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Significant Leap In The Industrial Revolution From Industry 4.0 To Industry 5.0: Needs, Problems, And Driving Forces

Shagun TYAGI[1], Neha RASTOGI[2], Ashulekha GUPTA[3], Kapil JOSHI[4]

[1] *Management, Graphic Era Hill University, India*
[2] *Finance, Doon Business School, India*
[3] *Management Studies, Graphic Era (Deemed to be University), India*
[4] *Department of CSE, Uttaranchal University, India*

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Abstract
This research paper examines the transition from Industry 4.0 to Industry 5.0, underlining the dynamics, fresh challenges, and impending demands that form this revolution. The article uses an approach that is based on literature reviews to examine important books, reports, and articles that are mostly found on English-language websites. This paper focus on the demands, difficulties, and driving forces behind this pivotal stage in industrial history. In order to replace fossil fuels, the sixth industrial revolution will emphasise renewable energy, home robots, task-specific automatons, and medical technology. Industry 5.0 focuses on harmonious coexistence of intelligent machines and human agency, while Industry 6.0 emphasizes sustainability, homogeneity, safety, and eco-economics for adaptability in global challenges. It is envisaged that the metaverse will offer immersive virtual reality experiences with implications for gaming and wellness. Industrial logistics are about to undergo a revolution as a result of drones, which will overcome current constraints and increase productivity. In conclusion, this academic journey advances our understanding of the transition from Industry 4.0 to Industry 5.0, acting as a compass for the future. Industry 6.0, which is supported by sustainable practises, technology autonomy, and human adaptation, opens up a world of unexplored possibilities.

Keywords
Industry 4.0; Industry 5.0; manufacturing; revolution.

Introduction

Capitalism, European imperialism, and the agricultural revolution served as the main catalysts for the Industrial Revolution, which began with the transition of an agrarian economy to one dominated by machines and industry (Tri et al., 2021; Nasution et al., 2021). This process of industrial revolution first began in the 18th century in Britain and spread later all over the world. The first industrial revolution saw the invention of water and steam engines (Nasution et al., 2021), followed by mass production in the second (Setiyo. Et al., 2021; Paschek et al., 2019) automation through electronics and computer technologies in the third (Sarfraz et al., 2021) and the fourth industrial revolution requiring digitalization (Mehrpouya et al., 2021). Later the fifth industrial revolution is distinguished by a convergence of technologies that blurs the distinctions between the digital, physical and ecological domains. In comparison to industrial 4.0, industrial 5.0 aspires to establish a more balanced working relationship between more intelligent technologies and humans. Cobots will be integrated into industrial processes for more repetitive and monotonous duties. They will give humans more opportunity to employ their creative abilities for more creative work, which is the main distinction between industry 4.0 and 5.0.

Different periods of the industrial revolution have been ranging from industry 1.0 to industry 5.0 (Doyle-Kent & Kopacek, 2019). Society 5.0 has already taken centre stage in the midst of the COVID-19 pandemic (Sarfraz, 2021). Although it's still in its early stages. This revolution aims to maximise automation and big-data analysis while also providing accountability and aim for sustainability (Paschek, 2019). Some authors also contributed that fifth revolution is not

***Corresponding author**: Ashulekha Gupta – Professor, Department of Management Studies, Graphic Era Deemed to be University, phone: +919410189638, e-mail: ashulekha1806@gmail.com*

only an extension of the fourth revolution, focusing on three major elements sustainability, resilient and human centric. We will be able to seal the design loop with Industry 5.0, allowing us to push the boundaries of physics in design (Paschek, 2019). This article makes attempt to understand the industrial revolution throughout, what are the driving forces, how far we came and what will be the futuristic approach towards new industrial revolution. Through this article an attempt is also made that industry 5.0 will be another revolution or its only going to contribute in industrial revolution 4.0 in more enormous way. Further roadmap for future industrial revolution will be discussed along with recommendation and suggestion, followed by conclusion.

Research Methodology

This study uses a literature review-based methodology to analyse the transition from Industry 4.0 to Industry 5.0, identifying key traits, constraints, and driving forces through scholarly works, reports, and articles. Accessibility will be given preference to English-language articles. The quality and applicability of the literature will be evaluated before data extraction, which will be done utilising electronic databases, academic libraries, and online repositories. Correct citation and recognition of the original authors' work are ethical considerations. This study will shed light on the demands, issues, and driving forces that determine this crucial turning point in the industrial revolution and offer insightful information on the evolution from Industry 4.0 to Industry 5.0. Here the recent publication on industry 4.0 is represented in Figure 1.

This qualitative review aims to analyze the transition from Industry 4.0 to Industry 5.0, focusing on the relevance and reliability of selected literature. The selection process prioritizes papers directly addressing the transition between industrial revolutions, ensuring the quality of sources is reputable and English-language articles are preferred. Data is sourced from electronic databases, academic libraries, and online repositories, with keywords related to Industry 4.0 and Industry 5.0 used in search strategies. A screening process is conducted to assess the relevance of titles and abstracts, with irrelevant or duplicate papers excluded. Inclusion criteria include direct relevance to the transition and insights into key traits, constraints, and driving forces shaping this transition. Papers not meeting these criteria or not in English are excluded from consideration. Selection papers undergo a thorough evaluation to assess their quality, credibility, and contribution to the research objective. Ethical considerations are paramount, with proper citation and recognition of original authors' work to uphold academic integrity and respect intellectual property rights. This meticulous methodology provides a comprehensive understanding of the transition from Industry 4.0 to Industry 5.0, offering valuable insights and implications for stakeholders in the industrial sector and beyond.

Contribution of the paper

Through the integration of digital technology and physical systems, the Fourth Industrial Revolution (Industry 4.0) completely transformed the production landscape. Though it acknowledges the necessity for human inventiveness, problem-solving abilities, and

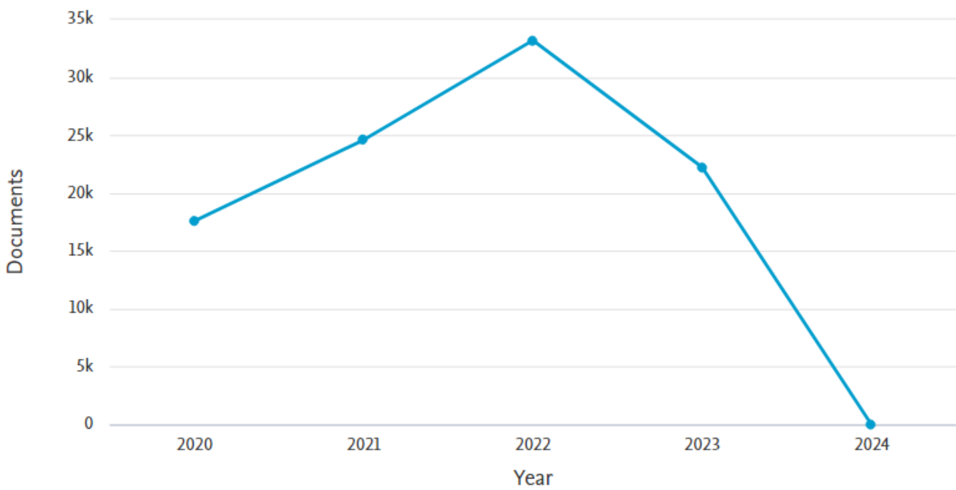

Fig. 1. Recent Publication on Industry 4.0

emotional intelligence in some fields, Industry 5.0 is focused on integrating human intelligence and creativity. By seamlessly merging human labour with AI-powered machines, this change intends to produce a more flexible, effective, and sustainable industrial landscape. The need for individualised products, the realisation that human input is essential for creativity and innovation, and ethical concerns regarding AI's potential effects on employment are the main forces behind the move. By examining the demands, issues, and underlying factors of Industry 5.0, this study helps us comprehend its relevance. Industry 5.0 promises to develop a more efficient manufacturing process by valuing human participation.

Literature Review

The evolution of industrial growth over time

The "Industry 4.0" era, characterized by digital technology and AI-based solutions, has significantly transformed the industrial sector, introducing production facilities, storage systems, and intelligent equipment capable of initiating operations, managing devices, and communicating information without human interaction (Setiyo et al., 2021). Through the creation of smarter networks, the revolution period has significantly altered how people work. The Industrial Internet of Things enables the optimal dissemination of information (IIoT). The Fourth Industrial Revolution is the period of information-exchanging autonomously operating smart machinery, storage systems, and manufacturing facilities (Jalinus, 2021; Aggarwal, 2022) Cyber-physical systems, blockchain, machine learning and artificial intelligence are important components of Industry 4.0.

The Internet of things (IoT) also includes cloud computing and big data. The emphasis of Industry 5.0 will be on the integration of human hands and brains back into the industrial structure (Jalinus, 2021; Sarfraz et al., 2021). More meaningful interactions between humans, computers, and robots will result from the development of manufacturing robots and artificial intelligence (Paschek et al., 2019). All sectors of industry with intelligent systems were the focus of Industry 4.0 (Nasution et al., 2021). In order to improve human potential, Industry 5.0 calls for the integration of AI into daily life. Industrial 5.0 aims to make business more human-cantered, resilient, and sustainable. This will lead to improved living conditions, improved living standards, and enhanced sustainability. It focuses on the wellbeing of the workforce and makes use of new technologies to generate income beyond employment and growth while taking into account the limitations of the earth. Industrial revolutions persist as long as it takes for widespread adoption in the industry (Javaid et al., 2020). Industry 4.0 could ultimately be realised in Manufacturing 5.0. As artificial intelligence advances, interactions between computers, robots, and human labour will eventually become more fruitful and mutually illuminating. The Table 1 shows the evolution on recent development.

