

Industry 5.0: Moving Towards Inclusive and Sustainable Industrialization

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ABSTRACT

The entire globe is going through a technological golden age. The use of modern technologies in various fields of business has become very popular and common. Innovative methods are being developed in every aspect of production, distribution, finance, and marketing. The gradual development of the industrial revolution continues and it is in its fourth and fifth phases. The foundation of Industry 4.0 was laid down by the concept of the smart factory for production, and machine learning, with huge data storage systems and this revolution is connected with the cyber-physical production system. The collaboration of humans with machines elevated in Industry 4.0 but the social angle of this revolution has been ignored. Industry 4.0 was technology-driven so people noticed that their job opportunities were getting replaced with machine work and so there were many cut-offs in the service sector. Industry 5.0 is both technology-driven and value-driven, and in this revolution, humans will also get better opportunities and tasks to show their efficiency and creative skills and to overcome those insecurities in Industry 4.0, the main focus of this evolution was to use the creativity of human experts working together with efficient, intelligent and accurate machines. This paper tries to emphasize inclusive and sustainable industrialization through the Industrial Revolution.

Keywords: *Industry 5.0, Technology, Inclusive growth, Sustainable development.*

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1. INTRODUCTION

In the late 17th century Industrial activities dramatically increased with the advent of machinofacture in place of manufacture. The process of industrialization spread throughout the world in three waves. The first was the period between 1763 and 1863 which began in England and its associated states. Industrialization in the 19th century affected countries like the USSR, Germany, and Japan. As a result of this, a decrease in agricultural activities and an increase in industrial activities were seen. The impact of industrialization in third-world countries (e.g., the tigers and dragons of Southeast Asia) occurred after the Second World War. (Shimanandan, 2020) Technological progress for any society or country is easy and possible only when there are enough resources available for the existence of all classes and people in the society. For those major economic countries that have abundant economic resources, their chances of moving forward in the direction of technological development are strong. Any revolution brings socio-economic technological changes in society. Due to digitization and overuse of information and communication technology, the production and manufacturing process has become more complicated over the past several decades, resulting in technical, logistical, organizational, and environmental developments that have led to a new industrial revolution (Zizic et al. 2022; Paridaet al. 2019; Zhou 2013; Ciffolilli et al. 2018).

German economist Professor Klaus Schwab, also famous for the World Economic Forum (WEF), is credited with originally introducing the idea of the fourth industrial revolution. Big data, IoT, cloud computing, robotics, and artificial intelligence are all part of Industry 4.0 (Nawang, 2022). Industry 5.0 is the result of how technology and the environment interact with each other and use technology to help factory workers perform their physical labor more effectively and efficiently. Industry 5.0's three main tenets are resilience, human centricity, and sustainability (Zizic et al. 2022). Industry 5.0 is the first industrial revolution led by humans based on the 6R (recognize, reconsider, realize, reduce, reuse, and recycle) principle of industrial up cycling, a systematic waste prevention technique and logistics efficiency design to evaluate life standards, innovative creations and produce high-quality custom products (Michael Rada, founder, & leader, industry 5.0). European Economic and Social Committee state that the new revolutionary wave, industry 5.0, integrates the swerving strength of cyber-physical production systems (CPPS) and human intelligence to create synergetic factories. Furthermore, to address the manpower weakening by Industry 4.0 the policymakers are looking for innovative ethical and human-centered design.

Industry 5.0 is trying to create an environment in a society where technologies get in control of humans which can fulfill the psychological, social, and personal needs of humans because it is humans' psychological need to be engaged in a job and if they will be free from any duties or accountabilities then it can also affect the crime rates of a country because there is also an idiom explaining that "An idle mind is the devil's workshop".

Technology will continue to advance, but we must protect social, human, and moral values as well as environmental values. We cannot continue to ignore the fact that industrial development is necessary at the expense of environmental concerns. Support for industrial growth and technological development is acceptable as long as it has a minimal negative impact on the environment, natural resources, and the next generation. During the pandemic, the entire globe has confronted severe social and environmental issues and it should be strongly considered in the fifth industrial revolution (Javaid et al.2020; Xu et al. 2021). The foundation for creating society 5.0 was laid by Industrial Revolution 5.0. The idea of society 5.0 is to use virtual and physical space to tackle societal issues. It is not limited only to the manufacturing sector; rather it is used to improve the standard of living of the common public and to solve health and basic problems of living life.

