

DEVELOPMENT OF THE INFORMATION ECONOMY CONCEPT AND THE TRANSITION TO INDUSTRY 5.0

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Abstract. In recent decades, technology has advanced unprecedentedly, particularly with the advent of the Internet. This paper aims to delve into the evolutionary trajectory of the Information Economy concept, tracking its progression and paradigm shifts catalyzed by technological advancements and the digital revolution, which have collectively reshaped economic structures. A historical overview elucidates how the Information Economy has transformed into a more intricate and nuanced understanding that encompasses digital platforms, big data analytics, and the pervasive influence of artificial intelligence. As the global economy stands on the cusp of a new industrial revolution – Industry 5.0 – we also attempt to explore the opportunities and challenges associated with this transition, characterized by integrating human intelligence with cutting-edge technologies. This evolution is mirrored in Society 5.0, a vision of a super-smart society where digital innovation and human-centric development coexist harmoniously.

Keywords: Society 5.0; digital economy; informatization; information society; digitalization

Introduction

The information economy, as part of the knowledge economy, is developing rapidly. It is related to the impact of digital and telecommunications and the achievement of economic efficiency from the use of information and communication technologies (ICT). In recent decades, we have witnessed accelerated technological progress leading to a societal transformation of socio-technical and economic relations. Society 4.0, or the so-called Information Society, is being formed, where the main resource and source of growth is information. Information is identified as a path of creating public, national wealth, which emphasizes its role in the information economy.

The concept of the information economy has evolved over the years, adapting to technological advances, the emerging capabilities of machines to

automate a range of cognitive-human tasks, and changing social and economic conditions. Technological innovations that have emerged globally, from the advent of the Internet and mobile technologies to the development of artificial intelligence, blockchain and cyber-physical systems, have led to significant changes in economic structure and practices (Harmash, Hubarieva, Harmash, Trushkina 2024; Cézanne & Saglietto 2020; Trushkina 2019). Hence, as a consequence, we are witnessing a shift in how business is conducted, including creating new business models and a redefinition of the relationships between market participants. With rapidly developing information and communication technologies, the world is entering a new era of industrial development characterized by integrating human and technological resources in innovative and synergistic forms. We are witnessing the emergence of Industry 5.0, based on the interaction between man and machine, and the so-called Society 5.0 (“Super intelligent society” (Huang, Wang, Li, Zheng, Mourtzis, Wang 2022). They represent the next steps after the information economy, aimed at creating more intelligent and sustainable systems that meet the needs of modern societies, focusing on man and his collaboration with machines to achieve higher efficiency and productivity, but at the same time, sustainability and environmental friendliness.

The purpose of the article is to trace the evolutionary trajectory of the information economy concept, outline its development through various stages, and summarize opportunities and challenges related to the transition from the information economy to Industry 5.0 and Society 5.0.

1. Methodology and analysis – historical background

In this section we review the *evolutionary development of the concept of the information economy*.

The economic system reflects the transformation of resources into products and the relationship between producers and consumers of economic goods. Hence, a distinction is made between technical-economic relations describing the production of goods from existing resources and socio-economic relations associated with appropriating production effects. The development of the information economy is determined by the degree of organization of information exchange in society, which goes through four phases of different durations: oral, written, book, and computer (Vasilev 2015), and provokes changes in society and the economy. We can assume that the various stages of society's development form the main conditions for the emergence of the concept of the information economy.

– The initial stage of development of the information economy

The roots of the information economy can be traced back to the Industrial Revolution in the 18th and 19th centuries. In this period, the first computers and

telegraph systems appeared, transforming how information was transmitted and processed. Tools such as the printing press and the telegraph were created that increased the speed of transmission and exchange of information. During the Industrial Revolution, the use of machines in production and early information technologies led to the emergence of mass production and division of labor (Stereov 2018). Decision-making about doing business is primarily based on experience (Zizic, Mladineo, Gjeldum, Celent 2022), while technology's role in the management process increases gradually. During this period, conditions for increasing the volume of information and its distribution (publicity) emerged, and the use of patents to protect intellectual property was also instituted.

