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Concept Paper

The Fifth Industrial Revolution as a Transformative Step towards Society 5.0

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Abstract: This concept paper aims to shed light on the emergence of the first to the fifth industrial revolutions, their evolution, and their transformative steps towards Society 5.0. By explaining the nuances of the different phases of industrial revolutions and their positive and negative externalities, we found that the fifth industrial revolution can be considered a transformative step for the emergence or coevolution of Society 5.0. By examining how Society 5.0 affects various aspects of human society (e.g., advances in healthcare and improved life expectancy; business, the economy, growth, and industry; education and skills; privacy and cybersecurity; smart cities; labour and the workforce), we conclude that Society 5.0 should move forward by adhering to the harmonious integration of humans and technology to address the world's pressing problems in the future.

Keywords: industrial revolutions; harmonious coexistence; Society 5.0; Industry 5.0; social problems; cobots; sustainable development

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> *"Toward the close of the twenty-sixth century, the great tide of Science had at last begun to ebb. The long series of inventions that had shaped and molded the world for nearly a thousand years was coming to its end. Everything had been discovered. One by one, all great dreams of the past had become reality".*
>
> *Arthur C. Clarke, "The lion of Comarre & Against the fall of night"*

1. Introduction

Throughout history, humanity has witnessed considerable achievements and progress, marked by a steady progression towards scientific achievement and technological innovation [1,2]. Indeed, the continuous exploration, invention, and use of technology (i.e., fire, hunting tools, hand axes, etc.) began with the evolution and development of humankind. As humanity has progressed, technological progress has continued to be an essential force for human well-being, as we have witnessed from the pre-industrial revolution through the various phases of the industrial revolution, as we can call it, from the first to the fifth industrial revolution.

Presenting the trajectory and progress of technological innovation within a given timeframe is challenging. It is believed that the first industrial revolution was sparked by the steam engine in the late 18th century, transforming society from agrarian to urban. The second industrial revolution introduced electricity, automobiles, and telecommunications, further industrialising society. The third industrial revolution brought computers, electronics, and automation, ushering in the information age. The fourth industrial revolution has further impacted humanity with the development of the internet, artificial intelligence, AI-driven automation, and the advancement of biotechnology. The fourth industrial revolution, also known as Industry 4.0, has technology as the focus of progress, particularly

robots, artificial intelligence, and various other elements. The fifth industrial revolution, or IR 5.0, perceives individuals as partners at work in manufacturing and production organisations [3].

As we progress from the first to the fifth industrial revolution, technological advances have led to a shift from manual to machine-based production, resulting in new smart industries, AI- and robotics-based technologies, and other innovations that have enabled mass production and increased labour productivity, allowing more goods and services to be produced per unit of time, with significant implications for all aspects of human well-being. For example, improved technological advancements will help customers obtain what they need in the business and service industry. This will result in employees gaining meaningful, productive, fulfilling careers [3]. By reviving human efforts with collaborative robot (cobot) capabilities, the manufacturing process will advance and become more personalised in a wide range of areas [4].

Several previous studies have elucidated the characteristics of the fifth industrial revolution, which explains how humans and robots work synchronously and advance in different areas of human well-being. One of them is the energy revolution [5], a highly transformed workplace culture where robots replace routine tasks [3], and the introduction of collaborative robots [6]. In addition, the fifth industrial revolution will see robots given tasks and decision-making capabilities, primarily aiming to improve quality and production processes. This development represents an outstanding opportunity for synergistic collaboration between humans and, in due course, advanced human–machine systems, fostering a dynamic evolution characterised by unprecedented progress.

Although concerns have been raised about the possible impacts of technological advancement, as it has been observed to displace traditional jobs and create new forms of social, economic, and technological inequality [7], the fifth industrial revolution will facilitate human well-being. For example, cobots will be the main actors in the essence of Industry 5.0 when it comes to standard tasks such as data mining and drilling, while workers will perform more complex tasks [3]. Facilitating the integration of robots into unstructured environments populated by humans requires their ability to acquire new skills through various forms of learning, similar to the cognitive adaptability observed in humans [8]. Cyberphysical systems (CPSs) are collaborative organisations or entities with a comprehensive connection with the external environment and its current environment, along with the simultaneous access, processing, provisioning, and use of data accessible through the internet [9]. To achieve communication between different elements of a CPS, devices are required to function simultaneously, along with devices for control and computation [4].

This conceptual study seeks to elucidate the emergence and evolution of industrial revolutions, delineating their evolutionary trajectories and transformative phases leading to the conceptualisation of Society 5.0. Conceptual work is recognised for formulating and understanding phenomena by developing abstract concepts. Industry 5.0 and Society 5.0 represent novel conceptual frameworks that are ready to take humanity to the next stage of its developmental continuum.

