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Analysis and Prediction of Future Research Trends in the State of Industry 5.0

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Abstract

Industry 4.0, also known as the fourth industrial revolution, is a term that refers to a higher degree of automation with the purpose of increasing operational productivity and efficiency. This is accomplished through merging the virtual and physical worlds within an industry. Because Industry 4.0 was unable to adapt to and satisfy the growing need for customization, the term "Industry 5.0" was coined to address customised production and empower people in industrial processes. To provide manufacturing solutions that are more user-friendly and resource-efficient than those provided by Industry 4.0, the goal of Industry 5.0, which is thought of as the next stage in the development of industry. This will be accomplished by combining effective, intelligent, and precise machinery. Industry 5.0 is projected to reap the benefits of a wide range of potentially useful technologies and applications that will make it possible to boost production and facilitate the on-demand supply of individualised products. We then elaborately discuss the potential applications of Industry 5.0, such as Information and communications, Real estate, Business services, Manufacturing, Finance/Insurance, Public admin, Automotive, Healthcare. This acts as the impetus for the writing of this article, which use text mining tools and procedures to uncover and assess the many subjects and research trends associated with what Industry 5.0 is doing. Before continuing with additional research using text mining approaches such as key word extraction and frequency analysis, the data was cleaned and preprocessed. In the next part, we will discuss a number of the technologies that will make Industry 5.0 possible. Some of these technologies

include edge computing, digital twins, collaborative robots, blockchain, and network speeds of 6G and beyond. The five primary focuses of Industry 5.0 are transformation, supply chain analysis and optimisation, business innovation and digitization, and smart and sustainable manufacturing. It has been observed that there has been a recent increase in interest regarding the concept of Industry 5.0 as a bridge to human-machine communication and cohabitation among members of the scientific community.

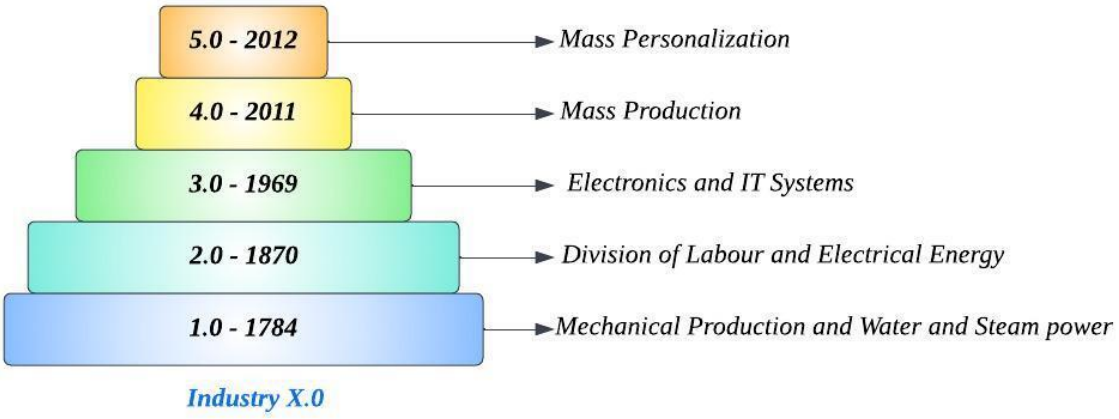
Keywords: Industry 5.0, Industry 4.0, Information and communications, Transformation

Introduction

It took around 100 years for the first three revolutions to emerge, but it only took 40 years for the third revolution to give way to the fourth revolution. During the 1800s, the development of Industry 1.0 was facilitated by the establishment of infrastructures for the mechanical production of water- and steam-powered machinery. The increase in the capacity of industrial plants has been very beneficial to the economy. The year 1870 saw the beginning of the conceptualization of electric power and the assembly line manufacturing process. Manufacturing companies saw an increase in their overall productivity as a result of Industry 2.0's primary focus on mass production and the delegation of tasks. 1969 saw the birth of industry 3.0, which was characterised by the incorporation of electronic concepts, some degree of automation, and information technology. In 2011, the concept of intelligent production for the future evolved into what is now known as Industry 4.0. The primary objectives are to obtain increased productivity and succeed in producing in large quantities by using the new technology that is being developed. The concept of Industry 5.0 refers to a change that is slated to take place in the not-too-distant future and will include the collaboration of human experts with equipment that is more accurate, productive, and smart [1].