– Development of the concept in the 20th century

The next stage of the development of the information economy is related to unfolding the potential of information technologies, the (industrial) information revolution, and the automation and digitization of production. The transition from the industrial to information economy was realized in the 60s and 70s of the 20th century when significant changes in the social and economic state of society's development began to be observed. The idea of the post-industrial society arose – a transition from traditional industrialism to a service economy based on the technological factor, science, innovation, and education. The production process was automated, and computers spread in large organizations. Knowledge and information become factors of primary importance for public production. During these decades, data has been considered a side of business activities that are to be stored and processed according to the needs of enterprises rather than as a means of adding new value. Gradually, as computing power and the volume of data increased and the cost of technology decreased, more organizations began to realize the potential of data as a strategic asset. This period is associated with the rise of the information economy. In the 80s and 90s of the 20th century, when personal computers and the World Wide Web began to spread widely, the information economy acquired its modern outlines. Computers enable the processing of large volumes of data with high speed and accuracy, while the Internet facilitates global communication and information exchange. Large volumes of digital data are accumulating, and questions about their economic use and potential to create value are being raised. During this period, digitization became the main driver of the information economy. As a result, the information revolution is affecting the economy on a global scale – leading to the restructuring of businesses, affecting employees' skills and employment, contributing to growth, and facilitating the opening of markets through the broader and faster flow of information and knowledge.

– Paradigm shifts in the 21st century catalyzed by technological advances and the digital revolution

The rise of the Information Economy occurred at the end of the 20th and the beginning of the 21st century with the mass entry of the World Wide Web

and Internet technologies into the production process, by which the so-called "big data" can be created, processed, and distributed. In 1996, M. Castells introduced the term "information economy" for the first time in his work "The Information Age: Economy, Society, and Culture". Many economists and sociologists began to study the concept of the information economy, as well as the importance of electronic commerce and business and the understanding of the global information society. Various definitions of the concept of the "information economy" are found in the scientific literature (Porat 1977; Castells 1996; Sukhodolov, Popkova, Litvinova 2018; Anie, Budak and Kajh, 2016; Fırat, Karaçor, Özkan 2017; Vassilev, Petkova 2018; Vasilev 2015, among others). It is presented as a knowledge economy (Machlup 2014; Kuleshov Untura & Markova 2017), a new economy (Dzwigol 2019), an electronic economy (Zysman, Weber 2001), digital economy (Xia, Lv, Wang and Ding 2023; Tapscott, 1996), Industry 4.0 (Zizic, Mladineo, Gjeldum, Celent 2022; Nair, Kumar and Sreenath 2021; Oztemel and Gursev 2020, among others). All concepts are built on the definition of the information society as a complete system based on social and economic interactions between individuals resulting from the information exchange process and accumulation of knowledge. The concept of the information economy "includes a type of economic system where the predominant part of the national product is provided by activities that are somehow related to the production, processing, storage, and distribution of information" (Trushkina 2019).

The accelerated technological transfer, the processes of informatization, digitization and innovation of business models have reshaped the traditional production and consumption practices. The focus has shifted from simply processing the data to using technology to extract valuable insights. The purposeful use of this information to perform certain activities or make a decision is associated with knowledge (Varamezov 2024). The ability to collect, store, and analyze this data has become a critical competitive advantage for businesses in all sectors. Simultaneously, advances in artificial intelligence, machine learning and big data analytics, cloud technologies, etc. have brought the physical and digital worlds closer together and enabled seamless interaction between machines and humans. Data is no longer just a by-product of business activities; it has become the new currency, a driving force for real-time decision-making and creating new forms of value.

The benefits of technological progress and digitization are associated with advanced data analytics, allowing companies to anticipate trends, optimize and automate operations to save costs, speed up production, and significantly reduce errors (Parida, Sjodin, Reim 2019; Grubic, Jennions 2018; Hasselblatt, Huikkola, Kohtamäki, Nickell 2018, among others). Entrepreneurs can personalize their customer experience; products can be designed, manufactured, and delivered

based on real-time data, meeting the specific needs of individual customers, and also because of already more flexible supply chains.

The following more important changes induced by Industry 4.0 (Cézanne, Saglietto 2020) and the free exchange of data can be summarized:

- Emergence of new services and business models – Chesbrough (2010) emphasized as early as 2010 the importance of firms shifting their business models along with making significant investments in technologies that will add value. The author points out that the economic results of the market implementation of the new technology differ significantly depending on the business model used. The new business models, based on the information technology are manifested in varieties of e-commerce, application stores, online advertising and others. (OECD 2014). The so-called platform economies, sharing economy, and subscription services can also be mentioned. Laurell and Sandström (2017) defined the sharing economy as “ICT-enabled platforms for exchanges of goods and services”, leading to more efficient use of available resources. To the extent that some of these business models represent evolved existing business models, it is important to consider their – e.g. the opportunities for significant business expansion, overcoming greater distances and access to markets. Models related to e-commerce stand out here (such as Business-to-business models, Business-to-consumer models, Consumer-to-consumer models, Growth of e-commerce); Payment services (Cash payment solutions, e-wallets); application stores; online advertising; Cloud computing; etc.

- Restructuring of the labor market – Automation and digitalization have reduced the need for manual labor in production and an increase in “the scope for automating not only the tasks of manual workers, but also the tasks of occupational categories” (Cézanne, Saglietto 2020), but they have also increased the demand for highly qualified specialists in the service sectors, including analytical and information activities.