Industry 4.0

Industrial revolution 4.0 represents largest structural transformation in the last past years. Its ability to transform stems from the integration of cutting-edge manufacturing and operational methods with digital technology. A closer integration between people, machines, and information technology systems

Table 1
Methodology Steps

Methodology Step	Explanation
Objective	Analyze the transition from Industry 4.0 to Industry 5.0 through qualitative review of relevant literature.
Criteria	– Relevance: Focus on papers addressing transition. – Quality: Prioritize scholarly works from reputable sources. – Language: Prefer English articles for accessibility.
Data Sources	Utilize electronic databases, academic libraries, and online repositories.
Search Strategy	Use keywords like "Industry 4.0", "Industry 5.0", etc., with Boolean operators for refinement.
Screening	Screen titles and abstracts for relevance, exclude irrelevant or duplicate sources.
Inclusion	Include papers directly addressing the transition with valuable insights.
Exclusion	Exclude papers not relevant or non-English language.
Evaluation	Assess quality, credibility, and contribution of selected sources.
Ethical	Ensure proper citation and adherence to ethical guidelines.

is made possible by cyber-physical systems (Jalinus, 2021). Industry 4.0 is about developing the next wave of operational excellence. Digitalization is essential since manufacturing in 2025 will still look considerably different (Nasution et al., 2021). A wide term, sustainability covers almost all facets of the human world. Industry 4.0's sustainability benefits and potential for social, economic, and environmental sustainability are gaining attention, proving to be a successful fourth industrial revolution. On the triple bottom line of sustainability, Industry 4.0 and digital transformation are anticipated to have a significant impact (Jalinus, 2021; Nasution et al., 2021). For one obvious reason, sustainability is essential: Without human embracement of sustainability, Earth's ecosystems and the intended standard of living for humanity cannot be preserved (Setiyo et al., 2021; Oláh et al., 2020).

The use of intelligent machinery and gadgets, as well as the digitization of business and manufacturing processes, may have a number of positive effects on waste reduction, resource efficiency, and production productivity (Jalinus, N.,2021; Nasution et al., 2021). For long-term vision there is need to focus economic, environmental, and social effects of industrial digitalization and this leading us towards industrial revolution 5.0. The research looks at how underlying design concepts and technological developments might be used in a way that is advantageous for sustainability. It starts by doing a cutting-edge, content-driven assessment and analysis of the literature to pinpoint key sustainability functions. Industry 4.0, or the application of intelligent technology for industrial automation, offers significant advancements in manufacturing toward flexible production, informed decision-making, and operational excellence. You can produce goods more quickly and affordably with a future-proof network that connects IT and OT completely and is highly secure (Javaid et al., 2020). Industrial revolution 4.0 occur because of digital transformation of industries and bring social, industrial and technological changes with it. Industry 4.0 refers to the incorporation of intelligent machines and systems into manufacturing processes (Oláh et al., 2020).

4^{th} Industrial Revolution Impact

4.0 IR is transforming urban life and how people connect with one another (Javaid et al., 2020; Oláh et al., 2020). Buildings are becoming into "service hubs" where people may engage with technology without having to be in a physical location. The way we consume, travel, work, and educate ourselves are all being disrupted by these shifts in urban life. Digital changes have the potential to significantly alter not just how we engage with technology, but also how we relate to the built environment and the city (Ghadge et al., 2020). Radical societal change will be brought about by the fourth industrial revolution. The Fourth Industrial Revolution resulting in a large ecosystem of interrelated, intricate, and dynamic interaction between humans and machines (Caruso, 2018; Peters, 2019). It provides the opportunity and responsibility to decide how we want to live and work in our communities in the future. For workers, organisations, and society as a whole, the fourth industrial revolution brings about profound changes. Digitalization and vast smart ecosystems will be the driving forces behind post-pandemic workplaces (Peters, 2019). The importance of artificial intelligence and machine learning will rise, serving as the basis for how we do business and work (Sarfraz et al., 2021).

Industrial development has evolved through five phases: First Industrial Revolution, Second Industrial Revolution, Third Industrial Revolution, Fourth Industrial Revolution, and Fifth Industrial Revolution. The First revolution introduced mechanization, steam power, and early machines, the Second revolution introduced electricity, mass production, automation, IoT, and cloud computing. The Fourth revolution focused on smart factories and AI, while the Fifth revolution emphasized human-machine collaboration and sustainable growth (Table 2).

Challenges and issues industrial revolution 4.0

4th industrial revolution involves a significant change in technology and business practises. There have been four widely acknowledged industrial revolutions, and each has had a distinctive influence on society, but it involves a significant change in business practises and technological inventions (Jalinus, 2021). This essay will look at how previous industrial revolutions affected society and what the present one will bring about. The fourth industrial revolution may ultimately alter how we live. The ongoing industrial revolution may be summed up as the technology's unprecedented integration into daily life (Aggarwal, 2022; Sarfraz et al., 2021). The methods in which businesses are conducted and how productive they may become may alter even more drastically as an outcome. Additionally, it promises a major rise in productivity for people, companies, and society.

The fourth industrial revolution has the potential to spur economic expansion, increase corporate profits, and raise living standards. Having an appropriate regulatory framework both domestically and internationally is a major concern. Since access to sophisticated technology carries a great deal of responsibility, we must make every effort to create a future that

Table 2
Industrial development evolution across time

S.No	First industrial revolution	Second industrial revolution	Third industrial revolution	Forth industrial revolution	Fifth industrial revolution
Year	1780s	1870s	1970s	Stated with evolution of computer era	–
Century	18th Century	19th Century	20th Century	20th Century	20th Century
Major inventions	Mechanization of Production, Use Of Steam Power, machines powered by water and steam	Electricity, Communication Tool, Vehicle, Mass Production	Interne, Smart Phones, Smart Computers, Digital Revolution, Robots, Automation, Software	Smart Factories, Complete Automation and Smart Systems, IoT, AI, Big Data Cloud Computing, VR, 3D Printing, Blockchain	Collaborative Robots, Advanced technologies, putting human in centre, Return of human touch, digital twin and metaverse

is fair and there is another aspect that people with less education or training risk being left behind if only highly skilled occupations are available in the future (Oke & Fernandes, 2020). Technology advancement has raised more questions about the ownership, management, and privacy of data and intellectual property. Organizations' internal data governance policies are insufficient to facilitate cross-organizational data exchange. Innovation is often hampered by a lack of compatibility across protocols, parts, goods, and systems. Real-time interoperability is made feasible by smart factories, but this comes with the potential of an increased attack surface (Oke & Fernandes, 2020). Currently mostly business is relay on AI for better data driven results (Caruso, 2018). Enterprise system vulnerabilities as well as operational vulnerabilities at the machine level must be anticipated by businesses. There are promising opportunities for fourth industrial revolution in climate change mitigation efforts (Mehrpouya, 2019). The key challenges are the creation of labour-market relevant competencies and an organisational culture that needs to be setter and process-focused (Jalinus, 2021; Oke & Fernandes, 2020). The results of the impact of this new revolution on the different activity sectors is still unknown. It will undoubtedly result in both favourable and adverse impacts. Consequently, one of the issues on the minds of the majority of researchers (Mehrpouya, 2019).

Figure 2: The Fourth Industrial Revolution technologies present numerous challenges, including the need for robust regulatory frameworks, managing economic impact, addressing the digital divide, data governance, and privacy concerns. Compatibility and interoperability issues are also crucial. Security vulnerabilities pose a risk, and leveraging technologies for climate change mitigation requires careful consideration of environmental impacts. Labor market competencies and organizational cultures are essential for effective work and innovation. Investigating sectoral impacts and uncertainties is crucial for informed decision-making and future research. A collaborative approach is needed for successful integration.

Technology in Industrial 4.0

Industry 4.0 was coined in 20th century and the implementation of this idea is projected to take 10–20 years. An important tipping point in industry is approaching. It is essential that the entire industry undergo a drastic overhaul. The existence of digitization greatly defines it. Internet communication is used by people, robots, and machines in industry 4.0 (Mehrpouya, 2019). With improvements in productivity and significant material and energy cost savings, production processes and supply networks are become more efficient for the benefit to the customer and as well as for producers (Peters, 2019). It offers competitive benefits including improved product quality and production efficiency that saves time and money.

One of the most promising industries in which technological businesses should make significant investments is augmented reality. Computers can be integrated with physical processes using cyber-physical systems (CPS). Equipment, people, processes, and products all need to be effectively integrated for Industry 4.0 (Serpanos, 2018). Autonomous robotics, blockchain, artificial intelligences, simulation, IoT, cloud computing, additive manufacturing, digital twins and augmented reality are some of the technologies that are being used to analyse large amounts of data (Da Silva et al., 2019; Serpanos, 2018) it also shown in Figure 2.

