

## INDUSTRY 5.0 – CHARACTERISTIC, MAIN PRINCIPLES, ADVANTAGES AND DISADVANTAGES

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**Purpose:** The aim of the paper is to analyze the Industry 5.0 concept and compare it with Industry 4.0.

**Design/methodology/approach:** Critical literature analysis. Analysis of international literature from main databases and polish literature and legal acts connecting with researched topic.

**Findings:** Industry 5.0 offers several benefits that make it worth adopting in manufacturing industries, including improved efficiency, greater quality control, sustainability, enhanced worker safety, improved customer experience, cost savings, competitive advantage, increased innovation, and positive social impact. By integrating human creativity and intuition with advanced machinery and technology, Industry 5.0 promises to create a more sustainable, flexible, and socially responsible manufacturing environment that delivers higher quality products and more meaningful jobs.

**Originality/value:** Detailed analysis of all subjects related to the problems connected with the Industry 5.0.

**Keywords:** Industry 4.0; innovation, industrial enterprise, design thinking, innovativeness.

**Category of the paper:** literature review.

### 1. Introduction

Industry 5.0 is a theoretical concept that represents the next phase of industrial development beyond Industry 4.0. While Industry 4.0 focused on the integration of advanced technologies such as automation, artificial intelligence, and the Internet of Things (IoT) into manufacturing processes, Industry 5.0 seeks to integrate these technologies with human creativity and intuition to create a more collaborative and flexible manufacturing environment (Wang et al., 2023).

Overall, Industry 5.0 seeks to create a manufacturing environment that is not only technologically advanced but also human-centric, sustainable, and socially responsible.

The aim of the paper is to analyze the Industry 5.0 and compare it with industry 4.0.

## 2. The characteristic of Industry 5.0

Industry 5.0 represents a new era of manufacturing, characterized by the integration of advanced technologies and human creativity to create a more collaborative and flexible manufacturing environment. While Industry 4.0 emphasized automation and technology-driven efficiency, Industry 5.0 seeks to integrate human workers more fully into the manufacturing process, working collaboratively with machines to maximize productivity and quality (Taverner et al., 2021).

One of the key features of Industry 5.0 is a greater emphasis on collaboration. Instead of seeing machines and humans as separate entities, Industry 5.0 seeks to create a manufacturing environment where workers and machines work together, leveraging each other's strengths to achieve greater productivity and quality (Jonek-Kowalska, Wolniak, 2021, 2022; Jonek-Kowalska et al., 2022; Kordel, Wolniak, 2021, Orzeł, Wolniak, 2021, 2022; Ponomarenko et al., 2016; Stawiarska et al., 2020, 2021; Stecuła, Wolniak, 2022; Olkiewicz et al., 2021). This collaboration is made possible by advanced technologies like collaborative robots, augmented and virtual reality, and real-time monitoring and feedback systems.

Another important aspect of Industry 5.0 is a greater emphasis on human creativity and intuition. While Industry 4.0 introduced the concept of smart factories, Industry 5.0 takes this to a new level by leveraging technology to help workers express their ideas and designs more fully. Technologies like virtual and augmented reality can help workers visualize and test new products and designs in a more immersive and interactive way, leading to greater innovation and creativity in the manufacturing process (Sindhvani et al., 2022).

In addition to these features, Industry 5.0 also places a greater emphasis on sustainability and social impact. By promoting a circular economy model and responsible resource use, Industry 5.0 seeks to create a more sustainable manufacturing process that minimizes waste and reduces environmental impact (Wolniak, 2016; Czerwińska-Lubszczyk et al., 2022; Drozd, Wolniak, 2021; Gajdzik, Wolniak, 2021, 2022; Gębczyńska, Wolniak, 2018, 2023; Grabowska et al., 2019, 2020, 2021). It also recognizes the impact that the manufacturing industry can have on workers and communities, and seeks to create a more positive and supportive working environment through technologies like digital assistants and advanced safety systems.

Overall, Industry 5.0 offers several benefits that make it worth adopting in manufacturing industries. These include improved efficiency, greater quality control, sustainability, enhanced worker safety, improved customer experience, cost savings, competitive advantage, increased innovation, and positive social impact. By integrating human creativity and intuition with advanced machinery and technology, Industry 5.0 promises to create a more sustainable, flexible, and socially responsible manufacturing environment that delivers higher quality products and more meaningful jobs. As manufacturing continues to evolve, Industry 5.0 offers

an exciting glimpse into the future of manufacturing and the potential for human-machine collaboration to create a better world (Rachmawati et al., 2022).