But it will also not be so easy to work with the cobots and machines so easily, this generation needs to work hard and it may also take a whole generation replacement because the children of today are growing in the surrounding of machines so it will be easy for them to cooperate with the machines and cobots but today's people are not prepared for these sudden changes so the sudden technological advancement resulted in their demotivation and dissatisfaction of those workers towards their work.

Technology can satisfy human needs but not greed. The Industrial Revolution ought to be continued in a way that makes up for earlier mistakes and allows for the attainment of sustainable development attributes. Resilience and sustainability are key components of Industry 5.0, which keeps people at its core responsible innovations, are prioritized. Industry 5.0's effects are particularly evident when combining technology, the environment, and people. Beginning with water and steam energy, the industrial revolution progressively moved from electricity and digitalization to cyber-physical systems, and then on to the human robots and bionomics, which encompasses, artificial intelligence, green manufacturing, the internet of everything, robotics, resilience, and sustainability are receiving special attention. The industrial revolution has resulted in significant environmental advancements such as circular manufacturing, renewable energy, and bio-inspired technologies that maximize material efficiency and minimize waste. To fulfill the objective of sustainable development, technology has led to the creation of unconventional renewable energy sources. Humans

have been motivated to work in new ways by technology. The importance of creativity, critical thinking, and sound judgment has been emphasized, as has the idea that utilizing cutting-edge technology might improve human happiness. Hence, the present paper is focused on Industry 5.0 which leads towards inclusive and sustainable industrialization and also highlights the chronological development of the industrial revolution.

The characteristics of Industry 5.0 can be summarized as follows:

- Human Centric:** The main aim of Industry 5.0 is to take humans back to factory grounds because in the past industrial revolution, machines were slowly replacing humans which was causing less involvement of human creativity and thinking skills and increase in repetitive jobs by artificial intelligence. Artificial intelligence will also be a part of this industrial revolution but the human will need to operate those cobots and machines by themselves.
- Sustainability:** Industry 5.0 is sustainable, as it focuses on reusing, repurposing, and recycling resources. It aims to reduce the environmental impacts. It tries to recover the deficiencies of Industry 1.0 to Industry 4.0 as the past industrial revolutions also damaged the environment at a large scale with their chemicals, pollutants, gases, etc. The 5th industrial revolution is convincing many countries and industries to work with those energies that are not non-renewable because using non-renewable resources can also affect future generations.
- Resilience:** At the time of the pandemic COVID-19, everyone has learned to be resilient and the industry revolution also adopted the same feature and tries to be resilient & robust.
- Hyper customization:** In this era, where everyone wants a customized product that can help them show off and make them feel special. So, industry 5.0 launched, which helps a manufacturing company to involve human creativity more and more and make products more customized for each customer. At this time, with a large population, a large amount of customization is also in demand. Each class of people wants customized products according to their choices and demands. Industry 4.0 was also fulfilling customization needs but in this revolution, customization is getting more creative and interesting.
- Removal of dull, dirty, and dangerous tasks:** Industry 5.0 also involves artificial intelligence or collaborative robots, who work on orders given by their bosses, who are humans. So, the jobs which are repetitive or dangerous, can be done by cobots and AI and this will be a better option with the safety view. For example, in a car manufacturing factory, there is not only designing work but welding work are also a part of the car manufacturing work which is not much safer for humans because fires are coming out at the time of work so if these types of work are done by the cobots then it will be a much safer option in respect of human resources.
- Human-machine interaction:** Industry 5.0 focuses on managing cobots, which means there will be artificial intelligence used in

manufacturing works but will be controllable by humans. In this revolution, the humans will order the cobots and they will do the work for them which will also create a relationship and interaction between them. **Effective:** The 5th industrial revolution focuses on dividing the works of humans and machines among themselves where both get the best task according to their capabilities Humans get the creative and customization work and the machines get repetitive work because they never get bored and this makes the industry 5.0 more effective than earlier revolutions. **Efficient:** Industry 5.0 can be seen as efficient because there is the least amount of wastage of energy by both humans and cobots/machines. Industry 5.0 focuses on delegating the work to both parties in such a way that the production can be maximized and the energy and resources also don't get wasted. **Finding greener solutions:** In Industry 5.0, the industries try to do different works and solve different issues in such a way that doesn't harm the environment and nature because it has already been affected in the last few industrial revolutions very badly. So this revolution wants to regain the lost green and fresh environment because the pollution, waste and toxic gases of the environment are already causing a high amount of diseases and human resources wastage.

