

## ARTIFICIAL INTELLIGENCE APPLICATION IN DIFFERENT SCENARIOS OF THE NETWORKED SOCIETY 5.0 ENVIRONMENT

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**Abstract:** *A technologically based society geared towards every human being represents a Society 5.0 environment whose goal is to upgrade society to improve daily human life. It can be achieved through the significant application of information and communication networks, technologies, services, and user equipment. Industry 4.0 is the basis for developing the Society 5.0 environment in which the harmonious coexistence of people and machines comes to the fore. Artificial intelligence is one of the critical technologies for the further growth and development of the Society 5.0 environment, whose ability is to convert collected networked stakeholder's data into values. The authors in this paper systematically review the literature to investigate the application of artificial intelligence technology within the Society 5.0 environment. This paper aims to present the possibilities and scenarios of using artificial intelligence in different areas of the Society 5.0 environment, such as the digital transport system, healthcare, and manufacturing.*

**Key words:** *Digitalization, Robotics, Smart Factory, Industry 4.0*

### 1. Introduction

Artificial intelligence (AI) is a set of concepts, problems, and methods designed to address specific challenges. The field of computer science, which is intended to develop intelligent tools that respond and learn as humans, includes a concept such as Machine Learning (ML). The AI system involves understanding and analyzing speech, image, and language while learning to plan, solve, and respond to specific tasks. AI can transform almost every aspect of life and the economy. It is considered a key technology for the digital transformation of society. It is already present in everyday life as digital assistants on smartphones or personal computers to Internet search, shopping, and advertising on the Internet or machine translations. According to the Japanese Artificial Intelligence Technology Strategy, AI is a crucial technology for creating the Society 5.0 (S5.0) environment. The concept of this environment is based on a human-oriented society and a system that highly integrates physical space with cyberspace to meet users' potential needs and reduce certain shortcomings. Transforming and reducing disadvantages such as the generational, gender, or language gap among people requires addressing the challenges of

economic and social change. It can be achieved by using advanced information and communication technologies, AI, and robots. The Japanese government, which is also responsible for the idea of S5.0, has proposed the establishment of global rules on data sharing and the Social Principles of Human-Centric AI [1].

This paper is the result of a systematic review of the literature in which peer-reviewed scientific literature published in English was examined to connect the terms AI, S5.0, transport, healthcare, and manufacturing. The search of relevant scientific databases was strictly limited to papers not older than two years (due to the rapid development and advancement of technology) and papers published in journals, book chapters, and proceedings of scientific conferences that have open access. It is important to note that the authors studied the professional literature in reports published by one of the most important consulting companies in this field in the world: Gartner, Inc. and McKinsey & Company. Furthermore, our analysis includes several references outside of this search that highlight essential aspects of the extensive search that scientific search engines have not recognized and are considered necessary to support some critical arguments. The purpose of this paper is to conduct a brief systematic review to assist other scientists in selecting literature that addresses the terms AI, S5.0, transportation, healthcare, and manufacturing.

## **2. Society 5.0 and artificial intelligence market**

S5.0 cannot be mentioned without the Industry 4.0 environment and the fourth industrial revolution, given their close interconnectedness and intertwining. Industry 4.0 focuses on transforming all industrial components with the help of new innovative information and communication technologies and networks [2]. In the transformation mentioned above, Industry 4.0 has made digital innovations, products, and services accessible, while on the other hand, it has almost eliminated the role of man in the whole process. S5.0 includes a human-centered community capable of balancing rapid economic growth and resolving social obligations with a high degree of convergence between cyberspace and physical space [3]. Implementing digital transformation through every industry perspective is a provision of the Industry 4.0 environment. Likewise, with S5.0, everyday life is encouraged to move towards a digital transformation spreading to different levels of the community. The rapid and constant change of information and communication technology and networks and the S5.0 environment are presented as constant mutual support [4].

Concept S5.0, as an initiative of Japan, addresses several key pillars that include infrastructure, logistics, healthcare, finance, and more. One of the most significant features of this initiative is the integration of AI and other scientific evolutions to help solve and manage social issues. The activities and goals of the S5.0 environment are aligned with the Sustainable Development Goals (from the United Nations Development Program) shown in Figure 1. Sustainable Development Goals are designed to make joint progress between governments and citizens to avoid the consequences of social inequality. Many countries have focused their investment and research strategies on a similar model. In this model, the focus is on sustainable development, which is idealized from the very initial planning step concerning the progress of information and communication infrastructure and technology, and thus the improvement of industrialization and the environment is achieved [5]. According to the Japanese government, one of the actions that need to be implemented and performed within the S5.0 environment to achieve implementation according to the

goals of Sustainable Development Goals in 2030 are R&D technologies. In doing so, the emphasis is on AI, which must be precisely integrated because of the goals of the Japanese government aimed at the advanced merging of cyber and physical spaces.