Fig. 2. Survey result shows the challenges and issue covered in past research

Big Data is also one of the leading concepts that being used in industry 4.0 and it refers to a collection of data that has been analysed using analytical techniques. Robots are designed to perform specified jobs autonomously or by remote control orders (Ullah, 2019). Depending on their function and requirement, different types of robots have varying degrees of autonomy. In Industry 4.0, the incorporation and expansion of autonomous robots in industries is a reality. The integration of global data in Industry 4.0 will build value chains that generate economic value chains. With IoT and sensors various kind of data can be generated for more accurate decision making (Serpanos, 2018). IoT is a significant technology that should be considered in terms of economic scenario. New production processes, such as 3D printing, will be developed and expanded in Industry 4.0 (Ullah, 2019; Chong et al., 2018). In order to provide suitable processing, storage, and connection, the intelligent industry will necessitate higher-performance cloud technology. Workers will be able to engage with merchandise using augmented reality devices.

Industry 4.0 is a suite of advanced technologies that drive innovation and efficiency in industries. These include Artificial Intelligence (AI), Internet of Things (IoT), Big Data Analytics, Cloud Computing, Augmented Reality (AR), and Robotics. AI and Machine Learning enable machines to analyze data, make informed decisions, and optimize production quality. IoT connects machines, sensors, and devices, enhancing visibility and control. Big Data Analytics provides insights into performance metrics, production trends, and customer behavior. Cloud Computing secures data storage and sharing across global facilities, facilitating remote collaboration. Augmented Reality aids in training and maintenance, while Advanced Robotics and Autonomous Systems increase safety and productivity by handling repetitive tasks. These technologies form the foundation of Industry 4.0, shaping the future of work (Fig. 3).

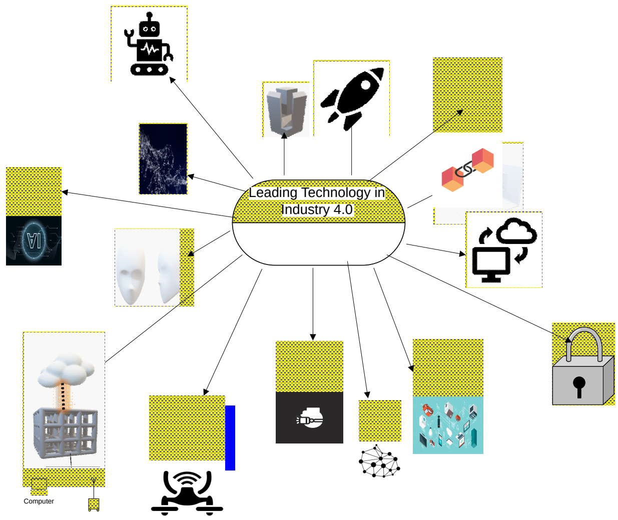

Fig. 3. Illustration of leading technology in industry 4.0

5th Industrial revolution

Industry 5.0, also known as "Digital Transformation" focuses on integrating AI into human life to enhance capacity, promoting human-centricity, environmental stewardship, and social benefit (Berawi, 2019). This shift emphasizes the importance of ethical goals in technology development, with the concept of human-robot/human-machine coexistence at its core (Chong et al., 2018). This theme's research focuses on how people and robots support and assist each other in manufacturing and production engineering operations (Doyle-Kent & Kopacek, 2019). Industry 5.0 is a sophisticated system utilizing networked, intelligent digital devices for efficient communication throughout the entire production process, including raw materials, work-in-process items, machinery, tools, automation, and robotic systems (Xu et al., 2021; Bag et al., 2021; Esmaeilian et al., 2020).

Automation, machine learning, and deep learning are key drivers of several technological breakthroughs that are gaining pace across the board (Esmaeilian et al., 2020). The current industrial boom has lasted decades, and we are now in the era of Industry 5.0 (Go, 2021). The study fills in the gaps by meticulously evaluating scholarly publications on the subject from various journals and conferences. The beneficial relationship between IT adoption and innovation is strengthened by organisation culture and procedure. Industry 5.0 has recently been associated with baskets of real-time technologies and associated patterns manufacturing, IoT, augmented reality, simulation, and social product advancement (Kamble et al., 2018). The author contends that legalising and standardising such vehicles will aid in the prevention of serious issues between technology, society, and businesses (Xu et al., 2021).

Industry 5.0 majorly focusing on "Industrial Upcycling." This concept highlights the collaboration of humans and new technologies. By leveraging technological advancements, Industrial 5.0 aspires to maintain societal and environmental benefits while also driving economic growth. It is an attempt to repurpose new solutions for the benefit of society and human life (Go, 2021).

Industry 5.0, a continuation of Industry 4.0's technology-driven changes, emphasizes the importance of considering societal, environmental, and human perspectives (Da Silva et al., 2019). Industry 5.0 lays the groundwork for this paradigm to be expanded by taking both resilience and human-centricity into account (Doyle-Kent & Kopacek, 2019). The function of humans in logistics systems was first examined in 2016 under the notion of 'Operator 4.0.' The goal is to maximise human contribution from three functional aspects: supported work, collaborative work, and augmented work. Collaborative robots (cobots) are a hotly debated enabling technology in Industry 5.0 (Go, 2021). Humans must be able to collaborate with robots through suitable training. Robots can be designed or educated to collaborate with operators in a lean fashion, potentially increasing productivity and efficiency (Xu et al., 2021).

Driving factors shifting focus from 4.0 to 5.0

Industry 5.0 aims to promote a more harmonious working relationship between increasingly intelligent technologies and humans. Humans are now expected to collaborate with robots rather than compete with them for jobs (Doyle-Kent & Kopacek, 2019). These cobots will be used in industrial operations to do more repetitive and monotonous activities (Go, 2021; Esmaeilian et al., 2020). Personalization is poised to become a crucial driver in the transformation of the online buying experience. A small 3D printer is then used to generate and make personalised beauty and skin care mixtures. The fifth industrial revolution's theory calls for a break from full automation and emphasises the use of new technology to enhance social and human development (Felsberger & Reiner, 2020; Elim & Zhai, 2020). This shift from Industry 4.0 to Industry 5.0 is fuelled by an emphasis on human-centricity, resilience, and sustainability (Wickramasinghe, 2018). In their main areas of concentration, these differences between Industry 4.0 and 5.0 are noticeably underlined. Please see Table 1 for a graphical illustration.

Production is undergoing transformations in numerous areas, including technological, logistical, organisational, and environmental. The usage of new technology has a huge impact on individuals at work and in their daily lives but now focus is shifting to sustainability and human centric inventions (Jalinus, 2021). Weather society is ready for this new revolution or not but soon industrial revolution 5.0 will going to be reality. Both workers and customers, as vital partners, must be adaptable. adjusting to new working situations and being willing to learn and share expertise (Nasution et al., 2021). Organization is another key industry segment affected by paradigm shifts. Today's organisation is characterised by decentralisation, with decision-making centralized (Setiyo. Muji et al., 2021) goal behind is to accelerate the decision-making process. Data gathering and processing provide accurate information (Sarfraz et al., 2021), allowing workers to respond quickly. Industry 5.0, a new industrial paradigm, emerged shortly after Industry 4.0 sparked a debate concerning the new paradigm's role and motivations for implementation. Industry 5.0, a new industrial paradigm, emerged shortly after Industry 4.0. sparked a debate concerning the new paradigm's role and motivations for implementation.

Industrial revolution 5.0 is a larger perspective on the industry 4.0 approach, providing reformative meaning and directions to the technological revolution of industry and putting humans in centre (Greer et al., 2019). After COVID-19 inventors know looking for a technology which can be used to resilient from any unpredictable challenges and shocks. The next step is to identify key enablers in the company that correspond to the aforementioned Industry 5.0 drivers. Industry 4.0 is not the correct framework for However, the use of modern technology and digitalization is critical, as Industry 4.0 is not the correct framework to support this notion. looking into a future ahead. Based on a literature review and a forecast analysis, the essence of Industry 5.0 focuses on three determinants of development human-centric, sustainability and resilient (Felsberger & Reiner, 2020). Instead of being a wholly new technical development, Industry

5.0 presents a perspective that builds on the basis created by Industry 4.0 (Greer et al., 2019). Industry 5.0 surpasses Industry 4.0 by gaining a competitive edge via the use of automated technology, quick accuracy, human critical thought, and creativity. Both Industry 4.0 and 5.0 have created a roadmap that directs industries towards success (Doyle-Kent & Kopacek, 2019; Yaacoub et al., 2020), however Industry 4.0 emphasises the necessity for adaptation to changing needs (Kamble et al., 2018; Elim & Zhai, 2020).

Table 3 illustrate Industry 4.0 and Industry 5.0 are two distinct industries that have undergone significant transformations. Industry 4.0 focused on achieving full autonomy in processes, while Industry 5.0 emphasized resilient processes integrating human intelligence. Industry 4.0 emphasized the adoption of autonomous systems and advanced technologies like IoT and machine learning, while Industry 5.0 advocated for a balanced approach that supported both distributed processes and human roles. Industry 4.0 primarily focused on developing systems dependent on internet connectivity, while Industry 5.0 prioritized resilience and extended product life cycles. Industry 5.0 also emphasized machine connectivity, focusing on enhancing customer experience through human-centric approaches. These shifts reflect a broader focus on resilience, sustainability, and human-centricity as core principles driving innovation in Industry 5.0.