These challenges may be overcome by participating in the subsequent industrial revolution, often known as Industry 5.0. Industry 5.0, to put it simply, is the concept of humans and machines working together as opposed to competing against one another. This revolution follows those that came before it, which are collectively referred to as Industries 1.0, 2.0, 3.0, and 4.0. at the 18th century, there was a time period known as "Industry 1.0," which focused on the manufacturing sectors of textiles, steam power, iron, tools, cement, chemicals, gas, lighting, glass, paper, mining, agriculture, and transportation.

Figure 1: *Industrial Evolution*



These sectors dominated the economy at this time [2]. Among the many achievements of this revolution are more employment opportunities, progress in agricultural practises, improved transportation, and steady economic expansion. It is said that one of the problems with Industry 1.0 was the pollution it produced as well as the amount of time it took to carry out the associated processes. In the era of Industry 1.0, two mathematical methods that were used were geometry and linear programming. When it first emerged in the 19th century, the primary areas of concentration for Industry 2.0 were iron, steel, rail, electricity, machine tools, paper, petroleum, chemicals, marine technology, rubber, bicycles, vehicles, applied science, fertiliser, engines, turbines, telecommunications, and contemporary corporate management. Among the many achievements of this revolution were the invention of the telephone, the telegraph, the telephone, and the internal combustion engine. The primary problem with Industry 2.0 is how costly it is to make use of power [3].

Equations of different types, linear equations, and geometry were all used in the development of Industry 2.0. In the 20th century, the primary areas of emphasis for Industry 3.0 were the semiconductor industry, digital circuits, programmable integrated circuits, communications, wireless communication, the renewable energy sector, and automation. Robotics, automated industry, alternative forms of energy, and improved communication are some of the advances made possible by this revolution. The most significant drawback associated with Industry 3.0 is the possibility that certain conditions might render automated equipment inoperable [4]. For instance, the implementation of Flexible Manufacturing Systems (also known as FMS) was an essential part of the Industry 3.0 initiative. However, because of the intricacy of these technologies, extra running costs were incurred while using them, which some businesses were unable to pay. The level of complexity as well as the extra costs put off a lot of different organisations. In the third generation of industry, differential equations, linear programming, and logical controllers were all used. Industry 4.0 is a concept that emerged in the 21st century and focuses on the use of intelligent technology across a wide range of business sectors. The term "fourth industrial revolution" refers to a series of technological developments that include fully automated systems, artificially intelligent systems that can operate in ambiguous situations, and machine learning [5].

The overarching goal of the fourth industrial revolution, also known as Industry 4.0, is to "smarten" the manufacturing sector by combining existing pieces of machinery and devising new devices that are able to interact with one another and exert control over one another throughout their operational lifetimes. Automation of processes is the top priority in Industry 4.0 due to the fact that it reduces the amount of human engagement that is required in the manufacturing process. The goal of Industry 4.0 is to improve both the overall productivity and performance of the sector as a whole by making use of machine learning to distribute intelligence across devices and apps [6]. Industry 5.0 is a concept that is currently being envisioned as a means to combine the robustness, ingenuity, and precision of technology with the unique inventiveness of human specialists. A good number of people who speculate about the future of technology believe that Industry 5.0 will introduce a more human element to production. It is projected that humans' analytical and cognitive abilities, together with very accurate technology, will come together in Industry 5.0. Another key advancement made possible by Industry 5.0 is mass personalization, which gives customers the opportunity to choose individualised and tailored products according to their tastes and prerequisites. Industry 5.0 will make it possible for humans and robots to adapt to one another, it will significantly increase the efficiency of manufacturing, and it will give responsibility for interaction and constant monitoring [7]. The rapidly increased production is supposed to be the end result of the collaboration between humans and machines. It is possible that the output quality will increase with the implementation of Industry 5.0. This will be

accomplished by shifting laborious, repetitive tasks to machines or robots and providing humans more thinking-intensive tasks [8].

