A Roadmap for Industry 4.0 and Beyond: Towards Sustainable Development through Digitalization

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Abstract

This research paper explores the intricacies of Industry 4.0 as well as examines the profound impact of Industry 4.0, revealing how technological advancement, interconnected systems, and automation proved highly efficient and productive for the industries but at the same time adversely affected human needs such as job displacement and diminishing role of humans in certain industries and making people overly reliant on technology. This paper also examines the remarkable growth of AI during and post-pandemic and its negative impacts. The paper also highlights the need for the emerging paradigms of industry 5.0, and the importance of infusing sustainability and human needs into the vision of industries, ensuring a more holistic approach for a more balanced future.

KEY WORDS

Industry, Sustainability, Digitalization, Artificial Intelligence .

INTRODUCTION

Industrial Revolutions in brief are defined as the major changes brought in the industry sector with the motive to introduce innovative technologies in the manufacturing and industrial process.

Technological advancement in the business industries is growing by leaps and bounds and societal trends have evolved to a very striking extent. One of the palpable evolutions witnessed at the present juncture would be the usage of Artificial intelligence in the Industry 4.0 and present Industry 5.0 scenario. AI technology has been prevalent even before the pandemic and the defence and financial sectors were the ones where AI was first implemented. The state-of-the-art defence equipments are powered by AI to

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enhance their capability. AI is also helping nations build their defence to boost their potency, hence, we can deduce that AI has multi-dimensional usage and it has become indispensable in the current economy. But before delving into the concept of AI and industry 4.0 and 5.0 let's first understand the origin of these revolutions.

History of Industrial Revolution

The First Revolution 1.0 started in 1784 with machines powered by water and steam which was a transformative phase in the history of the industrial sector. In this phase, agrarian and craft-based economies shifted to industrial and mechanized productions, with inventions like steam engines and the cotton gin. Though it started primarily in Britain its effects steadily permeated globally over time.

The second industrial revolution happened around 1870. It clearly substantiated its significance with the introduction of the Electricity & Steel. The focal point of the industries shifted to electrification and Mass production, transportation advancement, development in communication technologies, innovation in pharmaceutical and chemical industries, to boost the business of dominant players in their respective fields, urbanizations and migration, globalization and trade, cognizance of the labour movement and labour rights.

Then began the 3rd Industrial Revolution around 1969 the main focus of industries in this phase revolved around electronics, automation, and computers. The crux of Industry 3.0 was introducing automation in the industrial processes. The advent of such digital technologies especially the internet, transformed not only the industries but the whole society and the everyday life of every individual fundamentally.

Industry 4.0

The 4th Industrial Revolution came up with umpteen changes in every aspect of industrial practices. If we look at Industrial Revolution 3.0 it was all about computers and automation of an individual system but it clearly lacked behind in connecting these digital devices, physical and virtual worlds with one another as a single network, this is when Industry 4.0 came to the rescue; the efficiency and effectiveness of operations were increased tremendously. Technology is unequivocally omnipresent in today's era, be it in the manufacturing or production processes, health services sector, communication sector, or in the daily life of an individual. We can feel how deeply it has been ingrained into our lives. Industry 4.0 includes myriads of new inventions and advancements in the technological field which include:

1. Cyber Physical Systems which helps in bridging the gap between the physical systems and digital technologies.
2. All industries became data-driven; advanced analytical tools were introduced to provide significant insights from the given data.
3. The ubiquitous Internet of Things (IoT) through which every machine and web-enabled device with the help of the internet can connect with one another facilitating easy collection of large amounts of data and smooth exchange of data. For example- the LG ThinQ App can connect and control all LG devices such as washing machines, Air conditioners, televisions, refrigerators, and other appliances of the LG brand can all be operated by the single app with the help of the internet.
4. The advent of Artificial intelligence and robotics to lessen human intervention.
5. Cloud computing also came into the picture during Industry 4.0.

Growth of Artificial Intelligence during Pandemic

The pandemic has worked as a catalyst for rapid digital transformation and the growth of Artificial Intelligence. The majority of companies have made AI their mainstream technology during this period and by doing so they have protected themselves from the wrath of the pandemic which pushed many small businesses into bankruptcy. The pandemic hit the core of the labour force which created a huge gap between the demand and supply of labour forces, especially in critical domains such as healthcare and the financial domain. Earlier,

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these domains were heavily dependent upon the human component for their day-to-day functioning and the growth of AI was not substantial. In these times of crisis, AI came to the rescue not only for business leaders but also for society as a whole, in order to bridge the gap between demand and supply of human capital which was required for the smooth functioning of the certain huge gap in the labour force, people have realized the full power and potential of AI to bridge that gap.