2. LITERATURE REVIEW

2.1 Sustainable Development

Sustainable development relates to the quality of life concerning socio-economic and environmental dimensions. It also embraces caring for the environment, participation and partnership, equity, and justice for the entire globe (Gibbs, 2000). It tries to make a balance between human inhabitants and natural resources which can only be achieved through the deployment of systems that combine public participation and scientific knowledge based on scientific analysis (Jepson, 2001). One of the main agenda items for the 21st century is to achieve sustainable development goals (Saha, 2008). It is important not only for setting appropriate development goals but also for gaining social acceptance of what can prove to be very difficult (Mierzejewska, 2009). There are five basics of sustainability which are, societies that continue to use critical resources unsustainably will collapse, second, increasing rate of consumption and huge population can make resources unavailable, third, the use of renewable resources must be lower than the rate of natural replenishment and finally, to be sustainable, the use of non-renewable resources must decrease (Heinberg, 2010).

The main intent of sustainable development is to balance economic, environmental, and social needs (Abu-Ghazalah, 2008) and also strengthen policy reform in the area of

economics, empowerment, participation, and institutions for sustainable development. Despite that, there are major thrust areas such as land, agriculture, forests, water, climate, energy, cities, and poverty where strategic moves are necessary to overcome this problem (Holmberg 1991). In each field managing and attaining sustainable development with innovative and sophisticated planning tools and approaches are required (Rotmans, 2000). Sustainable planning can be seen as a form of participatory governance by government and society to achieve sustainable development. It must rely on ethical decisions rather than neutral technical exercises (Healay, 2004). There is no doubt that the interpretation and implementation of sustainability are shaped by different forms of governance that challenge traditional distinctions between local, national, and global politics. Sustainability should be focused on a long-term approach that anticipates and responds to a rapidly changing environment (Bulkeley, 2005).

Industry 4.0 is a concept that the German government first introduced in the year 2011. After a decade in the year 2021, the European Commission first proposed, conceptualized and referred to "Industry 5.0" as the 'fifth industrial revolution' for the globe (Roblek, 2016). Industry 4.0 is built on components such as cyber-physical systems, the Internet of Things, the Internet of services, and smart factories, which aid in connecting technology and society (Østergaard, 2018). This revolution is delineated by complete automation and digitization, which everything and every industry is closely associated with the Internet of Things and technologies such as health care, supply chains, security and privacy, and smart infrastructure (Sreedharan, 2017). In the year 1960, the automobile industry applied robots for welding the components of cars. Further, more robots were deployed outside of the automotive sector than inside. The primary goal of the introduction of robots was the elimination of boring, hazardous, and dirty jobs while incorporating quality and consistency into the robotic system (Khan, 2016). The applicability and adaptability of Industry 4.0 are rapidly popularized in various sectors such as sensors in healthcare machines that can deliver real-time conditions of patients to doctors at their clinic, or the advancement of the textile industry, which is introducing T-shirts with features such as measuring the number of calories burned, counting heartbeat rate and so on, and showing the data on connected smartphones, or cars with sensors that can reduce accidents and save a significant amount of money (Østergaard, 2018). To improve the experience of a transparent and organized supply chain, industrial management, data collecting from production lines, etc., it introduced features like quicker computers, smarter machines, tiny sensors, cheaper data storage, and transfer, etc (Skobelev, 2017).