Industry 5.0 understands that by requiring production to take into account the limitations of our planet and by placing the health of employees as the top priority, industry may be able to serve social goals other than employment and growth and become a sustainable source of economic growth. Industry 5.0 is an addition to the technology upgrade that is required by business in order to be a trustworthy system for those seeking for a vocation that is both satisfying and beneficial to their health [9]. It focuses an emphasis on the well-being of its workforce and embraces emerging technology in order to produce revenue beyond that of employment and development while at the same time preserving the ecological integrity of the land. It addresses workers' ever-changing demands for training and skill development, therefore empowering them. It raises the level of competitiveness within the sector and draws in top-tier talent. In order to put Industry 5.0 into action, the Commission has set three goals: "an economy that works for people," "a European Green Deal," and "a Europe fit for the digital age." Because of this, the principles of human-centricity, environmental stewardship, and social benefit will form the foundation of Industry 5.0 rather than technological advancements.

Review of literary

Standardisation and legal norms need to be enforced in order to face any technological, social, and management issues. This is necessary since a knowledgeable worker in Industry 5.0 is needed in order to provide a high-value job in production. When a range of management, employee, corporate culture, management infrastructure, and standard policy concerns are considered, it is possible to impart a trained workforce. The primary challenge associated with skill space is the absence of experienced trainers, which, along with financial constraints, makes it impossible for colleagues to get the necessary training they need. When Industry 5.0 is fully implemented, there will be an increased need for a skilled labour force as well as new technology. Because of this, there will be a want for appropriate training not only for the trainees but also for the future teachers. It's possible that this will boost public-private partnerships. In addition to this, changes need to be made to the regulatory structure. Additionally, the competent workforce may contribute to the outstanding performance of the firm [10].

It is possible that management is unaware of the fact that many different industries would embrace the most recent developing technology in order to maintain their digital competence. The well-informed personnel as well as the culture might use the management's lack of understanding to their advantage. In addition, if the members of the staff are not forward thinkers, the process of reengineering the things may take some time and result in considerable training expenditures from the perspective of management (the senior employee may take longer to adapt). In addition, some companies can lack the infrastructure required to handle the new technology, which might be an obstacle for them. Therefore, these challenges need to be taken into consideration while developing an open culture in the workplace and making long-term employment decisions for skilled individuals. since of this, future corporate modifications will be accelerated since they will be changed appropriately. The vast majority of issues that arise from people working together may be avoided by providing continuous and efficient training for both parties. In addition, providing operational workers with regular training will ensure that they are working with a competent team [11].

This important topic feature, which represents for 25 percent of the total data gathered, examines Industry 5.0 in the context of enabling smart and environmentally friendly

manufacturing. It has been shown that researchers have showed a constant interest in this topic as it pertains to Industry 5.0 throughout the course of time. This theme primarily focuses on the pathways to manufacturing systems that can adopt by investigating the drivers and barriers that manufacturing systems might encounter when seeking a transition to smart and sustainable paradigms towards Industry 4.0 and beyond, the impact of industrial mathematics on industrial revolutions and how it can enable smart industries to meet customer need for future uncertain business environments, and the incorporation of sustainable manufacturing measures for opportunistic opportunities [12].

Scalability is something that may be stated in terms of the system's resilience, adaptability, and reactivity when the workload of the system fluctuates in a dynamic manner. In the context of Industry 5.0, the term "scalability" refers to the performance of a system in a variety of different working scenarios. This is true regardless of the number of hyper-connected systems that are present in the network. Industry 5.0 is intended to connect to and have conversations with a wide range of systems located at other manufacturing facilities as well as a wide range of individuals. Scalability is a characteristic of Industry 5.0, which is an improvement over Industry 4.0; yet, it offers a bigger challenge when people and machines are required to work together as a team by sharing duties. This is because scalability is more difficult to achieve when humans and machines are forced to collaborate. The scalability may be monitored by using service level indicators that have already been checked to ensure that they are in compliance with the service level objectives that are outlined in service level agreements. This is a very important topic to discuss since non-determinism is becoming more prevalent with the expansion of data collection, production, and human activities. In order to provide scalability, technology providers working in an Industry 5.0 environment need to be able to supply their services regardless of the workload, be adaptable enough to extend and expand, and provide a low-latency response that is free of any data processing delays. The various requests that come in from the dynamic edge servers and the flexible cloud need to be handled by AI-based cobots as quickly as possible so that there are no unexpected delays [13].