2. Externalities of First to Fourth Industrial Revolutions (IRs) and Addressing Them in the Fifth Industrial Revolution

The industrial revolution has been a subject of criticism and challenge for human well-being as it is also associated with various detrimental aspects, including the overutilisation of natural resources, urban concentration and increasing urban slums, poverty and inequality, environmental degradation, the emergence of new diseases, and human security problems due to advancement of weapons, and so on. However, it is imperative to acknowledge that this epoch of industrialisation also produced several positive outcomes. First and foremost, the most notable positive consequence of the industrial revolution is its contribution to the contemporary improvement of human living standards. This

improvement is evident in our current access to a wide range of mass-produced goods. A key feature of the industrial revolution was the introduction of the factory system.

Each industrial revolution had its positive and negative externalities, and each had its unique features (Figure 1, Tables 1 and 2). According to Rifkin [10], in the past, steam power could provide better energy applications worldwide during the first IR and oil and electricity during the second IR. Moreover, during the first, second, and third IRs, humanity also witnessed negative externalities such as poor and long working conditions, environmental pollution, job displacement and migration, emerging slums and inequalities, data privacy concerns, and cyberinsecurity [11,12]. The externalities of the fourth industrial revolution are still unfolding; as Schwab noted in [13], the impact of the fourth IR has yet to go beyond the possibilities offered by the vast amount of data capacity and knowledge. Overall, humanity has experienced several positive and negative externalities of IRs, including urbanisation, labour and working conditions, environmental impacts such as climate change and sustainability, healthcare challenges in dealing with global pandemics (i.e., COVID-19), the use of innovation in education, and cultural and social changes that affect overall human well-being.

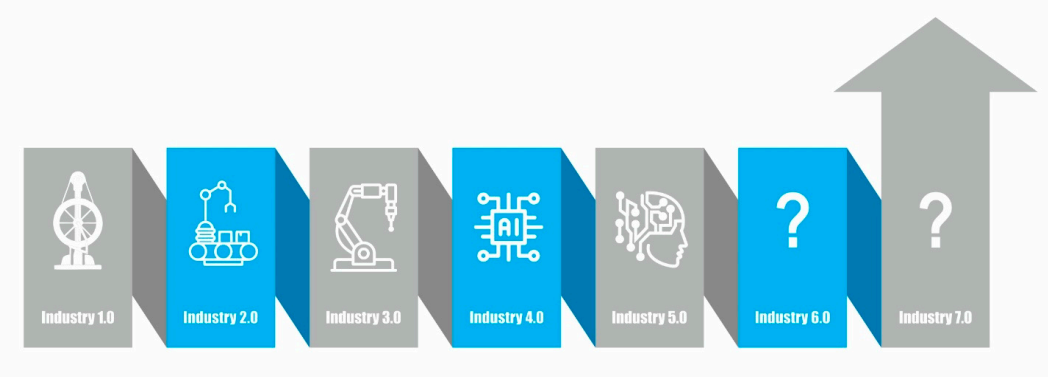

Figure 1. The timeline of industrial revolutions.

Table 1. Three significant positive and negative externalities of the four industrial revolutions by ChatGPT.

Industrial Revolution	Positive Externalities	Negative Externalities
First industrial revolution (late 18th to early 19th century)	Mechanisation of labour, increasing productivity.	Poor working conditions, child labour, and exploitation of workers.
	Growth of urban centres and improved infrastructure.	Environmental pollution and resource depletion.
	Advancements in transportation and communication.	Social inequality and economic disparities.
Second industrial revolution (late 19th to early 20th century)	Electrical power and the rise of new industries.	Harsh working conditions and labour conflicts.
	Mass production leads to more affordable goods.	Overcrowded cities and inadequate living conditions.
	Technological innovation and modernisation.	Economic depressions and financial crises.
Third industrial revolution (late 20th century)	Information technology, improving global connectivity.	Privacy concerns and data breaches.
	Automation, increasing efficiency and reducing errors.	Job displacement and inequality due to automation.
	Access to knowledge and e-commerce opportunities.	Cybersecurity threats and digital divide.
Fourth industrial revolution (21st century)	Integration of IoT, AI, and big data for smart solutions.	Job disruption due to AI and automation.
	Sustainable technologies for a greener future.	Ethical concerns around AI and autonomous systems.
	Personalised healthcare and improved quality of life.	Loss of privacy in the age of pervasive data collection.

Table 2. Positive and negative externalities of the 4th industrial revolution 1.