The evolution of Artificial intelligence during and post-pandemic has helped us across various domains by substantially reducing human interaction and dependency on human resources in the following domains:

1. Financial domain such as AI self-service Kiosk, KYC, Automated account opening, etc.,
2. Health services domain such as preliminary diagnostics, chatbox for particular symptoms-based diagnostics, and apps like Meddibuddy, Arogyasetu,
3. Education Technology domain example Byjus, Unacademy, etc.
4. Entertainment domain such as OTT platforms like Netflix, Amazon Prime, and Zee5 which does customer-based study and suggests content based on the pattern of consumption.
5. Use of AI in weather reports, etc.,
6. Instant payment system through UPI.
7. Food delivery system using drones and many more.
8. Interactive search engine such as chat GPT
9. AI-based chatbot for example Ria which can operate like a human coach.
10. AI-based customer services-Virtual assistance which provides immediate answers without any support agents.
11. Defense equipment, use an AI system to calculate the trajectory, geographical scanning, etc.

Implementation of AI in business has opened many new channels of revenue and created a more efficient process of functioning devoid of human errors and lack of skill. It has not only elevated the earlier processes but also helped with the strong recovery of businesses that suffered during the adverse time. At the same time, it has effectively helped the employees to advance their current skill set by making in-house training programs and digital assistance accessible to them.

Drawback of Artificial Intelligence

Artificial intelligence has proved itself to be a boon indeed but there are a few disadvantages of it as well:

Firstly, along with bringing efficiency and effectiveness with lesser human intervention, it has also led to the unemployment of myriads of employees as it requires only a few people to get the same work done after the implementation of AI.

There are high chance that students' creativity will be hampered by exposure to AI such as chat GPT an interactive search engine that can provide you customized solutions to your problem, students dependency on technology has already increased to a great extent which is ultimately making them lazy with their research, so instead of improvement in their cognitive skills there might come a possibility of cognitive decline when solution to every problem will be available at a click of a button only.

Also, these online classes have negatively impacted students physically as well as mentally, watching the screen for so many hours adversely affects the eyes and not only this when students learn in a physical environment they are a lot more active physically be it in intervals or games period. It also hinders the process of social and emotional development, especially in formative years when students mostly learn from one another, and make friends which gives them a sense of social and emotional security, a feeling of love and belongingness, all these crucial parts are unfortunately missing in online classes, students who get used to online classes often face lack of confidence and feels lonely most of the time.

AI often collects and analyzes our personal data for which it doesn't provide any guarantee of security so there are always threats of being leaked or/and misused.

Need for Industry 5.0

When technology had achieved such great heights then the question arises what was the need for a new revolution at all?

The major shortcoming of Industry 4.0 was, that it was all about technological inventions, advancements & connecting all tech devices with one another, mass production was still the focal point of all industries just like in Industry 3.0, and not concerned about predicting the future needs of sustainability whereas the main focus of industry 5.0 was shifted to sustainable development.

Industry 5.0 is about developing a synergy and cooperation between humans and machines. It talks about collaboration which is a more holistic approach than the earlier one, as the saying goes "The whole is greater than the sum of its parts" This philosophy means the parts will be of no use unless we combine them together to make something out of it just like that, technology and humans cohesive efforts are required to achieve both efficiency and effectiveness.

One of the other possible reasons was the over-dependency of industries on technology consequently, curtailing job opportunities for human beings. Increased automation was creating highly vexing conundrums on the job securities of human beings, to eradicate such ramifications a new revolution had to take place. Industrial Revolution 5.0 is less concerned about new innovations and development in the technological sector and more about human development, development in technology with development of job roles for human beings. As it is humans who made these machines, machines have not made humans, the business in order to make a profit gets everything it need from the society only therefore they must feel obligated towards the society's wellbeing.

Customers have become more aware than ever before, now we see a number of awareness programmes towards saving our environment by opting for green products. A new market segment has been introduced called the 'LOHAS' – which stands for 'lifestyle of health and sustainability' and consists of well-educated people who are cognizant about social and environmental issues and therefore choose products that don't harm the environment.

We can deduce from all these points that technologies have already been advanced to a great extent in Industry 4.0. Now all it needed was a more responsible perspective in the application of these technologies which should not have any adverse effect on humans or on the environment and also fulfil present objectives without neglecting the needs of the future.

Literature Review

1. Industry 5.0 and a critique of Industry 4.0 (2017) by Kadir Alpaslan Demir & Halil cicibas. They examined that Industry 4.0 has a constricted vision and scope, and their results showed that Industry 4.0's hyperfocus on technology alone was neglecting the needs of human beings and the need for sustainable development.