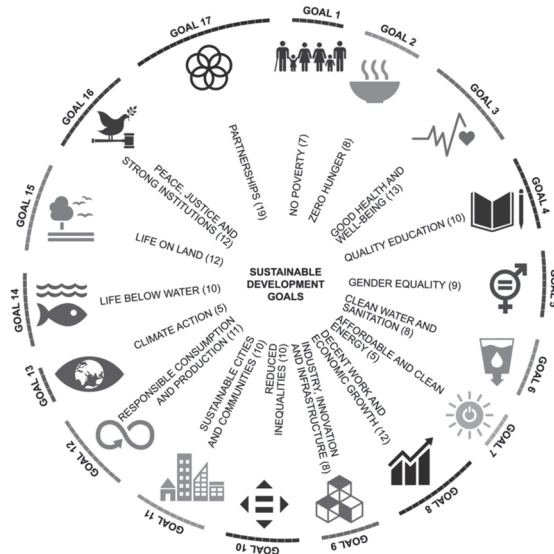


Figure 1. Sustainable Development Goals [6]

The AI market is growing, and its stagnation is not expected soon. By 2025, the global AI market is projected to be worth between 156 and 360 billion euros. Japan is currently the largest supplier of industrial robots globally, and in R&D, AI is after China and the United States [7]. According to a survey of 2,395 participants [8], 1,151 said their organizations had adopted AI in at least one function. Companies that have realized the significant value of AI continue to invest in it during the COVID-19 pandemic (Corona Virus Disease 2019). That value is increasingly coming in the form of revenue for the company. Most respondents increased their investment in AI in every vital business function in response to the pandemic. A study [9] conducted on 1032 respondents shows that the added value of AI use is shown through revenue growth to better decision making and improved user experience. The AI market has a high percentage of innovations appearing on an upward-leaning innovation driver. Four trends drive AI innovation: accountability, small and comprehensive data, operationalization of AI platforms, and resource efficiency [10].

### 3. Artificial intelligence application in Society 5.0 environment

AI is a rapidly evolving technology and is one of the most significant technological developments in history, and its use is changing the way the industry works [11]. Although some AI technologies have been present for more than half a century, advances in computing power, the availability of large amounts of data, and new algorithms have led to significant discoveries in the field of AI in recent years. It is difficult for companies to integrate AI into their business models [12], [13]. Given the changes in

different industry sectors due to the use of AI technology, there is also the implementation of new innovative business models whose development is shown in Figure 2.

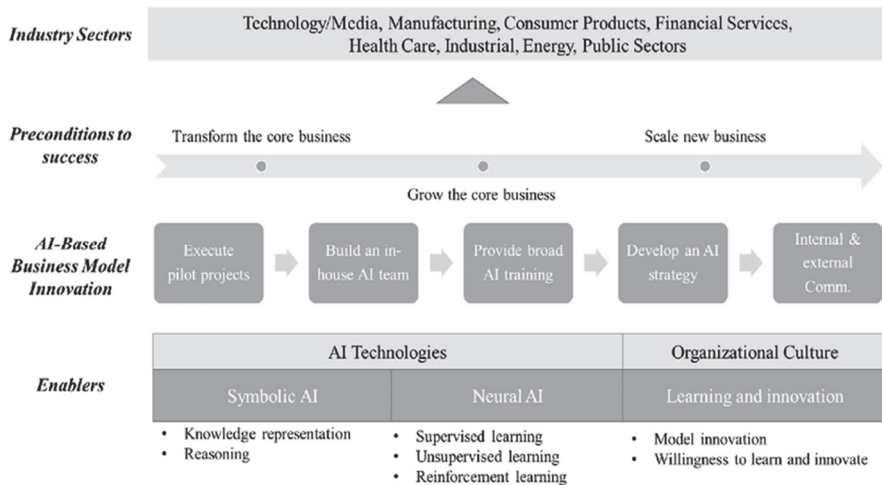


Figure 2. AI-based business model [14]

AI is considered a key technology for society's digital transformation, and its implementation has become a priority. It is predicted to bring considerable changes in the future, but it is already present in our daily lives. This paper aims to present some of the myriad possibilities and scenarios of using AI in digital transport systems, healthcare, and manufacturing. These areas were chosen because they form a S5.0 environment due to the direct focus of the systems used in these areas on a human to meet his daily needs while reducing the shortcomings encountered in each area.