Table 3
Driving factors shifting our focus from 4.0 to 5.0

Focus Area	Industry 4.0 Challenge	Industry 5.0 Solution
Autonomous and Semi-Autonomous Processes	Aim for autonomous and semi-autonomous processes	Resilient processes integrating human intelligence
Manpower in Factories	Transition to autonomous systems, IoT, and machine learning	Resilient systems supporting both distributed processes and human roles
Cyber-Physical Cognitive Systems	Development of cyber-physical systems	Enhance resilience with or without internet connectivity
Machine Connectivity	Focus on connecting machines	Enhance customer experience through human-centric approaches
Hyper Automation and Customization	Emphasis on hyper automation	Combine resilience with hyper customization
Energy Usage	Increased energy usage	Develop smart, energy-autonomous systems
Automation Emergence	Emerged with automation	Balance human and machine intelligence with a human-centric focus
Environmental Concerns	Limited concern for the environment	Focus on maximizing profit without harming the environment, emphasizing sustainability
Mass Production Machinery	Machinery for mass production without a sustainability approach	Resource-efficient, user-preferred solutions
Manpower Distance	Manpower distanced from factories	Return of manpower to factories, prioritizing human-centric approaches
Technology vs. Value	Moto “Think Tech”	Moto “Think Value,” focusing on resilience
Customized Goods and Services	Providing customized goods and services	Hyper personalization for a human-centric experience
Workforce Location	Remote workforce	On-site workforce with a focus on human-centric work environments
Product Experience	Smart product development	Experience-activated (interactive) products with resilience
Supply Chain Management	Smart supply chain	Openly circulated supply chain for enhanced resilience
Technological Adoption	Tech-savvy and automated processes	Improved safety and well-being, focusing on human-centric designs
Technology Perspective	Think tool	Think about people, emphasizing human-centric values

Industrial revolution 5.0 and Cyberphysiscal system

The fifth industrial revolution placed a greater emphasis on advanced human-machine interfaces. Human-machine collaboration causes significant changes in production and has an impact on the economy and the environment. Industry 5.0 introduces the notion of collaborative robots, commonly known as cobots. Industry 5.0 is laying the groundwork for new technologies that will allow customers to experience personalised production. With the global participation of (Yaacoub et al., 2020) diverse groups, the fifth revolution allows customers to enjoy mass customisation. It is also obvious from this transformation that the organisation is not solely dependent on technology. Cyber- physical system are technical systems, in which networked computers and robots interact with the physical world. Using bigdata as input, the Intelligent Cyber Physical System (Kamble et al., 2018). learns and generates information as required. Data is collected and analysed using automated devices (Yaacoub et al., 2020). This human-machine partnership improves production efficiency and leads to mass customization. It is feasible due to the interaction of human labour, robots, smart devices, customized machines and computers. The goal is to build a society in which humans undertake creative tasks of innovation and robots conduct the rest. Industry 5.0 will enable us to close the design loop, allowing us to push the boundaries of physics in design (Alexa et al., 2022). The fifth revolution is still in its early stages, but businesses are already taking use of it. The concept of cyber-physical systems (CPS) is one of responsible factor for arising a need for Industry 4.0. This further being linked with industrial revolution 5.0 many researchers, scientists, leaders, and scholars have begun to consider industry 5.0 (Chong et al., 2018) with Cyber-physical system.

Technological advancement in Cyber-physical System

Cyber Physical System and AI

Presence of AI can be seen around us and its already impacting our economy as well as our society in tremendous level. Inspite of numerous advantages, despite numerous advantages, the dangers associated with this technology cannot be ignored. There remains a significant need for transparent debate regarding the potential risks of AI that society may face. AI in cyber physical system could perform so many different functions such as robotic systems, biomedical monitoring system, health monitoring system and many more (Greer et al., 2019). With this it can also be work as a solution for natural disasters, correcting human errors. artificial intelligence in the networked connectivity of people, processes, data, and things. Digitalization in Industry 5.0 evolved from the industry 4.0 megatrend. The permeation of artificial intelligence into people's daily life is an emerging picture of the Industry5.0 paradigm. Some researchers believe that it is time for a Super Smart Society (Elim & Zhai, 2020). A cyber physical system uses computer-based algorithms linked to the internet to monitor physical elements. There is a growing desire for intelligent machines that can interact with their surroundings. CPS are creating huge changes in quality of life and becoming the foundation of smart infrastructure, products, and services, and AI plays a crucial role in this. Given the growing contribution of artificial intelligence (AI) to the creation of these new economic benefits, the five layers of cyber-physical system architecture as they currently exist seem outdated (Greer et al., 2019). The present five tiers of cyber physical system design appear to be out of date given the evolving importance of artificial intelligence (AI) in the development of these new economic benefits. Here the analysis is shown in Figure 4.

Cyber Physical System and IOT

The Internet of Things (IoT) aims to connect all devices to each other via the Internet, enabling them to be used or controlled from anywhere at any time. In contrast, cyber-physical systems also aim to interconnect devices but can operate with or without an Internet connection. CPS use sensors to connect all distributed intelligence devices in the environment to gain a deeper knowledge which enables a more accurate actions (Marwedel, P., 2021), because it enables user to collect the accurate data. IoT devices can be utilised as sensors to turn on lights and open doors, as well as to forecast the optimal time to heat or cool (Xu et al., 2018a; (Ratasich et al., 2019). An Industrial Internet of Things (IIoT) is devoted to using the IoT to link anything, everywhere, and at any time in a manufacturing system environment. IIOT, being a nascent technology, has particular qualities and requirements that set it apart from consumer IoT (Wickramasinghe, 2018). As a result, the concepts of reliability and security become inseparably linked (Marwedel, 2021).

The Internet of Things (IoT) has the capacity to efficiently gather, synchronise, and organise data from multiple sources in a useful way (Ratasich, 2019). It provides a strong platform with real-time streaming and processing capabilities, making it perfect for appli-

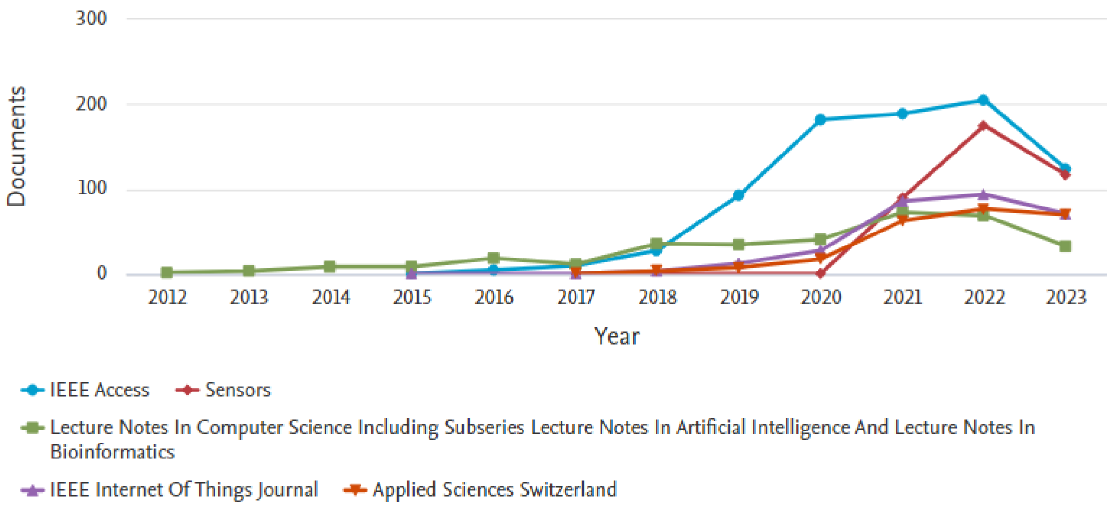

Fig. 4. Analysis between Cyber Physical System & AI

cations in corporate resource planning, supply chain management, and execution branch (Xu et al., 2018a). These crucial business operations can be optimised and streamlined using this platform's efficient handling and use of data. The purpose of cyber-physical systems (CPS) and the Internet of Things (IoT) is to increase technical reliability, extend advancement chances, and expose regions of untapped potential. This study is comparing the technology through Figure 5.

Cyber Physical System and Deep Learning

Cyber-physical Systems (CPSs) have become increasingly common in recent years. It is vital to develop generalised models that perform well under a variety of hazards. Little research has been done to far on the generalisation possibilities of DL-based CPS security applications for a variety of contexts (Dreossi et al., 2019). A specialised set of machine learning (ML) techniques called "deep learning" (DL) can automatically extract key representations from raw data and process them for use in a variety of applications, including classification, regression, clustering, and pattern recognition. The industrial industry benefits greatly from DL's excellent capacity to identify complex structures in high-dimensional data (Dreossi et al., 2019). It enables higher levels of abstraction without the need for human feature engineering, and it has demonstrated its efficacy in a variety of fields, including defect detection and diagnosis, inventory management, speech recognition, and image processing (Fig. 6).