During the time of the COVID-19 pandemic when people were not permitted to go outside their houses digital platforms and social media helped them in many ways. The businesses that are based in the tourism industry were so disturbed and some businesses also shut down at that time (Majerník, 2022). The internet of everything, big data, 4D CT and 4D MRI, smart sensors, holography and virtual reality, the internet of medical things, artificial intelligence, humanoid robots, smart inhalers, 3D printing, 3D scanning, machine learning and computing, drones, and many other major Industry 5.0 technologies were used for pandemic patients (Ozkeser, 2018). Robotic systems are employed in small enterprises along with in major industrial and logistical sectors because customers like highly customized products that make them feel unique, mass customization is being added gradually as well. This was also gradually turning human employment into machine jobs (Deguchi, 2020). Many people who lost their employment also began their modest businesses as entrepreneurs. Nowadays, no one chooses agriculture because it is so risky. As a result, the agriculture sector must innovate and adopt new technology to provide the greatest agricultural goods (Nawang, 2022). The impact of Industry 4.0 and 5.0 has made drastic impact on resources, technology, operation, and activity of businesses and enterprises. The basis of Industry 4.0 are digitalization of products, processes, equipment, and services and the application of exponential technologies. An innovative business model is required for the smart factory with a coordinated, healthy and smart environment. The fifth industrial revolution, which prioritizes the needs of humans, is bringing the world closer to a state in which autonomous machines and robots will function as intelligent agents that collaborate with people and carry out many tasks simultaneously in the same location (Xu et al., 2021). Its diverse scope, which may include human-robot co-working, where people and robots will work together whenever and wherever possible, as well as bio-economic can be another way where biological resources can be exploited wisely for industrial reasons. Additionally, many other things, such as space industries, space mining, and space life may contribute to the coming industrial revolution (Longo et al., 2020). The fifth Industrial Revolution more sustainable, economic, flexible, socially resilient and human-centric industrial revolution which created a durable, flexible, sustainably developed environment (Akundi et al., 2022).

However, there are some challenges and restrictions for gaining the acceptability of this revolutionary change. Industry 4.0 was wasting human problem-solving abilities, value-adding abilities, and creativity, and Industry 5.0 is attempting to restore all these features by replacing the robots with collaborative robots that work on the instructions given by humans with their critical thinking. This type of production will also add mass personalization and

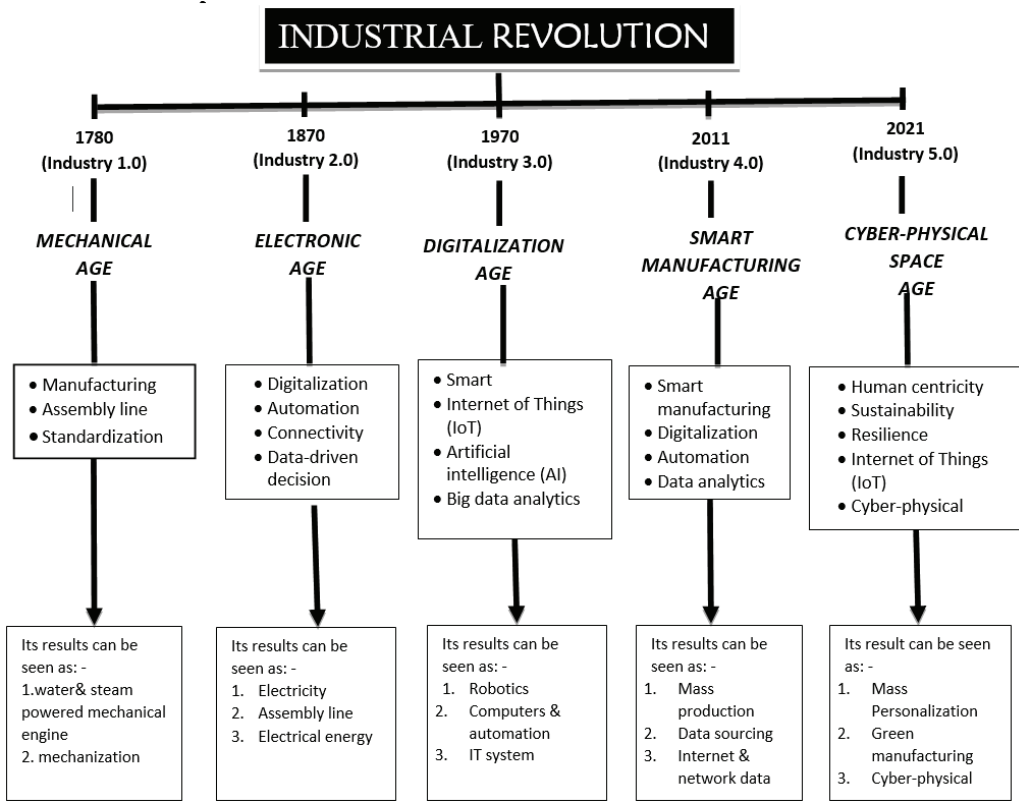
customization for everyone because the cobots will be working under instructions from humans and the humans will be able to do more creative things (Coelho et al., 2023). Then they concentrated on a few concerns related to Industry 5.0 and its notion of human-robot co-working, starting with legal and regulatory matters. It is suggested to legally define the term “robots” so that its structure and work may both be established. Moreover, while the current generation and individual preferences for working with robots are still not entirely in agreement, it’s feasible that future generations of people won’t have these kinds of problems since they will have grown up with machines and robots around them. Further, it is obvious that robots are machines and don’t care how people interact with them, there may be societal ramifications of human-robot co-working where a person won’t be cleared of behavioral concerns, such as whether they should respect robots as their employers or not (Demir, 2019). Industry 5.0 that has connections to values and ethics. This is a human-machine symbiosis and set out to investigate whether or not the industrial community is paying attention to the move towards industry 4.0’s human-machine symbiosis. It employs a value-sensitive design technique, which paves the way for future human-centered and valued systems in industry and factories. They viewed the 5.0 industrial era as the augmentation era and a hybrid agent created as a result of a mutually beneficial relationship between a machine and a person (Javaid, 2020).