2. Impact of COVID-19 outbreak on employee performance- The moderating role of industry 4.0 base technologies (2021) by Gopalakrishnan Narayanamurthy & Guilherme Tortorella. They conducted a detailed study on how the pandemic has impacted the work performance of the employees and how Industry 4.0 has helped in mitigating the implications of the pandemic on work performance. Their study found that Working from a work-from-home environment improved the employees' performance and Industry 4.0 has increased the interconnectivity and automation levels, and also enhanced the quality of performance.

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3. Industry 5.0- A human-centric solution(2019) by Saeid Nahavandi. The findings showed the importance of human and machine collaboration in improving the process efficiency, rather than replacing them we should empower humans which will improve the productivity of both humans and machines.

4. Identification of Social and Economic Expectations: Contextual Reasons for the Transformation Process of Industry 4.0 into the Industry 5.0 Concept (2022) by Sebastian Saniuk, Sandra Grabowska and Martin Straka. This study investigated the increase in digitization of the enterprises in Industry 4.0, which has caused many negative consequences for the employees and society and how Industry 5.0 is mitigating the ramifications caused by industry 4.0 and is focusing on sustainable development and enterprises, acknowledging their duty towards the society in industry 5.0.

Objective of The Study

1.   To study the key elements of Industry 4.0.

2.   To study the growth of artificial intelligence during and post-pandemic era.

3.   To study the need for Industry 5.0.

Research Methodology

A combination of primary and secondary sources was used to gather comprehensive data. Primary data collection involved the administration of a well-structured questionnaire, a total of 90 samples were drawn from the population using a convenience random sampling method. To Facilitate a comprehensive understanding and derive meaningful insights from the data, tables and graphs were used and a Descriptive research method was used to analyze the collected data, secondary data was incorporated into the study sourced from reputable websites and research papers, providing valuable supplement to the primary data and enriching the depth of the research finding.

Limitation of The Study

1. Samples were collected mostly from Prayagraj and Varanasi districts only.

2. A lot of respondents do not have comprehensive knowledge regarding Industry 4.0 and Industry 5.0.

Data Analysis and Interpretation

The charts and tables provided below represent the analysis of primary data gathered through the use of a questionnaire.
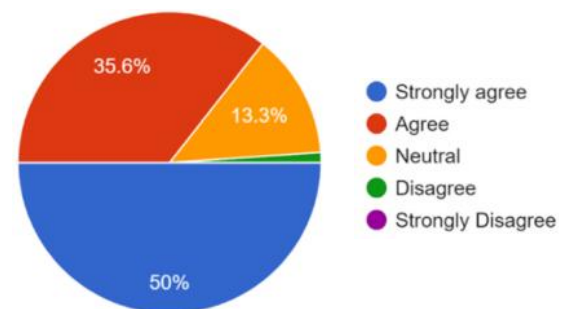
Q1 To what extent are you familiar with the terms industry 4.0 & Industry 5.1?
90 responses

From the above chart, we can see that out of 90 respondents, only 61.1% are familiar with the terms industry 4.0 and industry 5.0
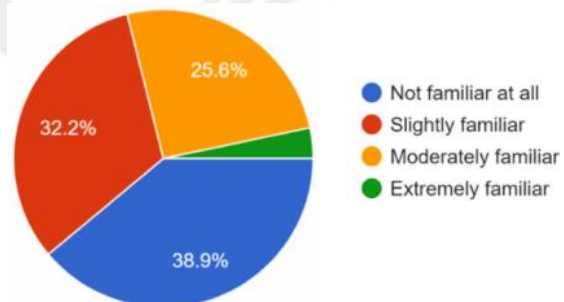
Q2 Do you Concure that there was a dire need to incorporte sustainable development into the vision of industries?
90 responses

The data collected infers the general consensus for the need to incorporate sustainable development into the vision of industries. 85.6% agreed with the incorporation while there was

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a neutral stance among 13.3% of the respondents.

Q3 Have industries shown an increasing commitment to social responsibility in recents years?
90 responses
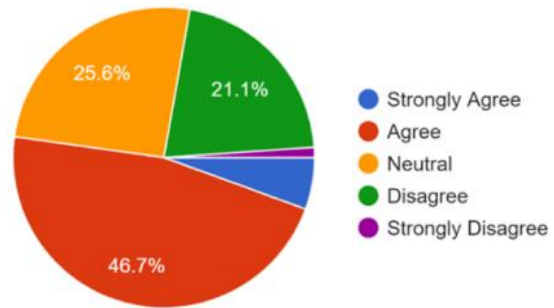
52.3% of the respondents believe that the industry has shown a positive inclination towards social responsibility but some ambiguities exist among a lot of the respondents.