Positive				Negative			
Human Well-Being	**Environmental Sustainability**	**Technology**	**Peace, Justice, and Partnership**	**Human Well-Being**	**Environmental Sustainability**	**Technology**	**Peace, Justice, and Partnership**
Improved healthcare through telemedicine and remote monitoring	Reduced carbon emissions through smart energy grids and renewable energy sources	Increased innovation and creativity through open-source platforms and collaboration	Increased transparency and accountability in government through e-governance and open data initiatives	Increased job displacement and income inequality due to automation and AI	Increased e-waste and environmental degradation from electronic devices	Increased cyber threats and security risks from interconnected systems	Increased potential for cyber warfare and digital espionage
Increased access to education and training through online platforms	Improved resource efficiency through circular economy models and 3D printing	Improved efficiency and productivity through automation and AI	Improved access to justice through online dispute resolution and legal aid platforms	Increased social isolation and addiction to technology	Increased energy consumption and carbon emissions from data centres	Increased reliance on technology and automation leads to a loss of skills and knowledge	Increased potential for privacy violations and data breaches
Enhanced safety and security through smart cities and connected infrastructure	Reduced waste through smart packaging and supply chain optimisation	Increased access to information and knowledge through the internet and digital libraries	Increased civic engagement and participation through social media and online platforms	Increased mental health issues and stress from constant connectivity and information overload	Increased resource depletion and pollution from the mining of rare earth metals for technology	Increased potential for algorithmic bias and discrimination	Increased potential for digital divide and unequal access to technology
Increased productivity and efficiency in the workplace through automation and AI	Improved water management through IoT sensors and data analytics	Improved data management and analysis through big data and cloud computing	Improved cross-cultural understanding and communication through language translation technologies	Increased potential for job surveillance and loss of privacy in the workplace	Increased disruption of ecosystems and loss of biodiversity from the development of new technologies	Increased potential for addiction and negative impacts on physical health from virtual and augmented reality technologies	Increased potential for social polarisation and echo chambers in online communities
Improved quality of life for people with disabilities through assistive technologies	Increased biodiversity through precision agriculture and conservation technologies	Increased security and privacy through blockchain and encryption technologies	Increased collaboration and knowledge-sharing among researchers and scientists through open science initiatives	Increased potential for cyberbullying and online harassment	Increased potential for unintended consequences and negative impacts from AI and automation	Increased potential for addiction and negative impacts on mental health from social media	Increased potential for misinformation and propaganda to spread rapidly through digital media
Greater work–life balance through flexible work arrangements enabled by technology	Reduced air pollution through smart transportation and electric vehicles	Improved user experience and interface design through human-centred design principles	Improved human rights monitoring and reporting through digital documentation and verification tools	Increased potential for job insecurity and precarious work in the gig economy	Increased potential for energy consumption and carbon emissions from smart homes and connected devices	Increased potential for job displacement and loss of traditional skills in manufacturing and other industries	Increased potential for digital authoritarianism and censorship
Increased social connectivity and community building through social media and online platforms	Improved waste management through AI-powered recycling and waste sorting	Increased customisation and personalisation through data-driven marketing and product design	Increased awareness and action on social and environmental issues through digital activism and social media campaigns	Increased potential for social comparison and negative impacts on self-esteem from social media	Increased potential for environmental harm from autonomous vehicles and drones	Increased potential for addiction and negative impacts on mental health from video games	Increased potential for digital surveillance and loss of privacy in public spaces

Table 2. *Cont.*

Positive				Negative			
Human Well-Being	**Environmental Sustainability**	**Technology**	**Peace, Justice, and Partnership**	**Human Well-Being**	**Environmental Sustainability**	**Technology**	**Peace, Justice, and Partnership**
Improved mental health through digital therapeutics and mental health apps	Increased awareness and education about environmental issues through digital media	Improved decision-making through predictive analytics and machine learning	Improved disaster response and relief through international cooperation and coordination	Increased potential for online radicalisation and extremism	Increased potential for environmental harm from 3D printing and other additive manufacturing technologies	Increased potential for job displacement and loss of skills in the service sector	Increased potential for digital monopolies and concentration of power in the tech industry
Increased access to financial services through mobile banking and digital payments	Improved disaster preparedness and response through early warning systems and predictive analytics	Increased efficiency and safety in manufacturing through smart factories and robotics	Increased economic opportunities for marginalised communities through mobile banking and digital payments	Increased potential for online scams and fraud	Increased potential for environmental harm from nanotechnology and other emerging technologies	Increased potential for addiction and negative impacts on mental health from streaming services	Increased potential for digital colonialism and exploitation of developing countries
Improved disaster response and relief through AI and predictive analytics		Improved creativity and entertainment through virtual and augmented reality technologies	Improved international cooperation and diplomacy through virtual meetings	Increased potential for online harassment and hate speech towards marginalised groups			

[1] These data were extracted from online sources dedicated to the 4th industrial revolution by https://www.chatpdf.com/ on 1 November 2023, and items inconsistent with the last industrial revolution were manually removed.