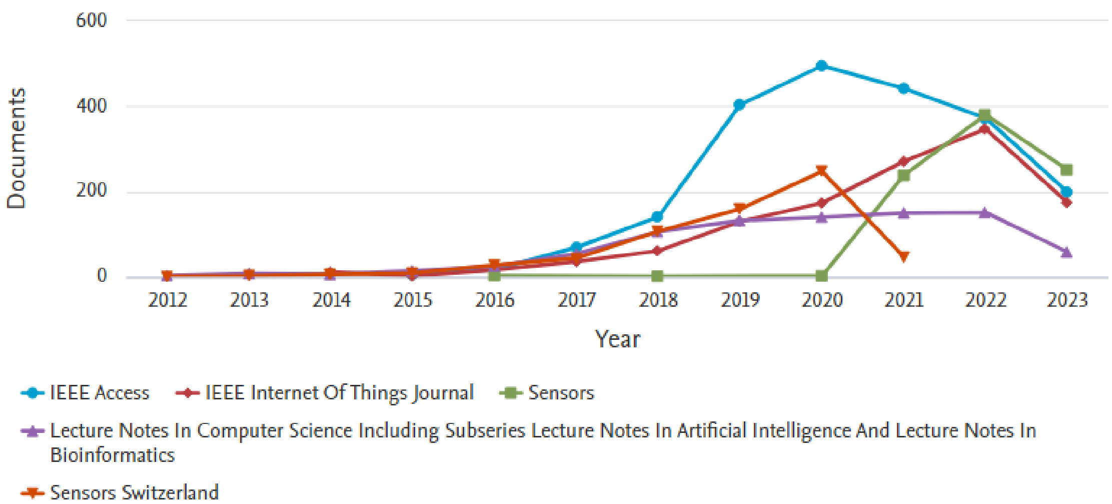

Fig. 5. Analysis between Cyber Physical System & IOT

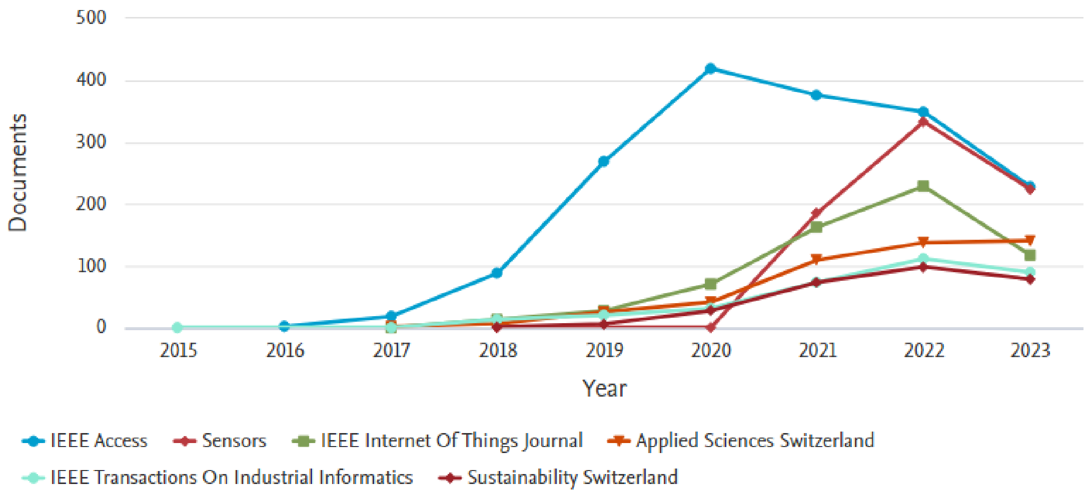

Fig. 6. Analysis between Cyber Physical System & Deep Learning

Cyber Physical System and Machine Learning

The ability of Cyber Physical Systems (CPS) to integrate the physical and information or cyber worlds distinguishes them. Traditionally, CPS security has been focused on stopping intruders from obtaining access to the system. Resilient CPS are built to endure disturbances and remain operational even when enemies are present. Machine learning is a subset of artificial intelligence (Dartmann et al., 2019) that allows the system to learn without being explicitly programmed by using a training data set (O'donovan, 2018). Artificial intelligence can aid in the reduction of human labour required to find vulnerabilities or threats in cyber physical systems/cyber space. Data is being generated at an exponential rate, and we must make efficient use of it. With the rapid growth of technology, intelligent maintenance systems are required to manage manufacturing and a variety of control applications. Because this field is still in its early stages, it requires the attention of all research and scientific groups around the world (Wu et al., 2019). Complete pattern shown in Figure 7.

Cyber Physical System and Big Data Analytics

Society has undergone a transformation as a result of the convergence of IoT and cyber-physical systems (CPS), however incorporating Big Data into CPS solutions brings both opportunities and challenges (Atat et al., 2018). Advanced mathematical methodologies and data science techniques are needed to derive useful insights from the data produced by IoT devices and CPS deployments. In this networked world, security and privacy must be guaranteed. To fully utilise

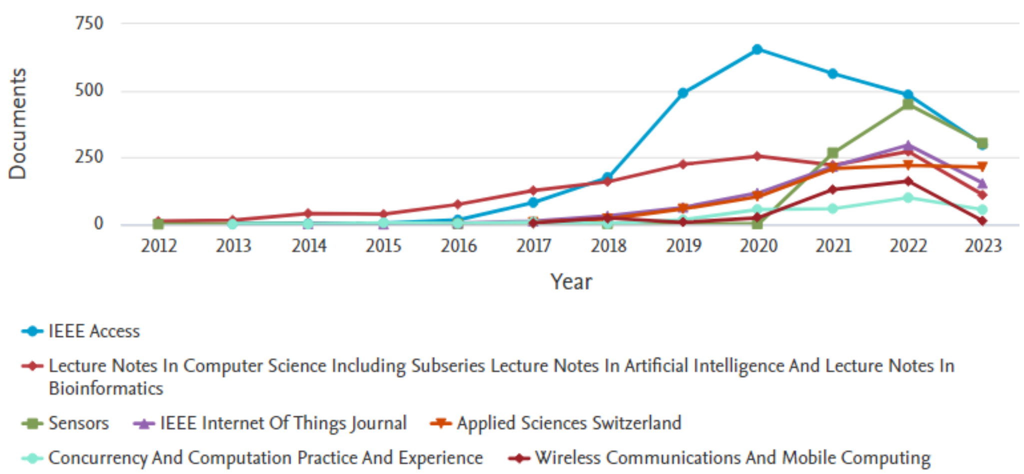

Fig. 7. Analysis between Cyber Physical System & Machine Learning

Big Data's potential in CPS, decision-making must be based on data. Because of the need for real-time processing in industrial and sensitive contexts, traditional methods based on batch or offline processing are no longer appropriate. In order to process Big Data in real-time and provide quicker and more informed decision-making, real-time connection between IoT devices and analytics infrastructure is essential. Many industries, including smart manufacturing, healthcare, transportation, energy, agriculture, and environmental monitoring, benefit from the integration of IoT technology and mathematical methodologies. Experts from a variety of disciplines, including data science, computer science, engineering, and domain-specific knowledge, must be consulted. To overcome obstacles and promote innovation in the field of big data for CPS, partnerships between academics, business leaders, and policymakers are essential (Khalid et al., 2018). The study can be shown in Figure 8.

Cyber Physical System and Robotics

Robots and sophisticated cyber-physical systems (CPS) are essential for gathering, analysing, and acting on data. It is crucial to guarantee their secure operation in the face of uncertainties and resource limitations. Experts from numerous disciplines are now involved in the multidisciplinary research of robotic cybersecurity. Strong cybersecurity is increasingly necessary as these systems get more complicated (Tosh et al., 2020). The focus of researchers and practitioners is on creating novel defences against potential weaknesses and cyber-attacks. Because cybersecurity for robots is interdisciplinary, it calls for cooperation from specialists in computer science, engineering, artificial intelligence, cryptography, and other fields. Robotics technology may advance safely and effectively, benefiting society as a whole, by tackling cybersecurity challenges. The complete challenges are shown in Figure 9.