3. RESEARCH METHODOLOGY

This study is a descriptive analysis of the newly popular topic of Industry 5.0, which defines the fifth industrial revolution. Related topics like Industry 4.0 and Society 5.0 are also included, which contributed to the development of various theories and concepts regarding the industry and the technologies being used in it.

The below figure provides a phased visual representation of the evolution of industry. Fast technological advancements and concerns from a wide range of industries, including the environment, climate change, adulteration, etc., are driving the evolution of these sectors. There are a total of 5 industrial revolutions that we have witnessed to date and two of them which are industry 4.0 and industry 5.0 are still in the development phase and factories and manufacturing units are adapting them to their needs and requirements.

4. GRAPHICAL PRESENTATION OF THE INDUSTRIAL REVOLUTION



4.1 Chronological Development of the Industrial Revolution

From Industry 1.0 to Industry 5.0, the following changes have occurred gradually:

(i) Industry 1.0: The earliest industrial revolution, known as the mechanization of industries, occurred during the 1760s–1780s and was characterized by a shift in emphasis from the production of handcrafted or manual goods to that of machines. Its primary goal was the advancement of trade and business. In addition to the invention of water and steam energy, industry 1.0 saw the beginning of several machine productions for other industries, including the textile sector.

(ii) Industry 2.0: The second industrial revolution, which concentrated on assembly lines, mass production, and labor division, occurred in the 1870s. Industrialization and standardization were the two main focuses of this revolution. The concepts and creations of Industry 1.0 were applied in this revolution to create new manufacturing methods. Additionally, this revolution is recognized for electrification, which saw the replacement of steam and water engines with electric machinery, a sharp increase in the usage of electrical

energy, and the creation of numerous new technologies such as the typewriter, automatic signalling, automotive industry, and electricity. When compared to the first industrial revolution, this one was more economical and effective.