With the advent of the fourth industrial revolution, global productivity growth has slowed considerably. As global productivity rates and research reach the bottom of a downward slope, the impact of the advances associated with Google Peak and other technological inventions has failed to contribute significantly to the economy [14]. Callaghan states that the global productivity slowdown has been substantiated and proven, in contrast to studies dealing with the fourth IR [15]. Similarly, Schwab [13] mentions that, based on the rationale of these discourses, innovative technologies have blurred the boundaries between the physical, digital, and biological domains.

Research and development are essential to the fifth industrial revolution, primarily as it seeks to address the externalities of industrial revolutions over time. Perhaps the fifth industrial revolution (5IR) ideal is the idea of humans and machines working harmoniously together, emphasising the well-being of multiple stakeholders—governments and policymakers, businesses and corporations, academic institutions and industries, civil society and humanitarian organisations, and technology providers and technology users. It thus paves the way for a (r)evolution in thinking about and harnessing human–machine collaboration for greater societal well-being [16], allowing the unfinished agendas of the first to fourth industrial revolutions to be addressed for human well-being. To achieve this goal, Rundle [17] and the European Economic and Social Committee in 2018, for example, describe the 5IR as being faster, more scalable and impacting more people through the nature of the technology at its disposal than previous ones, "*. . .focused on combining the creativity and craftsmanship of humans with the speed, productivity and consistency of robots*" [18].

3. The Significance of the Fifth Industrial Revolution

While the Fourth Industrial Revolution was characterised by hyper-connectivity through smart devices linking us to most parts of the planet, the upcoming Fifth Industrial Revolution will amplify and streamline this connection, replacing traditional smart devices with brain-computer interfaces and heralding a transformative evolution in our engagement with technology [19]. While the 4IR witnessed a competitive interplay between humans and machines, the 5IR aims to foster a collaborative and harmonious relationship between them [16]. Specifically, in 5 IR, humanity has expected further technological advancement to address complex global challenges, economic development with sustainable environmental impact, workforce transformation and more collaborative work with humans and machines, global connectivity with 5G networks and IoT, smart cities, and infrastructure advancement.

The 4th IR is surreal because it has embraced the possibilities of artificial intelligence, commonly known as AI. At its best, it is the most significant feature and contribution of the industrial revolution. The contributions of the legacy of artificial intelligence in entrepreneurship, industry, education, and everyday life remain, to some extent, shrouded in scepticism [20]. The applications of AI have their positive and negative aspects. The prevailing concern is that artificial intelligence, while still unfolding its full potential, may outstrip its job-creating capacity, leading to a net loss of employment opportunities. Its true potential and capabilities are still being explored with further discourse.

If AI is the fourth industrial revolution, the fifth industrial revolution has "cobots" as its primary technological offering. Collaborative robots, or "cobots" are designed to work alongside and, more importantly, assist their human counterparts [21] (see Figure 2). These technologically advanced machines are designed to be user-friendly and provide physical assistance in performing dangerous tasks. With the introduction of cobots, there should be no fear of losing the production line to automation, which has been a primary concern of Industry 4.0. All of this increases a company's agility [21].

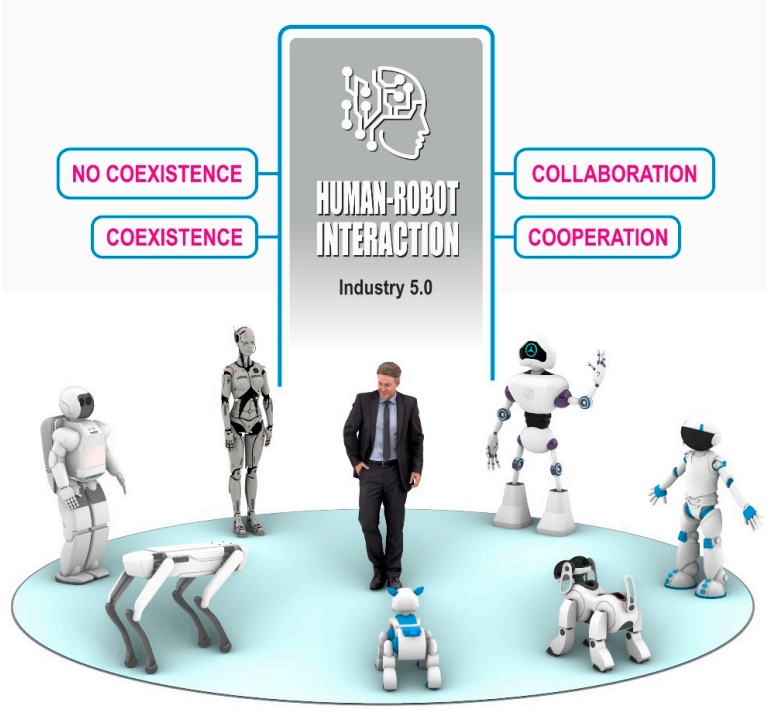

Figure 2. Levels of human–robot collaboration according to Aaltonen, Salmi, and Marstio [22].