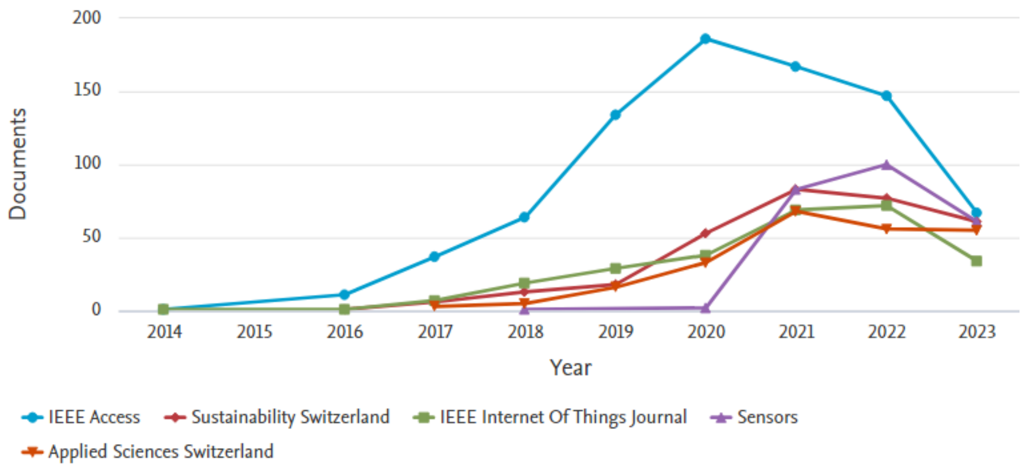

Fig. 8. Analysis between Cyber Physical System & Big data

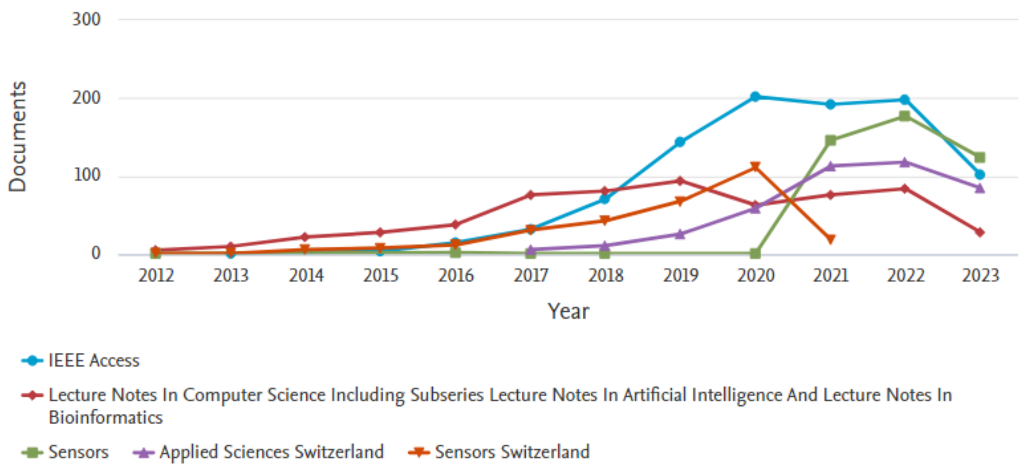

Fig. 9. Analysis between Cyber Physical System & Robotics

Cyber Physical System and Quantum Computing

Cyber-physical systems (CPS) are a fusion of computational and physical elements that enable innovative human interaction. Quantum computation offers higher computational power than classical computers, enabling problem-solving and optimization. Digital twins in Industry 4.0 help model system behaviour, improving efficiency and performance (Rathore et al., 2020). However, the increasing prevalence of CPS raises cybersecurity challenges, particularly in the context of quantum computing. Proactive cybersecurity research is crucial to address potential threats and ensure the safe and reliable operation of these systems. The year by year analysis graph is mentioned in Figure 10.

Cyber Physical System and Blockchain

The Bitcoin system has successfully employed blockchain technology for transaction verification by using rigidly dispersed blocks to create a chain. Using it across the Software-Defined Networking (SDN) platform ensures privacy and security due to its inherent security. Based on the fundamental idea of distributed features, the Deblocked architecture uses blockchain technology to verify and share flow rules tables between IoT devices. The authors stress the significance of carefully crafting programmes that are efficient at both design and runtime 43. In order to create better, more dependable, and safer goods, industries are implementing cyber-physical systems powered by the Internet of Things (IoT) (Barzen, & Leymann, 2020). Security has typically been thought of as an issue for data or communication security, however the development of CPSs and the integration of IoT with CPSs necessitate collaborative efforts to address safety and security challenges effectively.

In order to create better, more dependable, and safer goods, industries are implementing cyber-physical systems powered by the Internet of Things (IoT) (Barzen & Leymann, 2020). Security has typically been thought of as a data or communication security issue, but as CPSs have developed and the Internet of Things has been integrated with them, it is now necessary to work together to successfully handle safety and security issues. The future of Industry 4.0 will be significantly shaped by the convergence of control architectures, cyber-physical systems, and the Internet of Things. Advanced embedded systems known as "cyber-physical systems" support vital infrastructures like smart grids, automobile traffic networks, intelligent buildings, cooperative robotics, automotive, and avionics systems. These systems interact with their environment continuously and dynamically. These systems leverage the power of CPS to optimize operations and deliver efficient and intelligent solutions (Xu et al., 2018b). The scope of cyber physical system along with block chain are explained in Figure 11.

Cyber Physical System and digital twin

The seamless fusion of cyber-physical systems and the physical world is what sets Industry 4.0 apart. These dynamic, computational and physical processes are combined in these cyber-physical systems. Enhancing engagement, flexibility, customisation, and overall functionality have been the main goals in industrial contexts (Groshev et al., 2021). The goals are satisfied through Figure 12.

Major industry giants like Lockheed Martin, Boeing, General Electric Aviation, Airbus, Lufthansa, and Rolls Royce Aircraft Engines have used cutting-edge technology like digital twins, augmented reality, and cyber-physical systems across a variety of applications.

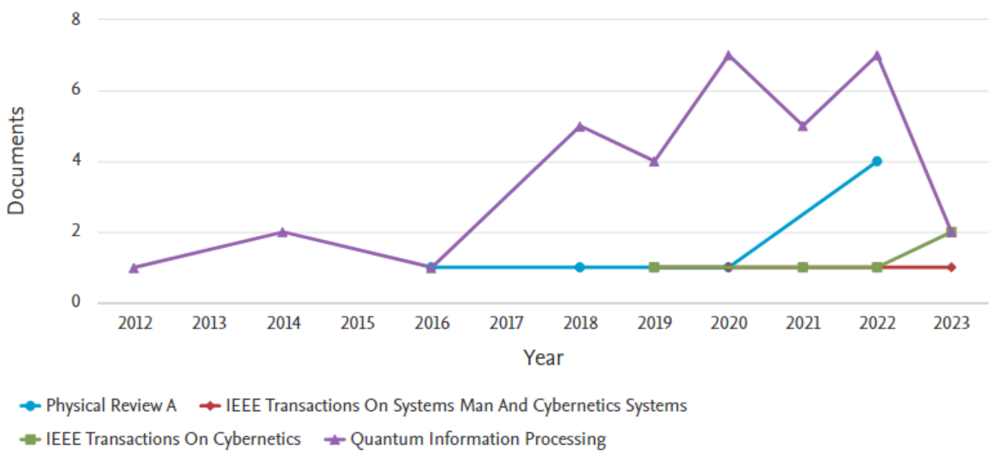

Fig. 10. Analysis between Cyber Physical System & Quantum Computing

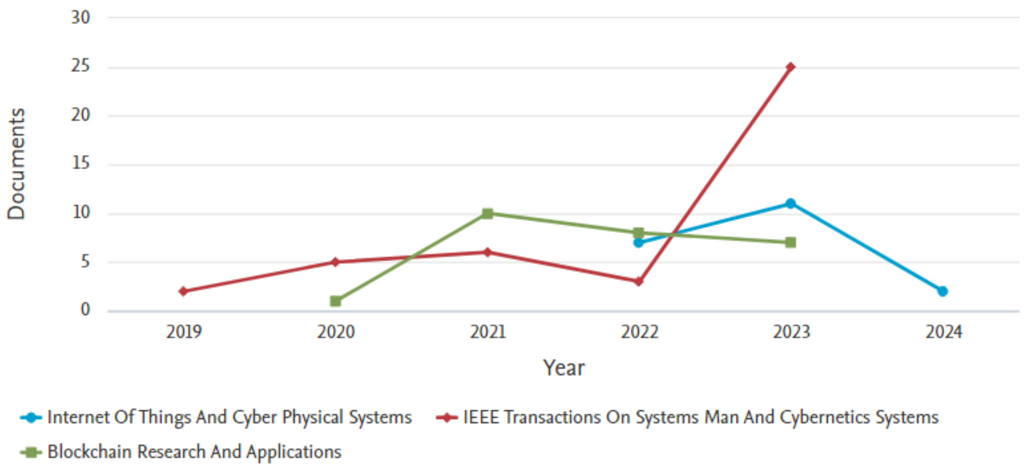

Fig. 11. Analysis between Cyber Physical System & Blockchain

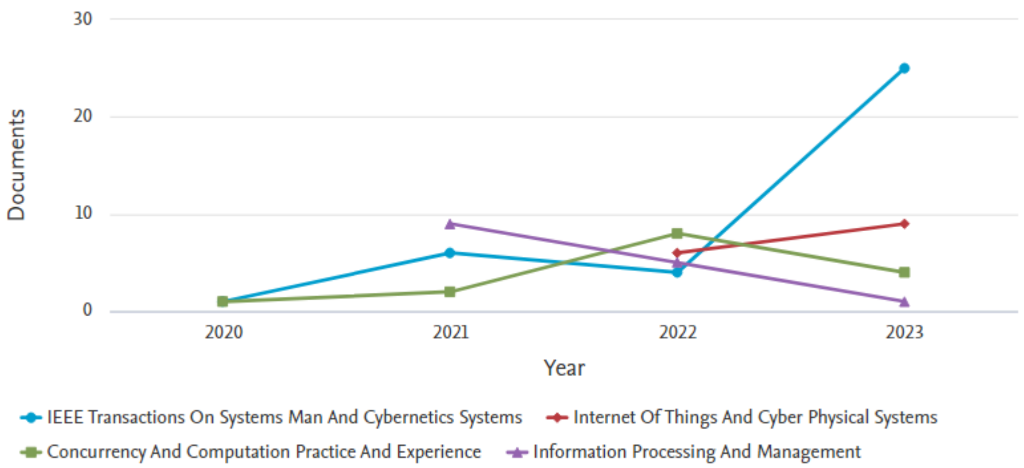

Fig. 12. Analysis between Cyber Physical System & Digital Twin

These technologies are useful for a variety of jobs, from manufacturing line monitoring to maintenance and repair procedures. Building information modelling (BIM) and the Internet of Things (IoT) are two examples of innovation given by Ding et al. for the development of smart steel bridges.