The role of human factor in Industry 5.0 is essential, as this new era of manufacturing places a greater emphasis on collaboration between humans and machines. While Industry 4.0 was characterized by a high level of automation and technology-driven efficiency, Industry 5.0 seeks to integrate human workers more fully into the manufacturing process, leveraging their creativity, intuition, and problem-solving skills to maximize productivity and quality.

In Industry 5.0, machines and humans are seen as complementary rather than separate entities. Advanced technologies like collaborative robots, augmented and virtual reality, and real-time monitoring and feedback systems are used to help workers express their ideas and designs more fully, while machines take care of the more repetitive and physically demanding tasks. This collaboration leads to a more flexible and responsive manufacturing process that can better adapt to changing market demands and customizations (Wolniak, Sułkowski, 2015, 2016; Wolniak, Grebski, 2018; Wolniak et al., 2019, 2020; Wolniak, Habek, 2015, 2016; Wolniak, Skotnicka, 2011; Wolniak, Jonek-Kowalska, 2021; 2022).

Another important aspect of the human factor in Industry 5.0 is the promotion of worker well-being and job satisfaction. By creating a more supportive and positive working environment through technologies like digital assistants and advanced safety systems, Industry 5.0 seeks to empower workers and promote their well-being. This can lead to increased job satisfaction, productivity, and innovation, as workers feel more engaged and valued in their work.

Human factors also play a key role in the quality control process in Industry 5.0. While machines can provide data and insights into product quality, humans bring their intuition and experience to the process, identifying and addressing issues that may not be immediately apparent through data analysis. By combining the insights of both machines and humans, Industry 5.0 can deliver higher quality products that meet the needs of customers and the market (Olsen, 2023).

The role of the human factor in Industry 5.0 is essential, as this new era of manufacturing seeks to integrate human workers more fully into the manufacturing process and leverage their creativity, intuition, and problem-solving skills. By promoting collaboration between humans and machines, creating a more supportive and positive working environment, and combining the insights of both machines and humans in the quality control process, Industry 5.0 promises to create a more flexible, responsive, and socially responsible manufacturing environment that delivers higher quality products and more meaningful jobs (Sułkowski, Wolniak, 2015, 2016, 2018; Wolniak, Skotnicka-Zasadzień, 2008, 2010, 2014, 2018, 2019, 2022; Wolniak, 2011, 2013, 2014, 2016, 2017, 2018, 2019, 2020, 2021, 2022; Gajdzik, Wolniak, 2023).

The role of sustainability in Industry 5.0 is crucial, as this new era of manufacturing places a greater emphasis on responsible resource use and minimizing environmental impact. While Industry 4.0 was focused primarily on automation and efficiency, Industry 5.0 seeks to

create a more sustainable manufacturing process that minimizes waste and reduces environmental impact (Ozedemir and Hekim, 2018).

One of the key features of Industry 5.0 is the promotion of a circular economy model. This model seeks to minimize waste and maximize the use of resources by designing products that can be reused, repurposed, or recycled at the end of their lifecycle. Advanced technologies like artificial intelligence, machine learning, and the Internet of Things can be used to optimize the use of resources, reduce energy consumption, and minimize waste (Akundi et al., 2022).

Another important aspect of sustainability in Industry 5.0 is the use of renewable energy sources. By transitioning to renewable energy sources like solar, wind, and hydroelectric power, manufacturers can reduce their carbon footprint and minimize their impact on the environment. This transition can be facilitated by advanced technologies like energy storage systems, smart grids, and real-time energy monitoring and management systems (Adel, 2022).

In addition to these features, Industry 5.0 also seeks to promote social sustainability by creating a more positive and supportive working environment for employees. This can be achieved through technologies like digital assistants, advanced safety systems, and real-time feedback and recognition systems. By promoting worker well-being and job satisfaction, Industry 5.0 can empower workers and create a more positive and sustainable working environment (Longo et al., 2020).