It is already common knowledge that Industry 5.0 refers to a movement with the objective of reintroducing human connection into the manufacturing sector. The desire of today's consumers for a high degree of personalization is the force behind this development. According to this point of view, consumers are willing to shell out more cash in exchange for the possibility of expressing themselves via the use of Industry 5.0 products, which provide them a means to do so. In conclusion, Industry 5.0 is a hypothesis that intends to make businesses more resilient, human-centered, and environmentally sustainable. Others consider Industry 5.0 to be an extension of the paradigm established by Industry 4.0, while others consider it to be an evolutionary, progressive progression that expands upon the concepts and procedures established by Industry 4.0. Methods for Industry 4.0 and 5.0 systems, human factors, supporting technologies and concepts, and environmental factors are all taken into account. Because the concept of Industry 5.0 is relatively new, there is not a lot of agreement on what it refers to. On the other hand, it has been observed that the primary tendencies of Industry 5.0 are the creation of a smart society and the establishment of a co-working environment in which people and robots may collaborate [14].

This topic stimulates research into the possibilities for analysing supply chains and optimising manufacturing processes in accordance with Industry 5.0. To be more specific, the optimisation of mining techniques through the utilisation of a multilevel, multifactor, multi-objective, and multi-index comprehensive evaluation system involving technology, economy, and safety; the application of a multi-objective mathematical model to the design of a sustainable-resilient supply chain based on strategic and tactical decision levels; and the

application of a multi-objective mathematical model to the design of a sustainable-resilient supply chain based on strategic and tactical decision levels. Research directions for supply chain transformations, the impact of the industrial internet of things and emerging technologies on the digital transformation capabilities of organisations, the exploration of Social Value Orientation theory to understand decision-making preferences for joint resource allocation, the exploration of Industry 5.0 constructs to support supply chain operations; these are just some of the topics that will be addressed by this research. The researchers have not lost interest in the remaining 13% of the data that was acquired during the course of their work [15].

Data Analysis

Text mining is the process of uncovering new information or information that has not been found in the past by extracting data from a number of sources that include text. Intelligent text analytics, text data mining, and text knowledge discovery are all names that have been used to refer to it. Text mining assists in the discovery of new information and knowledge by identifying patterns in documents derived from a variety of sources. In addition to text mining, other methodologies such as Natural Language Processing (NLP), information retrieval, clustering, document classification, web mining, information extraction, and idea extraction may be used. Text mining has been increasingly recognised by researchers as a valuable tool for analysing published information, as well as for locating subjects and patterns that are exclusive to a certain discipline.

The features of Industry 5.0 are presently being included into practically all of the newest flagship smartphones, and telecommunications firms are getting ready for an increase in the number of customers who use Industry 5.0 in anticipation of the launch of new phone models in 2023. Industry 5.0 has been spoken about for some time, but the infrastructure that is required for Industry 5.0-capable towers has taken some time to create. The current consensus among industry analysts is that income generated by Industry 5.0 will skyrocket over the course of the following five years, with certain subsectors forecasted to benefit far more than others. According to the predicted income data provided by Accenture, the information and communications industry is expected to make a profit economically as a result of a growth in the number of users of Industry 5.0, and this profit is anticipated to contribute an estimated $200 billion to the GDP of the United States between the years 2023 and 2027. In close pursuit will be the real estate and business services industries, which, taken together, are anticipated to contribute a total of $170 billion and $150 billion over the course of the following five years, respectively. It is projected that other industries, such as healthcare and insurance, as well as manufacturing, would benefit significantly from the widespread implementation of Industry 5.0.

Table 1: *Prediction in Industry 5.0 - 2023 to 2027 (in Billion U.S. Dollars)*

Industry sector	Billion U.S. Dollars(2023)	Billion U.S. Dollars(2027)
Information and communications	185	200
Real estate	142	170
Business services	132	150
Manufacturing	92	110
Finance/Insurance	70	80
Public admin	50	70
Automotive	105	130
Healthcare	95	120