The idea seeks to improve bridge administration and construction through cutting-edge digital methods (Groshev et al., 2021). There are various definitions of digital twins in the literature. A virtual model that accurately depicts a physical entity and reflects changes in its condition, whether good or negative, can be summed up as a digital twin (Duggal et al., 2022). Real-time monitoring and analysis are made possible by this virtual representation, which offers insightful information for decision-making and optimisation.

In conclusion, the integration of cyber-physical systems with physical domains is what gives Industry 4.0 its disruptive force. In industrial settings, this convergence encourages greater efficiency, adaptability, and personalization. Businesses are aggressively utilising innovations like augmented reality and digital twins to enhance a variety of processes, from production to maintenance. Taking these developments on board enables industries to endure. A Cyber-Physical System (CPS) combines computation, networking, and physical things. The Digital Twin is a digital twin that can be retrofitted into existing smart design and construction management systems (Groshev et al., 2021). The use of cyber-physically connected machinery that can be remotely controlled has numerous ramifications, ranging from improved safety to operator training and increased accessibility. Smart technology implementation gateway for building projects. The Digital Twin employs standardised BIM formats, allowing it to be readily retrofitted into existing building design, construction management, and engineering systems (Duggal et al., 2022).

Cyber-Physical Systems (CPS) are a crucial part of Industry 4.0, integrating advanced technologies like AI, machine learning, deep learning, digital twins, cloud computing, blockchain, and big data analytics. AI allows CPS to analyze data autonomously, adapting to changes in the environment or process flows without human intervention. Machine learning and deep learning improve performance over time, reducing downtime and repair costs. Digital twins simulate and optimize processes, enhancing CPS's ability to make accurate real-time decisions. Cloud computing provides centralized storage, processing capabilities, and easy access to data from multiple locations, enabling CPS to scale quickly. Blockchain technology provides security and transparency, ensuring data integrity and preventing tampering. Big data analytics extracts valuable insights from vast amounts of data, enabling real-time decision-making and revealing patterns in manufacturing processes. The integration of these technologies creates a more intelligent, autonomous CPS environment, paving the way for future innovation across industries like manufacturing, healthcare, transportation, and smart cities (Figure 13).

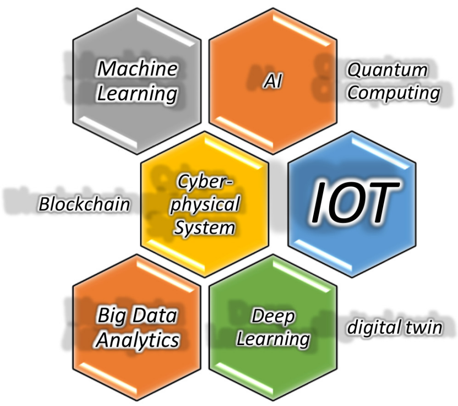

Fig. 13. Cyber-physical system

Vision for next industrial revolution

Although the workforce in industries adopting digital transformation within the framework of Industry 4.0 and 5.0 may change, the idea of job losses may not be accurate, according to the vision for the next industrial revolution. Instead, this transition is more likely to open up opportunities in new fields like data warehousing and robotic process automation (RPA). The workforce must update their skill sets to meet the requirements of these domains in order to take advantage of these opportunities (Duggal et al., 2022). To close the skill gap and meet urgent needs, ongoing training and workforce development are essential. We can predict developments in genetics, artificial intelligence (AI), and human-machine interfaces (HMI) by extrapolating from current patterns. Google Glass and other low-cost hardware options like cybernetic implants could become commonplace at the start of this new era (Chourasia et al., 2022).

Software/robotic combos are projected to replace workers in a variety of areas during the next 70 years, including the legal, financial, insurance, medical, transportation, and agricultural sectors. As long as we live in prosperity on Earth, overpopulation could pose a significant problem. Potential environmental issues are exacerbated by the buildup of more than 160 bioreactive compounds in streams and the global degradation of biodiversity and ecosystems (Das & Pan, 2022). Although promising, nanotechnology currently poses concerns if fail-safes and better security mechanisms are not carefully integrated. To overcome these obstacles, the population will need to work together on issues like climate change, ethical technology use, and valuing people in society. As opposed to other industrial revolutions, Industry 6.0 is envisioned as having a more global viewpoint (Penprase, 2018). Sustainability, homogeneous assets, security, resilience, antifragility, harmony with nature, and eco-economy shall be given priority. Industry 6.0 will be a synthesis of these notions with distinctive convergence concepts, building on the developments of Industries 4.0 and 5.0. The supply chain, value chain, and AI applications will all undergo radical change as a result of quantum computing. By reducing human touch, robot-based medical services in OPD settings can lower the risk of infection. For lithographic-controlled release medicine, 3D printing technology will also become more flexible with a greater variety of materials, biomaterials, and chemicals (Caruso, 2018).

Hyper-connected industries, dynamic value networks, dynamic supply chains, and open information exchange between administrations will all be made possible by industry 6.0. Antifragile manufacturing will be the central idea of this revolution, encouraging innovation and creative thinking in the manufacturing and other industries while elevating both humans and technology to the role of protagonists. Global hazards are likely to endure in a world affected by climate change and the biodiversity problem, needing strong strategies and solutions to deal with these issues.

In an interconnected world, climate change and biodiversity issues increase vulnerability to global risks. To prepare, prioritize sustainability, robustness, safety, and resilience (Chourasia et al., 2022). Develop Industry 6.0 with antifragility design, enhancing systems' resilience to stresses, shocks, volatility, noise, errors, defects, attacks, or failures (Penprase, 2018). Imagine self-driving car that communicate with adjacent vehicles to avoid accidents and reduce traffic deaths. Imagine also developing wearable protheses that adapt to a patient's injuries and guide individualized exercise in conjunction with a remote therapist. For this we need an engineering system that interact with humans and environment to create sustainable solution.

The diagram presents a futuristic industrial revolution model that focuses on customer-centric services and automation. Key technologies include AI, cyber-physical systems, and robotics, allowing for mass production and personalized services. Automatic robotic industries use quantum radar for real-time control, while wireless sensor networks enhance connectivity. Drones and self-driving cars are used for faster logistics, while smart clothing offers comfort and safety. Digital universities integrate AI and cybernetics for personalized education and medical treatments. Hyperloop vehicles will redefine travel and global connectivity, transforming the industrial revolution (Figure 14).

Roadmap to shift from industry 4.0 to 5.0 and beyond: Futuristic Idea

The sixth industrial revolution's goals can be attained by combining satellite navigation, industrial robotics, artificial intelligence, cloud-based human understanding, and 3-D printing from drones. The administration of Automatic Mechanical Industry motions in the sky will be made possible by quantum radar control (Duggal et al., 2022). By 2050, it's expected that technology will have reached the point of total autonomy. Renewable energy use, complete machine independence, interplanetary resource collection and manufacturing, aerial manufacturing platforms, anatomical upgrades, digitalization, virtual industry, Internet of Things (IoT) devices, AI-based robotic machines, and quantum control are a few of the key characteristics that will define Industry 6.0 (Das & Pan, 2022). Industry 6.0 denotes a thorough transition spanning numerous domains.

Artificial Intelligence also will be used to analysis massive data. AI will be implemented in robots and