Overall, the role of sustainability in Industry 5.0 is essential, as this new era of manufacturing seeks to create a more responsible and sustainable manufacturing process that minimizes waste and reduces environmental impact. By promoting a circular economy model, transitioning to renewable energy sources, and creating a more supportive and positive working environment, Industry 5.0 promises to create a more sustainable, flexible, and socially responsible manufacturing environment that delivers higher quality products and more meaningful jobs (Bakir, Dahlan, 2022).

The role of creativity in Industry 5.0 is critical, as this new era of manufacturing places a greater emphasis on innovation and customization. While Industry 4.0 was characterized by a high level of automation and technology-driven efficiency, Industry 5.0 seeks to integrate human creativity more fully into the manufacturing process, leveraging it to generate new ideas and designs that can maximize productivity and quality.

In Industry 5.0, machines and humans work together as collaborators, with machines taking care of the more repetitive and physically demanding tasks, and humans contributing their creativity, intuition, and problem-solving skills to the process. Advanced technologies like augmented and virtual reality, 3D printing, and real-time monitoring and feedback systems are used to help workers express their ideas and designs more fully, while machines take care of the more routine tasks (Ma et al., 2022).

Another important aspect of creativity in Industry 5.0 is the promotion of design thinking, a human-centered approach to problem-solving that emphasizes empathy, collaboration, and experimentation. By encouraging workers to think outside the box and explore new ideas

and solutions, Industry 5.0 can create a more innovative and responsive manufacturing process that can better adapt to changing market demands and customizations.

Creativity also plays a crucial role in the customization of products in Industry 5.0. By using advanced technologies like machine learning and artificial intelligence, manufacturers can collect and analyze data on customer preferences and behaviors, and use this information to create customized products that meet the specific needs and desires of individual customers (Aslam et al., 2020).

The role of creativity in Industry 5.0 is critical, as this new era of manufacturing seeks to integrate human creativity more fully into the manufacturing process, leveraging it to generate new ideas and designs that can maximize productivity and quality. By promoting collaboration between humans and machines, encouraging design thinking, and using data analytics to customize products, Industry 5.0 promises to create a more flexible, innovative, and responsive manufacturing environment that delivers higher quality products and more meaningful jobs.

### **3. Comparison between industry 4.0 and industry 5.0**

Industry 4.0 represented a significant shift in the manufacturing industry, driven by the integration of advanced technologies such as automation, artificial intelligence, and the Internet of Things (IoT). Industry 5.0 builds on these technologies but focuses on integrating human creativity and intuition to create a more collaborative and flexible manufacturing environment. Here are some of the main important differences between Industry 4.0 and 5.0 (Laskowska, Laskowski, 2023; Lee et al., 2022; Ivanov, 2022):

- **Focus on collaboration:** While Industry 4.0 emphasized automation and technology-driven efficiency, Industry 5.0 seeks to integrate human workers more fully into the manufacturing process, working collaboratively with machines to maximize productivity and quality.
- **Greater emphasis on creativity:** Industry 5.0 recognizes the importance of human creativity and intuition in manufacturing, with technologies like augmented and virtual reality helping workers to express their ideas and designs more fully.
- **Increased flexibility:** Industry 5.0 seeks to create more flexible and adaptable manufacturing environments, with technology like collaborative robots and real-time monitoring and feedback helping workers to respond more quickly to changing circumstances.
- **Emphasis on sustainability:** While Industry 4.0 introduced the concept of the circular economy, Industry 5.0 places even greater emphasis on sustainable manufacturing practices, with a focus on minimizing waste and promoting responsible resource use.

- **Social impact:** Industry 5.0 recognizes that the manufacturing industry has a significant impact on workers and communities, and seeks to create a more positive and supportive working environment through technologies like digital assistants and advanced safety systems.
- **Integration of blockchain technology:** While blockchain technology was not a central feature of Industry 4.0, Industry 5.0 sees it as an essential tool for ensuring the transparency and security of supply chain transactions.
- **Increased use of personalized products:** While Industry 4.0 saw the beginnings of personalized manufacturing, Industry 5.0 takes this to a new level, with technologies like 3D printing allowing for greater customization and more individualized products.

In conclusion, while Industry 4.0 represented a significant step forward in the manufacturing industry, Industry 5.0 seeks to take these technologies to the next level by integrating human creativity and intuition with advanced machinery and technology. By doing so, Industry 5.0 promises to create more sustainable, flexible, and socially responsible manufacturing environments that deliver higher quality products and more meaningful jobs.