BBC News reported a tragic incident in South Korea where a worker in his 40s was crushed to death by a robot [23]. While the worker was inspecting the robot, its robotic arm mistook the man for a box of vegetables, leading to the fatal incident. The robot, which was designed to lift and transfer boxes of peppers onto pallets, inadvertently caused severe injuries to the man's face and chest. This incident highlights the importance of safety measures in human–robot interactions and the need to take robots to the next level. Cobots, which may replace traditional robots, should be designed to allow humans to interact with them better and avoid any hazards.

The importance of the fifth industrial revolution needs to be further developed by optimising and streamlining everyday tasks, including in business, industry, academia, and healthcare. For example, introducing shop floor trackers in businesses could help improve productivity, operational efficiency, and quality control and reduce waste and mismanagement [21]. In the medical field, the partnership of human intelligence (HI) with AI has made it possible to diagnose a patient's disease, synthesise an appropriate treatment for it, monitor the body's response to the given treatment, and then constantly keep this dynamic cycle of automatically making changes to the treatment as per the body's requirements in a loop [21]. Notably, as noted in [21], with the use of Industry 5.0 technology, the pancreatic system will not only release insulin into the body but also regulate the body's responses in response to the amount of insulin. Furthermore, the significance of Industry 5.0 ideologies in academia could enhance the checking and updating of the latest research, discoveries, and innovations and provide precise and accurate knowledge and information.

4. Fifth Industrial Revolution: Complementarity and Coevolution of Society 5.0

4.1. Society 5.0: Definition and Concepts

There are several definitions of Society 5.0. As of 30 October 2023, a search for its definition using the query "Society 5.0 is" in Google Scholar yielded more than two thousand results, and Scopus lists about 160 articles published since 2017 (Figure 3). Interestingly, if we set a custom range in Google Scholar to 1900–2015, 173 results are returned that contain the keyword "Society 5.0" as of 12 January 2024.

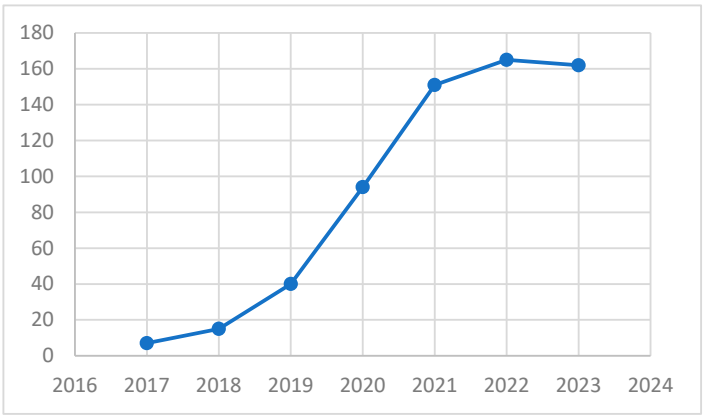

Figure 3. The number of Scopus-indexed articles containing the keyword "Society 5.0" in the article title, abstract, or keywords.

Up to now, the different conceptual frameworks of "Society 5.0" have been envisioned in domain-specific contexts as we synthesise the results of the search engines (i.e., Google Scholar, Scopus data, etc.). For example, in the technological context, it has been envisioned as integrating cutting-edge technologies such as artificial intelligence, the Internet of Things, and big data, focusing on people-centred solutions. In a government context, it is a paradigm shift towards a more inclusive, sustainable, and efficient governance. From a sociological aspect, it is a holistic approach that uses technological advancement for a human-centric future that combines economic growth with socioeconomic and sustainable well-being.

Japan Science and Technology Agencey-Mirai Program website [24] mentions that "Society 5.0, also known as the Super Smart Society, is a visionary concept for the future of our society (see Figure 4 for the chronology of the various societies). It emerged as a concrete manifestation and adoption of the Fourth Industrial Revolution and was introduced by the Japanese government through the Cabinet Office's Council for Science, Technology, and Innovation back in 2016". Many manuscripts refer to Society 5.0 as having been introduced by the Japanese government, but the concept had been mentioned earlier than 2016, mainly by Japanese researchers.