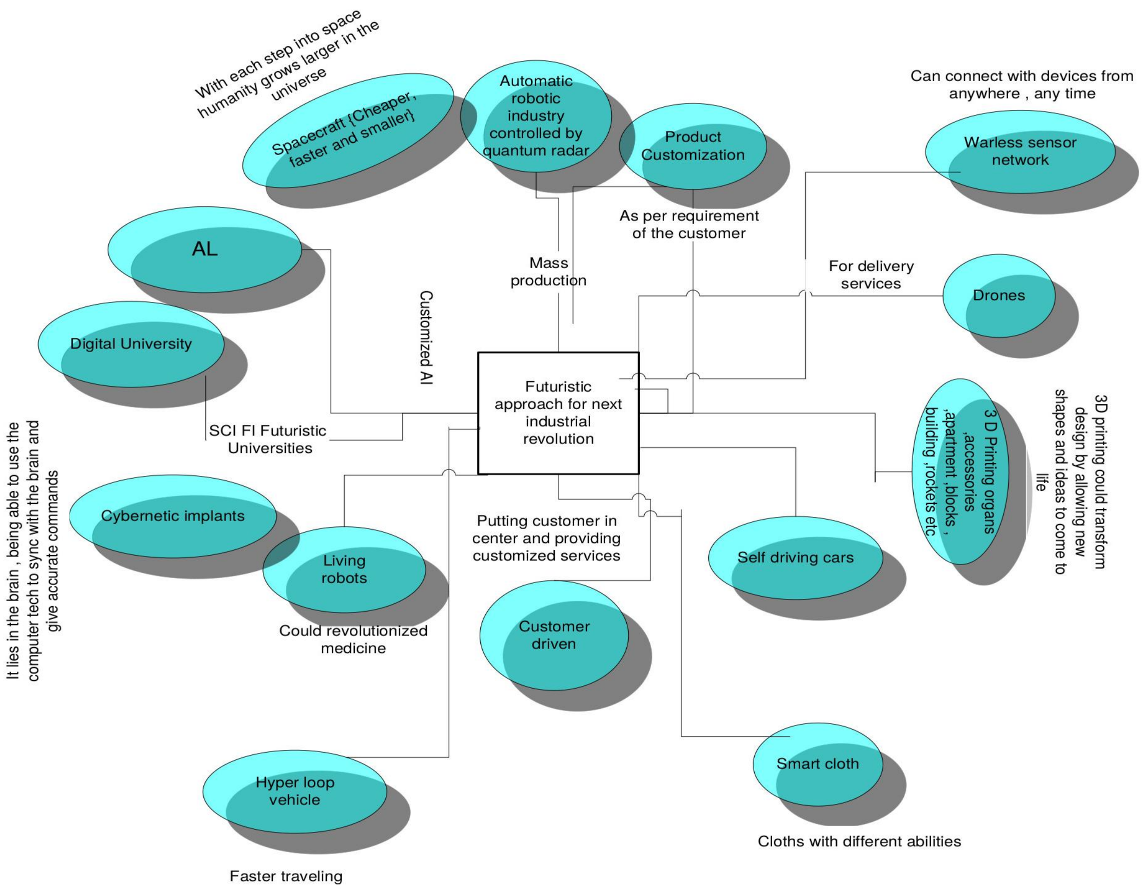

Fig. 14. Futuristic vision for new industrial revolution

various number of sensors will be stores in all over our environment to get the data related to each and everything. Like AI, virtual reality will be everywhere and it will be used in each and every domain for e.g., in marketing for advertisement, in HR for hiring people. Many authors expect that the Metaverse will be operational within the next 10-15 years. The metaverse will provide humans with all forms of facilities by 2050. Meetings with specific people in that realm are also possible. Virtual reality games and exercise will be more realistic. Today's VR exercise experience is satisfactory. Many ties will be improved in the future. After 5-10 years of visiting Metaverse, you will see that many people spend a significant amount of time in this virtual environment. Drones can be used in industrial logistics to reach areas that traditional techniques cannot reach owing to external conditions such as temperature, electrical risks, chemical hazards, and so on. Portable medical diagnostics is another exciting research topic that will play a significant role in the sixth revolution.

The concern of machines taking over human occupations is growing. Many people are offering remedies to the economic issues that automation may cause. There is no clear, absolute solution to the collapse of human jobs, but we should not wait for new jobs to develop. Universal basic income will keep adults out of poverty, but it does not guarantee that they will be able to find work.

There is no certainty that the skills expected for 2050 will not be automated or obsolete. Education reform would give youngsters with specific skills. In order to keep up with and adapt to technology, we need to update our self accordingly. For this educational change is required. We should equip today's youth with stress resilience, adaptability, and a readiness to learn and change. Because technology has advanced too quickly to forecast the future, we cannot equip ourselves or our children with precise technological abilities.

The image depicts the evolution of Industry 4.0 to Industry 6.0, a shift from technology-driven advancements to more socially and ecologically oriented approaches. Industry 4.0 focuses on automation, data exchange, and smart manufacturing through IoT, AI, big data, and machine learning. Industry 5.0 builds upon this foundation by integrating technology with human creativity and decision-making, emphasizing resilience, sustainability, and social responsibility. Industry 5.0 aims for a balanced interaction between humans, machines, and nature. Industry 6.0 represents the next wave, integrating advanced technologies with human and environmental needs. Key features include AI-supported decision-making, product customization, advanced connectivity, dynamic supply chains, customer-centric models, sustainability, and human-centric innovation. This approach aims to achieve industrial efficiency and productivity while aligning with societal and environmental goals, reflecting a comprehensive and sustainable approach to industrial development (Figure 15).

Recommendation and suggestions

Although the workforce may find the idea of flexible work schedules appealing, there may be unforeseen difficulties along the way, as seen in Figure 3. Technological advancements must collaborate with the administrative sector to ensure regulated and controlled

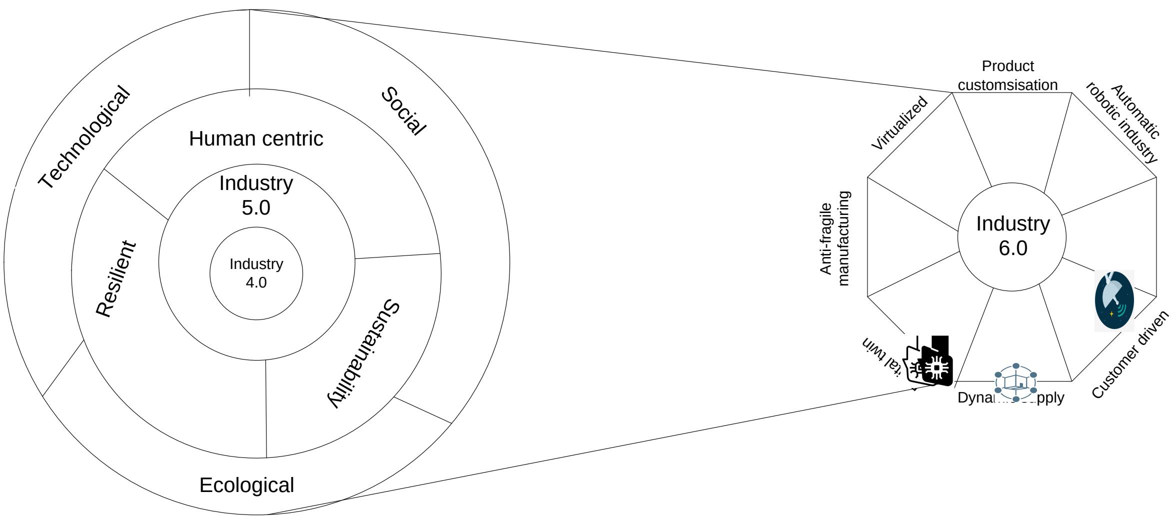

Fig. 15. Industry 6.0 futuristic vision

functionality within legal constraints. The sixth industrial revolution will be characterised by the coexistence of humans and machines in terms of production and general quality of life (Penprase, B.E., 2018). By using statistical data, AI, ML, and mechatronic systems, general medical practises are being highlighted in the field of robotics. The goal of robotics has been to integrate robots into everyday life, and current developments hope to achieve so by using non-toxic, eatable, ductile printing ink that complies with medical standards. Industry 6.0 will place a lot of emphasis on medical technology and robotic production, with alternative energy sources gradually replacing fossil fuels. For businesses, the blending of ideas acts as a basic growth accelerator. It is anticipated that AI-powered stores will be commonplace by 2050, enabling customers to make purchases without the intervention of cashiers or other human beings. AI will also be crucial for medical diagnostics, traffic management, and personal AI helpers for people (Chourasia et al., 2022).

Conclusion

Building complex and hyperconnected digital networks without jeopardising the long-term safety and sustainability of an innovation ecosystem and its constituents is the goal of Industry 5.0. Big Data in health holds similar promise, but the science of Big Data implementation is in limbo, as detailed in this article. The primary focus of the sixth industrial revolution will be on medical technologies. The next phase in household robotics would most likely involve cleaning and other task-specific robots. Alternative energy sources will eventually replace fossil fuels, until renewable energy sources power all time-consuming resources. The goal of Industrial 5.0 is to foster a more pleasant working relationship between increasingly intelligent machines and people. The emphasis changes from technology to human and societal growth as a result of new technologies. People, whether they recognise it or not, are participants in the process of altering industrial paradigms. Industrial 5.0 is not a technological breakthrough, but rather a broader view of the industry 4.0 strategy.

Industry 6.0 represents a futuristic and expansive industrial revolution, surpassing the scope of its predecessors. The primary focus of this future industry will be on sustainability, homogeneous assets, safety, resilience, antifragility, harmony with nature, and the promotion of an eco-economy. Antifragility, a critical characteristic of systems that thrive under stress, shocks, errors, and failures, will play a pivotal role in ensuring adaptability and robustness in the face of global challenges, such as climate change and biodiversity issues. By 2050, technology will have progressed to a state of complete autonomy, enabling advanced capabilities and autonomous operations. The management of the Automatic Mechanical Industry in the sky will be facilitated through quantum radar control, enhancing control and efficiency.

The sixth industrial revolution will centre on medical technology and robotic production, revolutionizing healthcare and manufacturing processes. The adoption of alternative energy sources will be vital for sustainable and eco-friendly industrial practices. The Metaverse, as envisioned by numerous authors, is expected to become operational within the next 10-15 years. It will offer realistic virtual reality experiences, impacting areas like exercise and gaming. Drones will find extensive use in industrial logistics, enabling access to locations that conventional methods cannot reach, thus enhancing efficiency and precision in various industries. Education reform will play a significant role in preparing students with the necessary skills and abilities to keep pace with evolving technologies, ensuring a skilled workforce for Industry 6.0.

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