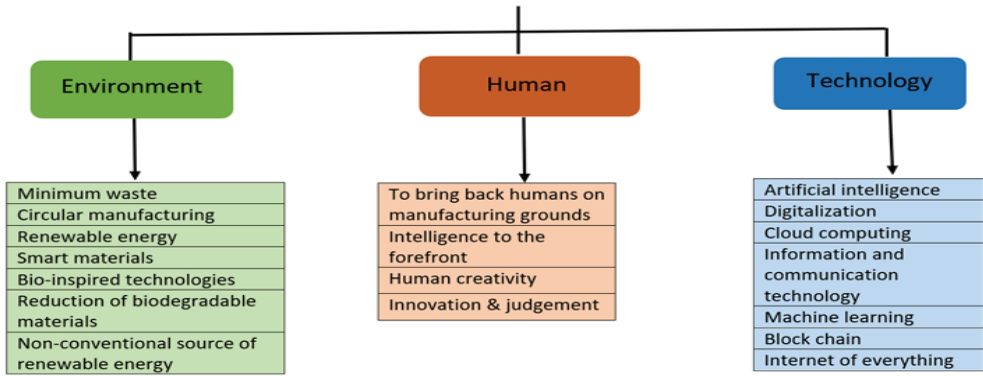
(iii) Industry 3.0: This incident happened in the late 1970s. The third industrial revolution, sometimes referred to as the “digital revolution,” produced some fascinating and helpful technologies, including computers, smartphones, integrated circuits, and the internet. It is also noted that this revolution catalyzed the beginning of automation. In addition to bringing about the digital revolution in industry, it sped up communication more than previously.

(iv) Industry 4.0: Cyber-physical systems served as the foundation for the fourth industrial revolution, which began to emerge in developed nations in 2011. Automation, data interchange, and manufacturing technology are at the center of this revolution. Numerous new technologies that emerged during the fourth industrial revolution are now widely used in workshops, homes, and all types of industries. Robotics and artificial intelligence were among the technologies of this revolution. which greatly increased the ease and enjoyment of all work. These days, we have machines for every task, and since they are so powerful and versatile, they can be employed in any sector of the economy. Making intelligent and smart machines is the main goal of this revolution, and examples of such technologies include 3D printing, robotics, wireless technologies, automated vehicles, and the industrial Internet of things.

(v) Industry 5.0: Industry 5.0 is still in its infancy, with its primary focus being on the interaction between humans and machines and creating a co-working space where each works according to their area of expertise and capability. Industry 5.0 is a resilient, sustainable, and human-centered revolution. The fifth industrial revolution will see the management of robots, machinery, and previously developed technologies so that humans can easily handle them and easily reintegrate them into the industrial world. This revolution will be founded in both values and technology.

It is evident from the aforementioned revolutions that human creativity and skill levels were not enhanced. Thus, keeping human resources in the manufacturing grounds became even more important during this revolution. Around the world, a large number of industries are directly embracing the fifth industrial revolution instead of the fourth.

IMPACTS OF INDUSTRY 5.0 ON DIFFERENT FACTORS



Technology is being used to revolutionize, enhance, and enrich human existence, as well as to reduce complexity and increase human connection. Reducing industrial waste is the primary objective of industry innovation to reduce production costs and advance intelligent manufacturing. Modern technology has led to the development of superb tools that support industrial advancement (such as cheaper data transmission, smart sensors, smart equipment, and quicker computers), strengthening supply chain management and industrial management. Growth is certainly aided by technology, but it would be better if this development did not lead to disaster. Although technology has a wide range of effects on people, society, and the environment, employing cutting-edge technology is bad for the environment. Both the human race and all animal species are harmed by it. Better and judicious use of technology can reduce its negative aspects. Human-robot collaboration is the way of the future. This requires the younger generation to adapt and be vigilant.

Any society's or nation's ability to advance technologically depends on its ability to provide enough resources for the needs of all social classes and individuals. The likelihood that major economies with ample financial resources will advance in the direction of technical advancement is higher. The Society plays an important role in the country's development. The society is made up by the normal public and when the public of a country will be educated, and then they will adapt any technology with more open hearted. Otherwise, if the people in society will be illiterate then they will never choose/accept a new model, where they need to guide a machine and pass commands to a machine

Industry 5.0 has made significant efforts to improve human well-being but society and the environment have also suffered considerably as a result of the industrial revolution. The integration of people, technology, environment, and society characterizes the new industrial revolution which is a unique advancement over the previous industrial revolution. However, industry 5.0 also carries several concerns, including the possibility of a nuclear holocaust,

destructive artificial intelligence, cyber security, and biotechnology. In addition, as industry 5.0 societies adopt the use of robots for labor, particular consideration must be given to the ethical concerns and environmental sustainability associated with these devices.