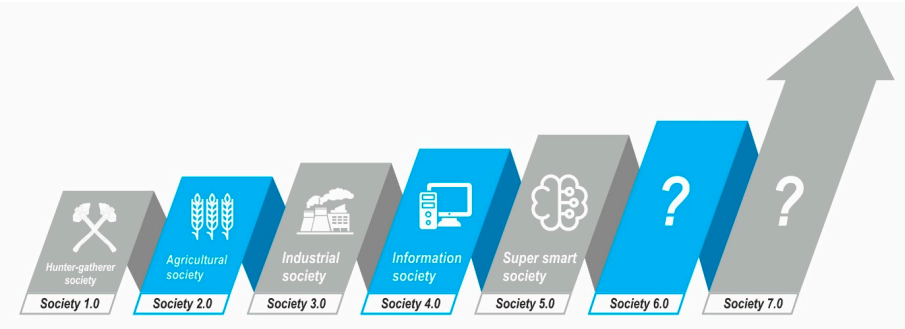

Figure 4. Society 5.0 together with previous and future societies.

On 22 January 2016, the Japanese government released the 5th Science and Technology Basic Plan [25]. In this plan, Society 5.0 is referred to as a new society that will be created through transformations led by scientific and technological innovation, following the hunter–gatherer society, the agricultural society, the industrial society, and the information society [26]. The notion of Society 5.0 and Industry 5.0 is more than a simple chronological progression or an alternative to the Industry 4.0 paradigm. Society 5.0 aims to put human beings at the heart of innovation, harnessing the impact of technology and the outcomes of Industry 4.0 through seamless technological integration to improve quality of life, promote social responsibility, and ensure sustainability [27].

4.2. How Society 5.0 Is Transforming Various Aspects of Human Society

As stated earlier, the boundaries of industrial revolutions, including conceptualisations of societal development and evolution, vary across countries. Nevertheless, we have witnessed the transformation of human society in various areas, including technological integration, innovation, education and workforce development, healthcare transformation, sustainable development, and many more. The following list is not exhaustive, but it briefly illustrates how Society 5.0 plays a critical role in the transformation of human society in various aspects, including health, the economy, sustainability, education, security, smart cities, and the workforce.

Healthcare advancement and improved life expectancy: Society 5.0 will make innovations in health-related technologies available and accessible to everyone. Easy access for people to medical services and personalised health data for the health sector will be considered as an adaptation measure in Society 5.0 [28]. Society 5.0 will provide technological support to improve healthcare and medical systems, leading to a better quality of life for all [29]. Through technological operations, data predictions will be available to help manage and prevent diseases, aiding both emergency and specialist health services [30].

The impact of age-related diseases has already been reduced, and the median age of adults in the global population has increased over time [31]. As we anticipate more advanced technological development and efficient health services (i.e., the use of AI, robotics, and IoT), life expectancy will be significantly improved. As we have already mentioned the positive externalities of different phases of industrial revolutions, we also anticipate a much more advanced social welfare system for older adults, including personalised healthcare, age-friendly communities, smart homes, connectivity, and telemedicine programmes, which can further contribute to an improved life expectancy. For example, Batin et al. report that the application of AI will be greatly improved and will enhance human life expectancy and anti-ageing through the detection of ageing biomarkers and personalised anti-ageing therapy [32]. Then, Batin et al. further report that integration with humans through brain–computer interfaces will help diagnose and treat health problems [32]. Finally, when AI reaches the level of superintelligence (i.e., the creation of nanotechnological bodies), it will be possible to reduce the probability of human death to near zero.

Business, the economy, growth, and industry: As we have outlined the positive externalities of different phases of the industrial revolution, businesses and industries will be driven forward. Increased efficiency, increased global value transformation for digital trade and e-commerce, effective use of fintech, and global connectivity are essential factors for the economy at the dawn of Society 5.0. The pursuit of these initiatives will support the creation of new businesses and contribute to value creation in both the economic and business spheres, with potential implications for reshaping the political economy, distribution of wealth and power dynamics. Future economies will meet and evolve, with societies, institutions and administrations playing a crucial role in regulating wealth and power, while serving as inspiration for others.

Human sustainability: We envision a more balanced and progressive society in which mutual respect is practised by citizens and passed on to future generations, enabling people to lead active and rewarding lives [33], linking science, technology, and innovation around "human sustainability". A keyword associated with Society 5.0 is sustainability. Society will prioritise a holistic approach that balances the environment, society, and economy in equal proportions to achieve the United Nations Development Programme's 2030 goals (UN SDGs, see Figure 5), such as poverty eradication, environmental concerns, and peace and prosperity [29,34,35]. Furthermore, Shchelkunov and Karimov [36] state that the establishment of Society 5.0 is related to transhuman evolution, which aims to dispose of the physical basis of being an individual by artificial means.