- Restructuring global value chains and the way international trade is conducted (Strange, & Zucchella 2017). Geographical barriers were removed, and global markets for goods and services were created. Businesses now easily reach international markets and new customers anywhere using online platforms and digital marketing.

- Adaptation to the needs of sustainable development. Green technologies and practices supported by digital tools and platforms enable more efficient resource management, ecological footprint reduction, and environmental protection. Sachs et al. (2019) claim they have great transformational potential that will contribute to achieving the UN Sustainable Development Goals.

The paradigm of the information society in the first decade of the 21st century was shaped by technological progress, focusing on automating processes and performing cognitive-human tasks through machines. This led to new social

interactions fuelled by the constant flow of information. Emerging real-life global processes in the second decade of the 21st century, such as the Covid pandemic, disruptions in supply and value chains, climate change, and others, have led to the acceleration of information exchange and revealed the need to adapt the existing public thinking. Society 5.0 emphasizes the importance of the central role of humans.

With the development of technologies from Industry 4.0 and upgrading to Industry 5.0, the need to change the business models is manifested strongly at the current stage. Panayotova, Dimitrova and Veleva (2023) claim that the “Industry 5.0 can be seen as a new philosophy of business”. The characteristics laid down in the main pillars of Industry 5.0 should manifest in the structuring of business models, given that the concept of Industry 5.0 expands with the creation of social value, exceeding the dynamics of the labor market, oriented in the long term to the standard of living and human well-being.

2. Discussion and future perspectives

Industry 5.0 – emerging opportunities and challenges related to Industry 5.0 and Society 5.0 transition

The European Commission defines Industry 5.0 (European Commission, 2021) as an industry that has the power “to achieve societal goals beyond jobs and growth to become a resilient provider of prosperity, by making production respect the boundaries of our planet and placing the well-being of the industry worker at the centre of the production process”. Ivanov (2023) pointed that integrated technologies add “value at the levels of ecosystems, supply chains, and manufacturing and logistics facilities, data-driven and dynamically and structurally adaptable to changes in the demand and supply environment.” Hence, the paradigm of Industry 5.0 evolved from the existing paradigm of Industry 4.0 and information economy provides the basis for innovation driving Industry 5.0 in the transition. It should be emphasized that Industry 5.0 is not a bias from the principles of the information economy, but rather their continuation.

The following three pillars of Industry 5.0 are derived from the literature (Harmash, Hubarieva, Harmash, Trushkina 2024; Ruiz-De-La-Torre-Acha, Guevara-Ramirez, Río-Belver, Borregan-Alvarado 2023; European Commission 2021):

- The human and society-oriented industry that places human needs and interests at the centre of the production process. The industry needs continuous information exchange to determine what machines can do for man. The development of technology and increasing informatization are associated with changes in business models, investment strategies related to knowledge and innovation, implementation of appropriate government policies regarding

the protection of personal data, the regulation of AI, the development of new professions, education, and social and ethical implications.

- Sustainability – Industry 5.0 technologies can potentially contribute to building a more sustainable industry. The exchange of information, the improvement of analyses, and the knowledge obtained will help companies optimize the use of resources and improve the technical efficiency of production. This will integrate sustainability principles from product design through the entire value chain to the consumer. At the same time, this will allow the introduction of new economic models of production and consumption, such as the Circular Economy, and reduce environmental damage.

- Resilience – This pillar concerns designing and implementing flexible production processes with higher reliability and security regarding the sustainability of supply chains and several production components.

From this, it can be concluded that the main goals of Industry 5.0 are related to solving the problems in the new information society (Society 5.0). The main tools are the development and integration of information and communication technologies and the transfer of knowledge. Society 5.0 (Saradha 2023; European Commission, 2021) is a vision proposed by the Japanese government in 2016 that aims to create a human-centric society where digitization and innovative technological solutions for knowledge creation and data processing are used to improve the quality of life.

The main goals of Society 5.0 include solving social problems, improving the quality of life, and economic sustainability (European Commission, 2021). They lead to the emergence of new possibilities in terms of technological progress, sustainability, and improvement of the well-being of the individual, such as:

- Developing new human-centric technologies, such as intelligent robots, AI systems, quantum computing technologies, blockchain technologies, and others focused on human needs and well-being. Advanced technologies will work with people to improve their productivity and create new opportunities for creativity and innovation.

- Promoting sustainable development and using green technologies that optimize the use of resources and address planetary issues. These practices also create new economic opportunities and promote the introduction of the principles of the Circular Economy, the Sharing Economy, and the Gig Economy.