Q4 Do you believe that excessive reliance on technology by industries will negatively impact human employment opportunitites?
90 responses
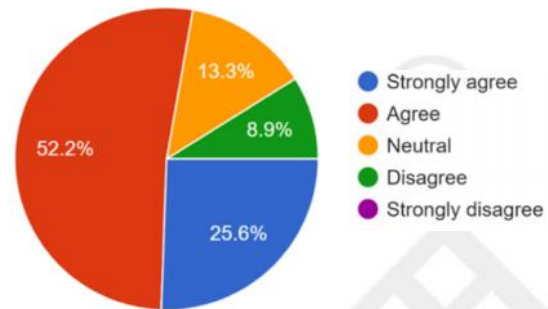
Almost 3/4th of the respondents believe that technological reliance would negatively impact employment opportunities for humans.

Q5 How frequently do you employ AI-powered tools in, your work or educational activities?
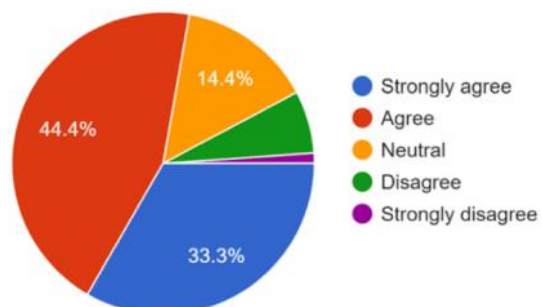90 responses
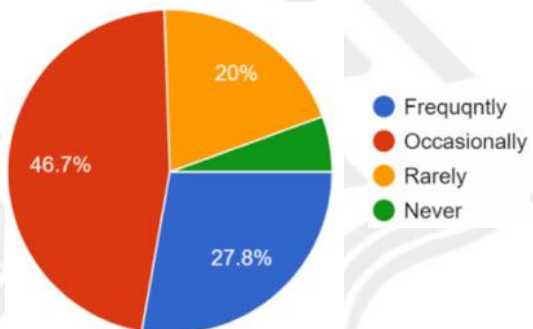
Almost half of the respondents occasionally incorporate AI-powered tools in their work and other activities while a little more than a quarter frequently use AI-powered tools. A mere 5.6% of the population does not use AI at all.

Q6 In your opinion, has Artificial Intelligence played a significant role during the dandemic?
90 responses
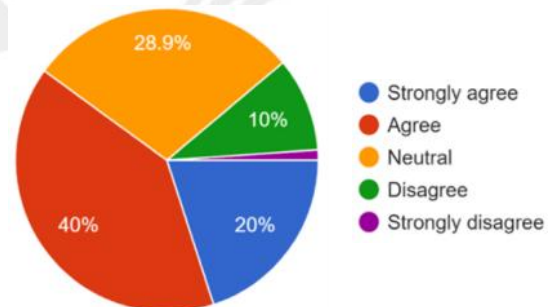
There is a consensus among 60% of the respondents that AI played a significant role during the pandemic while myriads of respondents have a neutral view towards AI's role during the pandemic.

Q7 Do you believe that AI tools have the potential to impede the creaticity of children?
90 responses

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A cumulative of 77.7% of respondents believe that AI tools will impede the creativity of children.

Q8 Do you believe that industry 5.0 is capable of mitigating the implications of the industry 4.0? 90 responses
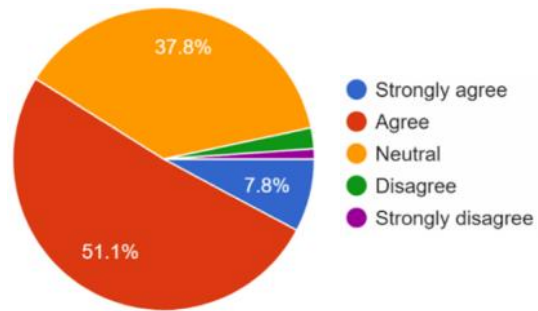
A majority of 58.9% of respondents have a view that Industry 5.0 is capable of overcoming the ramifications of industry 4.0 while 40.1% do not concur with the statement.