Education and skills: Society 5.0, emphasising advanced technologies such as AI, IoT, and big data, highlights the need for increased digital literacy and technology-related skills in educational curricula. This era promotes a culture of lifelong learning; as technology is rapidly evolving, knowledge quickly loses its value, and individuals need to acquire new

skills continuously throughout their lives. In addition, as Society 5.0 promotes the integration of different technologies and fields, education is becoming more interdisciplinary, requiring students to cultivate skills that transcend traditional subject boundaries. In this highly technological society, soft skills such as critical thinking, complex problem solving, and adaptability are of paramount importance, emphasising the need for education to foster these skills. In addition, the acceleration of online and distance learning, exemplified by the COVID-19 pandemic, is reshaping education delivery and requires the acquisition of new digital teaching and learning skills. Modern, advanced teaching methods and technologies enable personalised learning experiences and challenge universities and educational institutions to tailor education to the needs and aspirations of individual students. Universities, in particular, need to produce high-quality human resources to compete in the era of Society 5.0 [37].

Figure 5. UN Sustainable Development Goals.

Privacy and cybersecurity: While advanced technologies drive efficiency and convenience in various aspects of life, they also raise privacy and cybersecurity concerns, as protecting privacy and cybersecurity is also a goal of Society 5.0 [38]. Payton et al. discuss the vulnerabilities associated with massive data collection and analysis in Society 5.0, highlighting the need for robust data protection mechanisms and privacy regulation [39]. Undoubtedly, this era requires a delicate balance between technological innovation and protecting individual privacy, urging policymakers, businesses, and individuals to adopt strong cybersecurity measures to protect personal data in an increasingly connected and data-driven society.

Smart cities: Society 5.0 will have a transformative impact on the smart city landscape, ushering in an era of interconnected, technologically advanced urban environments that can prioritise the well-being of their residents. Under this paradigm, smart cities will see seamless technological integration across multiple sectors, from transportation and energy to healthcare and education, fostering greater efficiency, connectivity, and humanistic existence. The Internet of Things (IoT) will play a central role in collecting real-time data to inform city management. At the same time, artificial intelligence and predictive analytics will enable cities to proactively address issues such as traffic congestion, environmental concerns, and crowd management to prevent tragedies such as the Seoul Halloween crowd crush, which occurred in South Korea in 2022. Citizen engagement can be facilitated through e-government solutions, increasing transparency and encouraging residents to participate actively in urban planning. There is also the potential for future development from the internet to the BrainNet, which will allow individuals to collaborate and solve

problems using only brain-to-brain communication. The BrainNet has excellent potential in the near future, and in today's technology-driven times, it deserves serious consideration despite potential threats to people's privacy and the possibility of espionage [40]. Sustainability, resilience, healthcare, and security will be critical areas of focus as smart cities leverage technology to improve their residents' quality of life and happiness. In essence, Society 5.0 will profoundly change how smart cities are designed, operated, and experienced, ultimately improving urban life and addressing complex urban challenges.

Labour and the workforce: Society 5.0, underpinned by technological innovation and a focus on societal well-being, is set to reshape the work landscape and the workforce profoundly. As automation and artificial intelligence take centre stage, routine tasks will be significantly transformed, requiring the acquisition of new skills and a shift in job roles. Moreover, these technological advances are leading to the disappearance of jobs [41]. In one of his lectures, the famous futurist Michio Kaku said, "*The future job market will consist of those jobs that robots cannot perform. Our blue-collar work is pattern recognition, making sense of what you see. Gardeners will still have jobs because every garden is different. The same goes for construction workers. The losers are white-collar workers, low-level accountants, brokers, and agents.*" [42]. The era of remote working, accelerated by the COVID-19 pandemic, is set to continue, reducing the importance of physical proximity to the workplace. Digital skills and a commitment to lifelong learning will become essential, along with a greater focus on soft skills, which employers will highly value [43,44]. Society 5.0 also promotes human–machine collaboration, where individuals do not need to compete but adapt to work harmoniously with AI and robots. In addition, personalised learning, augmented reality, and ethical considerations are expected to play a pivotal role in the future workforce.

5. Conclusions

In the preceding section, we outlined some aspects of how Society 5.0 plays a critical role in transforming human society in various areas of human well-being. However, further questions remain as to what socioeconomic and spiritual criteria Society 5.0 should meet and what will happen if it remains more inclined towards the negative externalities of human well-being.

First, the complexity of creating clear boundaries and a transition timeframe across cultures and countries is noted, as not all cultures can simultaneously meet the content of such a society. In some cultures, the nature of relations between social institutions and the level of science and technology can lay the foundations and create the conditions for the transition; in others, it cannot. For example, there is no clear starting point for the transition from the Paleolithic to the Mesolithic: when some tribes were already building houses on stilts, others still lived in caves. This means that the transition took place in local habitat areas, not everywhere. On the other hand, while some countries develop a low-Earth orbit and send automated vehicles to other planets in the Solar System, others cannot solve the problems of poverty and disease. In this sense, it can be argued that the transition to Society 4.0 today is also local and not evenly distributed.