- Developing smart cities, which use technology to improve infrastructure and services, such as intelligent traffic management, energy efficiency, and improved public services. These innovations can significantly improve the quality of life in urban environments and impact a number of social problems, such as poverty, inequality, discrimination, crime, and access to healthcare.

– Offering personalized products and services for better customer satisfaction. Evolving technologies for data collection, processing, transmission, and analysis allow companies to seize these opportunities for economic gain.

Challenges and future perspectives for the New Information Economy (Industry 5.0) and the New Information Society (Society 5.0)

Of course, changing the existing paradigm always carries some challenges, especially for start-ups (Ivanov, Biolcheva 2024), related to implementing innovations at the present moment, but it also reveals new perspectives for growth in society. The main challenges and future perspectives the New Information Economy and the New Information Society must address are widely discussed in the literature (Saradha 2023; European Commission 2021; Communication: Shaping Europe's digital future, and Europe's Digital Decade: digital targets for 2030 – Documents).

The challenges are aimed at solving socio-economic, ethical, normative, and educational problems:

– Ethical standards and regulation of information technologies—The EU's main priorities are protecting personal data, cyber security, technological sovereignty, ethical issues related to artificial intelligence, and the determination of global technological standards. These issues will require careful consideration and effective solutions.

– Retraining and education – in today's digital and information environment, new digital skills and competencies are required, as well as those that promote critical thinking and creativity and the development of communication skills and conflict resolution (so-called soft skills). This requires the education system to be reformed in order to meet the new requirements for the workers of the future. At the same time, the need for permanent retraining and adaptation/training of the existing workforce also arises. This challenge is directly related to the changes occurring in the labour market due to the introduction of smart technologies.

– Investments in innovation will allow companies and countries to take advantage of new opportunities arising from the development of technology and new scientific achievements.

– Economic and social inequality—Technological progress can lead to an increase in economic and social inequality. The government must implement social and economic policies that support equal opportunities, access to education and resources, and the wide use of digital technologies in the economy and society.

More significant future perspectives are:

– Developing quantum computing technologies, which can revolutionize the information economy. These technologies are expected to be able to process

a massive amount of data with unprecedented speed and accuracy, which will open new horizons for scientific research and business applications.

- Implementation of the blockchain.
- Developing reliable human-centered artificial intelligence, enabling higher efficiency through new data-driven innovations.
- Expanding gigabit connectivity, 5G and 6G, enables faster data and knowledge exchange between more individuals.
- Creation of European data spaces and infrastructure.

Finally, evidence of application and proposals for applying Industry 5.0 technologies can be found in the literature. Adel (2022) describes the introduction of technology automated guided vehicle Cobot of Repsol, as an example of developing a smart social factory. According to the author, part of other possible applications are in smart hospitals – the possibility of providing remote monitoring systems or producing a personalized, innovative implant for patients; the manufacturing industry – the possibility that the client participates in the design of the product production; supply chain management – the technology will reduce the task management time; Industry 5.0 technologies – supporting data edge devices, e.g. autonomous or various robots; also collaborative robots; and as a future direction – cognitive computing, that models human thoughts.

Conclusion

The concept of the information economy has evolved rapidly in recent decades, from basic data processing tasks to the complex, interconnected systems that characterize Industry 5.0 and have the potential to stimulate the development of Society 5.0. This journey highlights the transformative power of technology and data in society and economic structure, demonstrating how the role of information has expanded and deepened in a global economy increasingly driven by information and innovation.

The evolution of the information economy in the 21st century has accelerated with the advent of Industry 4.0, characterized by the convergence of the physical and digital worlds through technologies such as AI and cyber-physical systems. A new paradigm shifts in the Information Economy followed where the data became a driver for real-time decision-making and new forms of value creation. Emerging real-life global processes in the second decade of the 21st century, such as the Covid pandemic, climate change, and others, have highlighted the need to accelerate the exchange of information and the accumulation of knowledge to address social and environmental issues centered on man and his well-being. Society 5.0 was born - a paradigm that complements the existing one, emphasizing the importance of data, scientific research, knowledge, and connectivity in transitioning to a flexible, sustainable, and human-oriented industry while preserving and protecting the environment.

The transition to Industry 5.0 should not be considered a bias from the principles of the information economy but rather as their continuation. In this new phase, the value of information is further enhanced by its application in intelligent systems that enhance human creativity, decision-making, and well-being. This change is amplified by the growing importance of ethical considerations in the information economy. Issues such as data privacy, security, and the impact of technology on the environment are becoming central to discussions. Companies are increasingly held responsible for how they use data and technology; there is a growing demand for sustainable and responsible practices. A successful transition to Industry 5.0 and Society 5.0 requires collaboration between governments, businesses, and society, as well as adaptation of educational and regulatory systems to ensure a balance between innovation and societal well-being.

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