Q9 Do you agree that real world applications of Industry 5.0 are demonstrating it's Potential? 90 responses
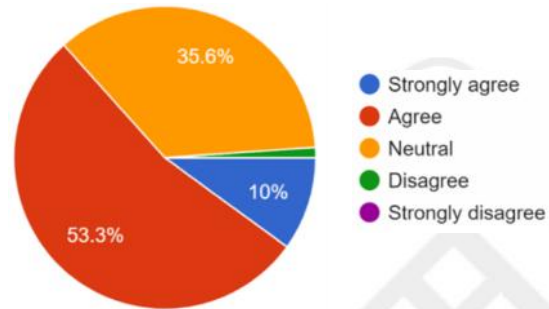
63.3% of respondents agree with Industry 5.0 demonstrating its potential. A very minute percentage believes otherwise and 35.6% of respondents have no opinion on the matter at all.

FINDINGS AND CONCLUSION

The survey conducted for the study revealed a pressing need to implement Industry 5.0, incorporating sustainability and human needs into the industry's vision. While industry 4.0 proved highly effective and efficient it was quite evident that it did not adequately address essential human needs. It may be stated that 70% of the people agreed that Industry 5.0 was a more inclusive approach than Industry 4.0 and there was an urgent need to bring sustainable factors into industries vision. Though many people remain uncertain about whether Industry 5.0 has successfully mitigated all the adverse effects stemming from Industry 4.0. So from the samples received in this paper, we can deduce that while people are aware of sustainable development concerns that are included in Industry 5.0 the outcomes or effects of Industry 5.0 remain unclear to many.

References

1. Demir, K.A., & Cicibas, H. (2017, October 17). INDUSTRY 5.0 AND A CRITIQUE OF INDUSTRY 4.0. ResearchGate. Demir, K. A., & Cicibaº, H. (2017, October 17). INDUSTRY 5.0 AND A CRITIQUE OF INDUSTRY 4.0. ResearchGate. https://www.researchgate.net/publication/337114167_INDUSTRY_ 50_AND_A_ CRITIQUE_OF_INDUSTRY_40, Retrieved on 10 February 2024

2. Employees want organisations to use AI tools like ChatGPT, reveals Microsoft's latest survey. (2023, January 30). The Times of India. https://timesofindia.indiatimes.com/gadgets-news/ employees-want-organisations-to-use-ai-tools-like-chatgpt-reveals-microsofts-latest-survey/articleshow/97440667.cms, Retrieved on 13 February 2024

3. Industry 5.0 – the essence and why it gets more attention. (2023, September 22). i-SCOOP. https://www.i-scoop.eu/industry-4-0/industry-5-0/, Retrieved on 13 February 2024

4. Kothari, P. (2023, September 29). AI-led bots make fitness SIMPLE, SCALABLE. The Times of India. https://timesofindia.indiatimes.com/business/india-business/ai-led-bots-

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A Double-Blind, Peer-Reviewed, Referred, Quarterly, Multi Disciplinary and Bilingual International Research Journal

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makefitness-simple-scalable/articleshow/104032893.cms?from=mdr, Retrieved on 14 February 2024

5. Marr, B. (2023, June 2). The 15 Biggest Risks of Artificial Intelligence. Forbes. https://www.forbes.com/sites/bernardmarr/2023/06/02/the-15-biggest-risks-of-artificial-intelligence/?sh=5fb457fc2706, Retrieved on 14 February 2024

6. More Advanced Manufacturing and Factory Automation Resources. (n.d.). https:// www.manufacturing tomorrow.com/story/2023/03/understanding-the-role-of- machine-vision-in-industry-40/20326/, Retrieved on 14 February 2024

7. Nahavandi, S. (2019, August 13). Industry 5.0—A Human-Centric Solution. Sustainability; Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/su11164371, Retrieved on 15 February 2024

8. Narayanamurthy, G., & Tortorella, G. L. (2021, April 1). Impact of COVID-19 outbreak on employee performance – The moderating role of industry 4.0 base technologies. International Journal of Production Economics; Elsevier BV. https://doi.org/10.1016/j.ijpe.2021.108075, Retrieved on 16 February 2024

9. Saniuk, S., Grabowska, S., & Straka, M. (2022, January 26). Identification of Social and Economic Expectations: Contextual Reasons for the Transformation Process of Industry 4.0 into the Industry 5.0 Concept. Sustainability; Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/su14031391, Retrieved on 16 February 2024

10. T. I. S. (2020, September 4). What is Industry 4.0? | What are the key Industry 4.0 technologies| All explained in 10 minutes. YouTube. https://www.youtube.com/watch?v=bNfZW qDLW0Q, Retrieved on 16 February 2024

11. Work and Organization in a Digital Industrial Context on JSTOR. (n.d.). https://www.jstor.org/stable/26381577, Retrieved on 16 February 2024

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April to June 2024   www.shodhsamagam.com
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