Concurrently, we emphasise that the main driving force of science and technology in various cultural and historical epochs were and are various socioeconomic conflicts caused by the struggle for resources. The consequence of these conflicts is developing and producing high-tech military products. Over time, these developments find their application in the civil sphere, where, spreading to different strata of society, they have other effects on individuals. Accessibility to products of scientific and technical "progress" is determined by the economic capabilities of individuals, place of residence, level of education, and culture. Simultaneously, concerning the level of development of science and technology, most of humanity is a passive consumer. An individual's understanding of the content of science as a form of social consciousness is at the level of satisfying everyday needs. And this is the best-case scenario. At worst, an individual can only be an outsider, utterly devoid of opportunities and the ability to interact with science and technology's achievements to influence their content and development.

It is assumed that in Society 5.0, science should bring humanity to a qualitatively different level of civilisation. Nevertheless, the question remains: to what end and with what content? Indeed, in Society 5.0, the robotisation of various fields of activity can free up time for sport, education, and creativity. The active use of quantum computers can help fight against diseases, solve unsolved scientific problems, and, in general, contribute to eradicating poverty and improving the well-being of every human being. In this context, everyone can be provided with the necessary living wage, for example, in the form of a guaranteed minimum income (GMI), which should increase in line with possible inflation. Human labour can be replaced by robot labour everywhere. The creation of artificial intelligence and its integration into a biological life form opens up limitless prospects, up to and including the acquisition of immortality by man. The participation of educated people of high intelligence and those with the skills to use "technology" properly for human welfare is essential to reap the fruits of "Society 5.0".

Of course, such a society is based on the technocratic principle of building a civilisation, and its content is determined by the scientific and technical intelligentsia that form the basis of the engineering elite. But what should be the content of the engineering elite itself? After all, such an elite will have enormous scientific and technical potential and resources that will enable it to discover and colonise new planets and project its scientific and technical power far beyond the Solar System. Will it be tempted to turn artificial intelligence into a weapon, reinforcing its truly unlimited power based on the power of science and the possibilities of technology? In this case, it is obvious that the first programme embedded in artificial intelligence will be a programme to search for the most effective way to suppress and subjugate the enemy. In any case, artificial intelligence will gain individuality. This is a natural consequence of the development of a self-organising system. Having created such a destructive monster, whose intellectual level will be several orders of magnitude higher than the intellectual level of man and whose actions will be determined only by the expediency requirements, humankind may lose control over it. Such an inorganic, artificially intelligent, self-organising form of matter may get rid of organic life and the Earth's atmosphere simply because oxygen oxidises other substances on contact.

This civilisation can achieve the highest technological development, drown in luxury and abundance, discover new worlds, and influence the course of their development. But having gotten rid of the vice of poverty, it can acquire the vice of violence and cross all imaginary boundaries of depravity and cynicism towards other open civilisations that have not reached a similar level of civilisation. Having attained the highest technical power, such a civilisation can abandon all humanistic ideas that prevent it from asserting the power of an absolute force. Progressive robotisation will make human labour superfluous. But will this not create a huge army of unemployed people?

All this points to a natural phenomenon in human history: the development of morality and ethics does not occur in parallel with the development of human intelligence and civilisation. The dystopia described above is a forecast of a possible scenario for the development of Society 5.0 and its outcome, considering human nature and historical patterns of social relations. Let us draw a historical analogy. Ancient Greece proclaimed the ideal of total human development, in which the mental, physical, and aesthetic development of a person were harmoniously combined. At the same time, having proclaimed such a progressive principle of human education, ancient Greek civilisation could not eliminate the vice of violence, which led to its natural and well-known end.

In summary, the world has experienced the first to fifth industrial revolutions, which have had different impacts on humanity over time. The transformation from the fourth to the fifth industrial revolution must be more human-centred and humanistic, focused on human empowerment and capable of collectively addressing potential global challenges, complementing a harmonious integration of society, science and technology, and industry for human well-being, as envisioned in Society 5.0. We also believe that Industry 5.0 is the "next phase of progress" in which people work with machines to optimise productivity, innovation, and efficiency and that the transformation from Industry 5.0 to Society 5.0 is

the further enhancement of "human well-being" through the appropriate use of technology, where technological progress is more human-centred and improves all aspects of human life. Indeed, a genuine transition to Society 5.0 is possible when a new type of personality is formed and conditions are created in which a person can truly identify with the content of Society 5.0 to reveal and enhance their potential to benefit themselves and all of humanity. Such a person as an individual should embody the unity of high project consciousness and spiritual culture as a condition for understanding and revealing the true universal symbolic and cultural meanings of Society 5.0.

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