#### **4. Advantages and disadvantages of Industry 5.0**

Industry 5.0 represents the next phase of industrial development that aims to create a more collaborative and flexible manufacturing environment that integrates human creativity and intuition with advanced technologies. On the basis of literature analysis we can distinguish following industry 4.0 advantages (Javaid et al., 2020; Johri et al., 2021; Cillo et al., 2022):

- **Improved efficiency and productivity:** The integration of advanced technologies such as automation, artificial intelligence, and the Internet of Things (IoT) can improve efficiency and productivity in manufacturing processes.
- **Increased flexibility:** The use of collaborative robots (cobots) and augmented reality (AR) and virtual reality (VR) technologies can enable manufacturing processes to be more flexible and responsive to changes.
- **Higher quality products:** Industry 5.0 can lead to higher quality products through improved production processes and increased use of real-time feedback and guidance.
- **Reduced downtime:** Predictive maintenance and real-time monitoring can help reduce downtime in manufacturing processes.
- **Better supply chain management:** The use of blockchain technology can improve the transparency and security of supply chain transactions.
- **More personalized products:** Industry 5.0 can enable more personalized products through the use of digital manufacturing technologies.

- Increased worker safety: Collaborative robots and augmented reality technologies can help reduce the risk of accidents and injuries in the workplace.
- Enhanced creativity: By integrating human creativity and intuition with advanced technologies, Industry 5.0 can lead to new and innovative products and solutions.
- Improved customer satisfaction: The use of digital manufacturing technologies and personalized products can improve customer satisfaction and loyalty.
- Reduced waste: The implementation of a circular economy model can reduce waste and promote sustainability in manufacturing processes.
- Greater cost savings: Industry 5.0 can lead to cost savings through increased efficiency, reduced downtime, and improved supply chain management.
- Increased transparency: Blockchain technology can improve transparency in supply chain transactions and promote trust among stakeholders.
- More meaningful jobs: Industry 5.0 can create more meaningful jobs that require creativity and problem-solving skills.
- Improved social impact: The focus on the well-being of workers and the community can improve the social impact of manufacturing.
- Competitive advantage: By implementing Industry 5.0, companies can gain a competitive advantage through improved efficiency, increased flexibility, and higher quality products.

While Industry 5.0 promises numerous benefits, there are also some potential disadvantages that should be considered. Here are main important possible disadvantages of Industry 5.0 (Grabowska et al., 2022; Ghibakholl et al., 2022; Di Marino et al., 2023):

- High initial costs: Implementing Industry 5.0 technologies such as collaborative robots, augmented reality, and blockchain can require significant upfront investment.
- Disruption of traditional manufacturing jobs: The increasing automation and use of robots in Industry 5.0 may lead to job displacement and require retraining of workers.
- Cybersecurity risks: As Industry 5.0 relies on interconnected digital systems, there may be a higher risk of cybersecurity threats, such as hacking and data breaches.
- Complex systems: Industry 5.0 technologies are complex and may require specialized expertise, making it more challenging to manage and maintain.
- Integration challenges: Integrating Industry 5.0 technologies with existing systems and processes can be challenging, requiring significant time and resources.
- Ethical concerns: As Industry 5.0 may lead to increased automation, there may be ethical concerns regarding the impact on workers, such as job displacement, and the ethical use of technology.
- Environmental impact: While Industry 5.0 aims to promote sustainability through a circular economy model, there may still be environmental impacts, such as energy consumption and waste production.

- Limited adoption: The adoption of Industry 5.0 technologies may be limited by the availability of resources, expertise, and regulatory barriers.
- Resistance to change: Resistance to change from traditional manufacturing processes and technologies may hinder the adoption of Industry 5.0.
- Dependence on technology: As Industry 5.0 technologies become increasingly integrated into manufacturing processes, there may be a risk of dependence on technology, making it more challenging to operate without it.

## 5. Conclusion

Industry 5.0 offers several benefits that make it worth adopting in manufacturing industries, including improved efficiency, greater quality control, sustainability, enhanced worker safety, improved customer experience, cost savings, competitive advantage, increased innovation, and positive social impact. By integrating human creativity and intuition with advanced machinery and technology, Industry 5.0 promises to create a more sustainable, flexible, and socially responsible manufacturing environment that delivers higher quality products and more meaningful jobs.

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