5. RESULTS

Man is the most fundamental, responsible and accountable part of nature that has always been making arbitrary efforts to guide as well as organize all the resources and parts of nature. This has had such a widespread impact that it is endangering its existence as well as the existence of its symbionts and natural resources. Industry 5.0 attempts to overcome the shortcomings of Industry 4.0. Undoubtedly, rapid industrialization is today's need and an essential part of industrial progress, but we have gone so far in indiscriminate development and technological progress that it is no longer easy to abandon technological advancement completely. The chaos and unrest arising from the insensible and irresponsible use of technology can be removed by adopting systematic and effective methods of Industry 5.0. The outcome of industry 5.0 is to reduce the degradation that has happened till now to society, man and nature through the joint efforts of technology and humans.

The most basic, accountable, and responsible element of nature is man, who has always made arbitrary attempts to direct and arrange all of nature's components and resources. This is putting not just its symbionts and natural resources in jeopardy, but also its own life due to the extensive influence it has made. Industry 5.0 aims to address Industry 4.0's drawbacks. Rapid industrialization is unquestionably necessary in the modern world and a necessary component of industrial growth, yet we have advanced so far in our indiscriminate development and technical improvement that giving up on technology progression entirely is becoming increasingly difficult. Adopting organized and successful industrial techniques can help to eliminate the turmoil and discontent brought on by careless and insensitive usage of technology.

5.1 Conclusion and Implication

It's challenging to use technology in industry. This requires bringing the organization's employees together. Reaching the full potential of cutting-edge technology exposes the business to new challenges and complications. This necessitates the development of regulations relevant to the culture of human-robot collaboration at different levels. Apart from this, acceptance of fellow workers, improvements in work regulations, necessitate changes to the work environment, and adjustment in organizational structure is required.

For the organization to comply with the laws governing the operation of human robots, human-technology law must be updated in addition to labor law. It is important to specify the kind of interpersonal interaction that should exist between the human and the robot.

Robots are capable of thinking, comprehending and making rational judgments, but there are no clear rules about how they should interact and behave with people in the workplace. However, in this stage of the Industrial Revolution, efforts are still being made this practicable. HR managers now have a wider role in this digital age, and one of their challenges in figuring out how to replace robots in job appointments with people. Because most industrial work is now automated in this era of smart manufacturing the HR department must drastically alter its strategies for recruiting, selecting in, developing and retaining staff members. This kind of technological integration with a changing society is seriously contributing to the rise of capitalism in addition to unemployment and layoffs. Industry 5.0 or the social revolution is required to integrate the new industrial revolution and put into practice the idea of human-robot co-working in an inclusive society.

5.2 Limitations of the Study

The Research study being a never-ending process makes ground for further research. All studies have their limitations and this study is no exception. Despite its theoretical and practical relevance, the study does suffer from limitations. The present study deeply conceptual subjects and makes a general study of the Industrial Revolution, which is not completely applicable to any particular sector or industry.

