre-empt prospective snags. This has contributed to decreased extraness and optimized the entire production procedure. Moreover, cloud computing is employed to aid in the integration of Industry 5.0 in medical device implant fabrication, allowing for more collaborative and shared data storage and enabling more effective decisions and planning of production. Ultimately, the combination of intelligent sensors, AI-driven analytics, and cloud computing has refined the precision, efficiency, and excellence of medical device implant fabrication production processes.

Industry 5.0 is the apogee of industrial development, coalescing physical production with digital technologies to form an integrated and automated production system. Implementing Industry 5.0 into medical device fabrication may yield substantive enhancements in production proficiency, caliber, and personalization. In terms of efficacy, Industry 5.0 technologies such as AI, robotics, and 3D printing may abet the streamlining of production via automation and the elimination of manual processes, consequently reducing both cost and time investment [17]. Moreover, these same technologies may be used to survey production systems and detect areas of inefficiency, providing producers with an enriched capacity for optimizing their processes.

Through the integration of Industry 5.0, the production process can be monitored in real-time, enabling the detection of any potential defects before they become problematic. Moreover, areas for improvement can be pinpointed and optimized to guarantee that products are produced of the highest caliber. Finally, customizability is increased by way of 3D printing, granting a personalized approach to implants, which can result in superior outcomes [18]. By exploiting the power of Industry 5.0, medical device implant producers can reap the rewards of greater efficiency, quality, and customization - thereby decreasing costs and satisfying customers.

## 9. Opportunities and Challenges

The infusion of Industry 5.0 into medical device implant fabrication necessitates a multifaceted appraisal of regulatory and ethical problems. From the regulatory standpoint, the industry must ensure that the medical device implant complies with all safety and efficacy regulations prescribed by controlling authorities. In addition, manufacturers must ascertain that the device is produced in harmony with Good Manufacturing Practices (GMPs). Ethically, the industry must guarantee that the device is made to safeguard the patient's autonomy and secrecy [19]. Furthermore, producers must ensure the device is not employed for unscrupulous or illegal aims. All these deliberations must be pondered when integrating Industry 5.0 into medical device implant fabrication.

Integrating Industry 5.0 into medical device implant fabrication offers potential benefits and perplexing problems. One of the significant benefits is the capacity to train and upgrade personnel more effectively. Automation and data-driven processes of Industry 5.0 enable employees to be better equipped with the newest technologies and systems, which can ultimately improve the efficacy and excellence of medical device implant manufacturing [20]. On the other hand, some challenges are associated with integrating Industry 5.0 into medical device implant production. One of the fundamental difficulties is the requirement for vast expenditure in training and up-skilling the labor force. For employees to effectively operate the most modern technologies and systems, they must be given instruction and upgraded, a process that requires considerable time and money, which can be difficult for medical device implant producers to afford.

The potential of Industry 5.0 to revolutionize medical device implant manufacturing is substantial. Manufacturers can gain efficiency, cost savings, and product quality enhancements by utilizing sophisticated technologies such as IoT, AI, Big Data, Robotics, and 3D printing. Furthermore, Industry 5.0 enables the production of customized implants suited to individual patient requirements and greater traceability and visibility in the manufacturing process. Despite the immense benefits of Industry 5.0 integration, challenges regarding technology adoption and integration still need to be addressed [21]. Medical device implant manufacturers must invest in the necessary equipment and develop the capabilities to use it proficiently. Furthermore, security and compliance measures must be put in place to protect data and integrate systems and databases to ensure smooth data exchange.

Implementing Industry 5.0 into medical implant production entails perks and conundrums regarding data privacy and safety. On the plus side, digital tools such as AI can heighten the dependability and usefulness of medical implants by providing real-time tracking and responses. This can lessen inaccuracies and amplify patient well-being [29]. On the other hand, applying digital tools also elevates the peril of data infringement since vulnerable patient data must be securely saved and defended. To guarantee data privacy and safety, manufacturers should remove unauthorized access, like scrambling data and limiting admittance to

certified personnel [22]. Furthermore, manufacturers must create a comprehensive data security plan to protect against data violations and ensure that patient data is not misused.

## 10. Future Direction for Research and Practice

The quickly evolving nature of emerging technologies and trends is revolutionizing the medical device implant production sector. From 3D printing to laser cutting and CNC machining - advanced digital fabrication techniques are revolutionizing manufacturing. With technology advancements, we can now quickly produce exact and complex medical implants while also cutting costs. Metals and polymers are increasingly used to create medical implants [28]. Improved performance, longevity, and compatibility with biology are all advantages of these modern materials over their traditional counterparts. Additionally, it should be noted that these materials may be personalized to cater to individual patient needs.

The utilization of automation and robotics in medical device implant fabrication is rapidly becoming ubiquitous. This allows for enhanced precision, expeditiousness, and cost-effectiveness during fabrication. Moreover, automation and robotics can decrease the likelihood of human error and guarantee quality control. Finally, data analytics and artificial intelligence (AI) are also increasingly employed in medical device implant manufacturing. Data analytics and AI can be leveraged to discern trends and refine production procedures [23]. This can aid in upgrading product quality, diminishing expenses, and ensuring patient safety. Generally speaking, the medical device implant manufacturing sector is quickly evolving due to new technologies and trends, such as the migration to digital fabrication techniques, utilization of biocompatible materials, automation and robotics, and data analytics and AI. As these trends keep developing, the industry will persistently become more efficient and cost-effective.

## 11. Conclusion

To summarize, this exploration has appraised the chance of implementing Industry 5.0 in the medical device implant manufacturing sector. It has been determined that Industry 5.0 is a revolutionary industrial transformation that will lead to considerable alterations in the production of medical device implants [24]. Characterized by the amalgamation of the Internet of Things (IoT), extensive data, artificial intelligence (AI), and modern robotics in the manufacturing process, it has been evidenced that these technologies possess the potential to revolutionize the medical device implant manufacturing industry, providing more proficient and economical fabrication [25].

The analysis has underscored the need for devising a structure for the amalgamation of Industry 5.0 into the medical device implant fabrication industry. Such a structure should ponder the potential advantages and impediments linked with implementing Industry 5.0 technologies, in addition to the regulatory stipulations for medical device implants [26]. Moreover, the structure should incorporate the formation of a roadmap for the amalgamation of Industry 5.0 technologies and contemplate the potential effect on extant production processes and systems.

This review has elucidated the feasibility of implementing Industry 5.0 into the medical device implant manufacturing sector. It has highlighted the necessity of constructing a paradigm to guide the integration of Industry 5.0 technologies. It has granted cognizance of their deployment's potential rewards and impediments [27]. The outcomes of this review have ramifications for the medical device implant manufacturing industry. They can be employed to formulate a model for integrating Industry 5.0 technologies.

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