Figure 2: *Prediction in Industry 5.0 - 2023 to 2027 (in Billion U.S. Dollars)*

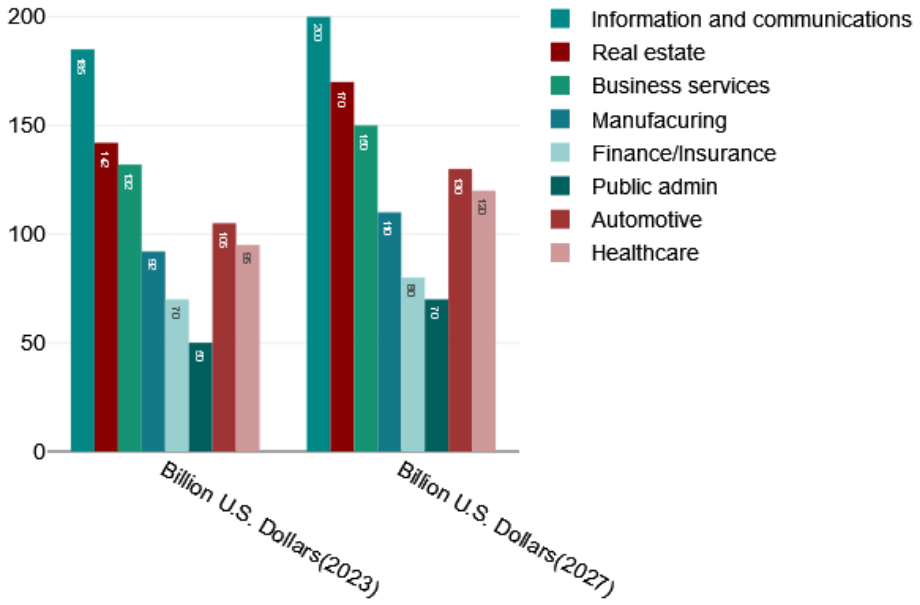


Table 2: *Two-factor ANOVA with repeated measures*

Null hypothesis	Alternative hypothesis
There is no significant difference between the groups of the first factor Billion U.S. Dollars (2023) and Billion U.S. Dollars (2027) (measurement repetition) in relation to the dependent variable.	There is a significant difference between the groups of the first factor Billion U.S. Dollars (2023) and Billion U.S. Dollars (2027) (measurement repetition) in relation to the dependent variable.
There is no significant difference between the groups of the second factor Industry sector in relation to the dependent variable.	There is a significant difference between the groups of the second factor Industry sector in relation to the dependent variable.
There is no interaction effect between the factor Billion U.S. Dollars (2023) and Billion U.S. Dollars (2027) and Industry sector	There is a interaction effect between the factor Billion U.S. Dollars (2023) and Billion U.S. Dollars (2027) and Industry sector

A two-factor analysis of variance with measurement repetition was performed to test whether there was

- A significant difference between the groups of the first factor "Billion U.S. Dollars (2023) and Billion U.S. Dollars (2027)" (repeated measures) with respect to the dependent variable.
- A significant difference between the groups of the second factor Industry sector in relation to the dependent variable.
- There is an interaction between the two factors "Billion U.S. Dollars (2023) and Billion U.S. Dollars (2027)" and Industry sector in relation to the dependent variable.

The two-factor analysis of variance with repeated measures showed that there is

- Significant difference between the groups of the first factor " Billion U.S. Dollars (2023) and Billion U.S. Dollars (2027) " in relation to the dependent variable, p=aN,
- Significant difference between the groups of the first factor Industry sector in relation to the dependent variable, p=aN,

- Interaction between the two variables Industry sector and " Billion U.S. Dollars (2023) and Billion U.S. Dollars (2027) " in relation to the dependent variable, p=aN.

Logistic Regression

Logistic regression analysis was performed to examine the influence of Billion U.S. Dollars (2023) and Billion U.S. Dollars (2027) on variable Industry sector to predict the value "Information and communications". Logistic regression analysis shows that the model as a whole is significant (Chi2(2) = 6.03, p .049, n = 8).

The coefficient of the variable Billion U.S. Dollars (2023) is b = 1.79, which is positive. This means that an increase in Billion U.S. Dollars (2023) is associated with an increase in the probability that the dependent variable is "Information and communications". However, the p-value of 1 indicates that this influence is not statistically significant. The odds Ratio of 6.01 indicates that one unit increase of the variable Billion U.S. Dollars(2023) will increase the odds that the dependent variable is "Information and communications" by 6.01 times.

The coefficient of the variable Billion U.S. Dollars (2027) is b = -1.1, which is negative. This means that an increase in Billion U.S. Dollars (2027) is associated with a decrease in the probability that the dependent variable is "Information and communications". However, the p-value of 1 indicates that this influence is not statistically significant. The odds Ratio of 0.33 indicates that one unit increase of the variable Billion U.S. Dollars (2027) will increase the odds that the dependent variable is "Information and communications" by 0.33 times.