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REFERENCES

- Abu-Ghazalah, S. (2008). The sustainable city development plan for Aqaba, Jordan. *Journal of Developing Societies, 24(3)*, 381-398.
- Akundi, A., Euresti, D., Luna, S., Ankobiah, W., Lopes, A., & Edinbarough, I. (2022). State of Industry 5.0—Analysis and identification of current research trends. *Applied System Innovation, 5(1)*, 27.
- Bulkeley, H., & Betsill, M. (2005). Rethinking sustainable cities: Multilevel governance and the urban politics of climate change. *Environmental Politics, 14(1)*, 42-63.
- Coelho, P., Bessa, C., Landeck, J., & Silva, C. (2023). Industry 5.0: The arising of a concept. *Procedia Computer Science, 217*, 1137-1144.
- Ciffolilli, A., & Muscio, A. (2018). Industry 4.0: National and regional comparative advantages in key enabling technologies. *European Planning Studies, 26(12)*, 2323-2343.
- Deguchi, A., Hirai, C., Matsuoka, H., Nakano, T., Oshima, K., Tai, M., & Tani, S. (2020). What is society 5.0. *Society, 5(0)*, 1-24.
- Demir, K. A., Döven, G., & Sezen, B. (2019). Industry 5.0 and human-robot co-working. *Procedia Computer Science, 158*, 688-695.
- Gibbs, D. (2000). Ecological modernisation, regional economic development and regional development agencies. *Geoforum, 31(1)*, 9-19.
- Healey, P. (2004). The treatment of space and place in the new strategic spatial planning in Europe. In *Steuerung und Planung im Wandel: Festschrift für Dietrich Fürst* 297-329.
- Heinberg, R. (2010). What is a sustainable city? *The Edmonton Sustainability Papers, 5*.
- Holmberg, J., Bass, S., & Timberlake, L. (1991). *Defending the future. A guide to sustainable development*.
- Javaid, M., Haleem, A., Singh, R. P., Haq, M. I. U., Raina, A., & Suman, R. (2020). Industry 5.0: Potential applications in COVID-19. *Journal of Industrial Integration and Management, 5(04)*, 507-530.
- Jepson Jr, E. J. (2001). Sustainability and planning: Diverse concepts and close associations. *Journal of Planning Literature, 15(4)*, 499-510.
- Khan, A., & Turowski, K. (2016, April). A perspective on industry 4.0: From challenges to opportunities in production systems. *Paper presented at the International Conference on Internet of Things and Big Data, 2*, 441-448.
- Longo, F., Padovano, A., & Umbrello, S. (2020). Value-oriented and ethical technology engineering in Industry 5.0: A human-centric perspective for the design of the factory of the future. *Applied Sciences, 10(12)*, 4182.

- Majerník, M., Daneshjo, N., Malega, P., Drábik, P., & Barilová, B. (2022). Sustainable development of the intelligent industry from Industry 4.0 to Industry 5.0. *Advances in Science and Technology Research Journal*, 16(2).
- Mierzejewska, L. (2009). Urban planning in Poland in the context of European standards. *Quaestiones Geographicae*, 28(1).
- Nawang, A. A. S. M. A. (2022, August). Digital marketing in the era of society 5.0 by applying design thinking. *International Conference Faculty of Economics and Business*, 1(1), 290-301.
- Oskeser, B. (2018). Lean innovation approach in industry 5.0. *The Eurasia Proceedings of Science, Technology, Engineering, and Mathematics (EPSTEM)*, 2018(2), 422-488.
- Østergaard, E. H. (2018). Welcome to industry 5.0: The human touch revolution is now underway. *Universal Robots*, 1-7.
- Parida, V., Sjödin, D., & Reim, W. (2019). Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises. *Sustainability*, 11(2), 391.
- Roblek, V., Meško, M., & Krapež, A. (2016). A complex view of Industry 4.0. *Sage Open*, 6(2), 2158244016653987.
- Rotmans, J., Van Asselt, M., & Vellinga, P. (2000). An integrated planning tool for sustainable cities. *Environmental Impact Assessment Review*, 20(3), 265-276.
- Saha, D., & Paterson, R. G. (2008). Local government efforts to promote the “Three Es” of sustainable development: Survey in medium to large cities in the United States. *Journal of Planning Education and Research*, 28(1), 21-37.
- Simandan, D. (2020). Industrialization. *International Encyclopedia of Human Geography, Second Edition*, 255–260.
- Skobelev, P. O., & Borovik, S. Y. (2017). On the way from Industry 4.0 to Industry 5.0: From digital manufacturing to digital society. *Industry 4.0*, 2(6), 307-311.
- Sreedharan, V. R., & Unnikrishnan, A. (2017). Moving towards Industry 4.0: A systematic review. *International Journal of Pure and Applied Mathematics*, 117(20), 929-936.
- Xu, X., Lu, Y., Vogel-Heuser, B., & Wang, L. (2021). Industry 4.0 and Industry 5.0-Inception, conception and perception. *Journal of Manufacturing Systems*, 61, 530-535.
- Zizic, M. C., Mladineo, M., Gjeldum, N., & Celent, L. (2022). From Industry 4.0 towards Industry 5.0: A review and analysis of paradigm shift for the people, organization and technology. *Energies*, 15(14), 5221.
- Zhou, J. (2013). Digitalization and intelligentization of manufacturing industry. *Advances in Manufacturing*, 1(1), 1-7.