Discussion on Industry 5.0 Potentials

Applications of Industry 5.0 that might be used to treat and diagnose individuals suffering from coronavirus sickness (COVID) and allow them to get more specialist treatment. A handful of different sectors, including the ones dealing with information and communications, real estate, business services, manufacturing, banking and insurance, public administration, the automotive industry, and healthcare, all employ the technology that comes with industry 5.0. In order to combat the COVID epidemic, these technologies, which can be found in a number of these companies, were used. They provided guidance on the primary challenges that Industry 5.0 would confront in an attempt to help find solutions to problems that were caused by the COVID outbreak. It was recommended that value-conscious manufacturing facilities take use of the value-sensitive design. It discusses the opportunities that might arise in the future industry, Industry 5.0, which will be founded on the cohabitation of humans and robots. In addition, the field of industrial systems engineering provided an explanation of the ethical repercussions that may result from the manner in which the machine treats human labour and highlighted how value-based design could help reduce the challenges that are involved with the implementation of the symbiosis. This is known as Industry 5.0. In order to meet the requirements of Industry 5.0 and the Internet of Things, managers will need to have a more in-depth understanding of the innovation ecosystem, as well as business strategy and design thinking. The study, on the other hand, offers no indication of the process by which the framework and safety measures would be applied after they have been incorporated into the functioning of the organisation.

In this article, we will talk about the benefits of using text mining to make predictions about the stock market, how text mining can be used to analyse social and environmental reports from organisations, how text mining tools and techniques can be used to analyse the

context of model-based systems engineering, and how traditional media outlets use social media. Text data that was gathered for the purpose of this study was employed in order to establish the issue categories into which industry 5.0 research may be classed. This was accomplished by conducting an inquiry and doing an analysis of key terms that are often used in published papers on industry 5.0. This was accomplished by using a text mining framework in all of our work. A study has been carried out to investigate the fundamental components of Industry 5.0 as well as the benefits it offers in comparison to its predecessor. According to the findings of the study, Industry 5.0 makes it possible to engage in intelligent manufacturing by making intelligent use of data and combining different types of industrial data with cutting-edge technology in order to produce more individualised products. It may be possible to finish jobs in a shorter amount of time by making use of technology, such as robots, to do mundane, repetitive work. This would free up human brainpower for more creative problem solving. In addition, the lean innovation technique that Industry 5.0 employs for the management of waste and the use of renewable resources has a beneficial impact on the surrounding environment.

Conclusions

Using a method known as "term extraction," we were able to locate the words that were included in the abstract text of the data that we had gathered from publications that were pertinent to the Industry 5.0 movement. This was carried out in order to achieve the objectives of the paper. This is congruent with the notion of Industry 5.0, which strives to improve human intellect while simultaneously alleviating the weight of repetitive work by automating routine activities using artificial intelligence and machine learning. In other words, the goal of Industry 5.0 is to increase human intellect while simultaneously easing the load of repetitive labour. After the discussion of the core enabling technologies for Industry 5.0, the next topic that was covered was some of the possible applications of Industry 5.0. These applications included ones for information and communications, real estate, commercial services, manufacturing, banking and insurance, public administration, automotive, and healthcare, in addition to other prospective uses. As a conclusion, Industry 5.0 is a theory that was developed with the intention of synchronising the production of humans and robots in a consistent manner.

The bulk of the scenario's five separate thematic aspects were tied to intelligent and environmentally responsible manufacturing, which was followed by human-machine interaction and cohabitation as the scenario's two most prominent subthemes. To be more specific, it can be noted that the scientific community is becoming an increasing amount of interested in the concept of Industry 5.0 as a way of encouraging cooperation and interaction between people and machines. A survey-based lecture on Industry 5.0's enabling technologies and anticipated applications was one of the themes that we discussed in this research. This lecture was one of the subjects that we addressed. It is projected that the implementation of Industry 5.0, which will be made possible by a number of innovative applications and enabling technologies, would enhance both industrial production and consumer satisfaction. This is due to the fact that the implementation of Industry 5.0 will be facilitated by a number of novel applications and enabling technologies. A few of these problems are scalability, security, and privacy; human-robot cooperation in industrial environments; human-robot interaction; and skilled labour.

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