### 3.1. Artificial intelligence in digital transport system

AI solutions lead to efficient traffic management. Secure integration of AI-based decision making, traffic management, or routing is just some of the solutions listed. The AI methods used in the traffic system are artificial neural networks, genetic algorithms, Simulated Annealing, Fuzzy Logic Model, and Ant Colony Optimizer. They provide intelligent solutions in areas where there is a more difficult understanding of the complex relationships among the characteristics of transport systems. Their goal in managing the road transport network is to alleviate road congestion, increase the reliability of passenger travel and improve the economy and productivity of the entire transport system [15]. There are currently many applications of AI technologies in road transport, and their number will only grow as AI develops and grows. Self-driving vehicles such as trucks, personal vehicles, or public transport are an example of automation with the help of AI. Many other applications include digitalization, the most important of which are AI applications in intelligent transport systems (ITS), travel planning and optimization, vehicle management system improvement, remote monitoring, infrastructure and vehicle maintenance and repair, and mobility as a service (MaaS) enabling or optimizing intermodal transport and travel [16], [17]. It is necessary to develop applications that can function as stand-alone

systems to realize AI's full potential. It is essential to introduce AI knowledge into traffic analysis, data collection and storage, decision making, and optimization modeling [18].

Given the increasing digitalization and financial investment in railway transport both in Europe and globally, this paper will present the possibility of applying AI in this part of the transport system. AI can help automate the rail system while maximizing capacity utilization, increasing rail reliability, flexibility, and accessibility. The paper [19] predicts that autonomous trains and automated transport will increase system capacity and flexibility without significant investments in the infrastructure itself. This will result in greater satisfaction of rail transport users, which will achieve greater flexibility in meeting demand in real-time. An AI-based study was also conducted that focuses on risk assessment of road vehicle and train collisions. This may lead to the development of a system to avoid collisions between vehicles and fibers at railway crossings with no human control [20]. AI can help improve safety and efficiency in data-driven intelligent transport systems and new Internet of Vehicle (IoV) services. The proposed AI-based traffic control system at level crossings uses area surveillance cameras and detects risky and dangerous situations using accelerated image processing techniques and deep neural networks [21]. AI is also a significant direction in developing future high-speed rail networks and is considered a promising technique for solving the complex problem of energy distribution in the railway system [22].

The capabilities and solutions of AI that currently exist in the digital transport system (road and rail), and which have been mentioned above, provide a wide range of services provided by this technology. The application of AI in the digital transport system applies to autonomous vehicles and the complete infrastructure and pollution reduction that vehicles produce. This leads to help in solving and managing social issues, which is one of the features of the S5.0 environment. In traffic in smart cities, AI manifests through intelligent traffic lights, sensors in parking lots, collecting information on road conditions, and the like.

### **3.2. Artificial intelligence in healthcare**

The application of AI in the field of health has an unlimited number of possibilities. Various devices diagnose various diseases in time and prevent or slow down the progression of autoimmune diseases. As a robot, AI is used during operations to make the procedure as successful as possible. In addition to devices directly related to treatment, innovative health is also manifested in measuring air quality, water, and everything that potentially affects a person's health. It is also used to manage medical records and patient histories. Administration of such a large amount of data is the most challenging undertaking because the data can be disorganized, and implementing AI and new fusion techniques would greatly facilitate this work.

Scientists are exploring using AI to analyze large amounts of health data and find patterns that could lead to discoveries in medicine and improve individual diagnostics. Although advances in health care delivery have accelerated the use of ML to develop the classification and prediction models that make up most current AI methods, these models are still not fully applied in the real world. The paper [23] discusses how to improve health care with the help of AI. The focus is on AI delivery science, which requires a broader set of design thinking, process improvement, and new care systems. The widespread application of AI technologies can shape human behavior to practice behaviors and disease

control strategies to improve global human health. AI offers enormous potential to health professionals and policymakers to expand access to health information and services and increase individual responsibility for the health and well-being of patients [24]. Mobile health (mHealth) is a fast-growing area of the digital healthcare industry. Mobile phones currently represent the largest mHealth delivery platform. A developed system that collects data from patients via mobile phones and remote monitoring devices uses AI and a platform to analyze extensive data displayed on a mobile care monitor [25].

Human application of information and communication technologies through S5.0 can improve coping with the speed, impact, and extent of outbreaks of infectious diseases. As the most powerful technology of S5.0, AI has shown great potential for controlling the COVID-19 pandemic. Some examples are thermal cameras that can successfully scan public places and identify potentially infected individuals, an application that scans potential virus-infected patients that might require further assessment, and AI cameras with computer vision to calculate social distance between people in public places and the like [26]. The new Medicine 4.0 scenarios put AI at the center, and all services are more user-oriented, as is the case with AI-based medical image analysis introduced in several COVID-19 centers [27].

### **3.3. Artificial intelligence in manufacturing**

AI is an integral part of business digitalization and entering the era of Industry 4.0. As part of Industry 4.0, intelligent factories aim to optimize production processes, and all systems within a smart factory are interconnected and participate in the exchange of data on every aspect of production in real-time. AI in such a complex system allows computers and digital machines to perform tasks previously performed by intelligent people in much more time [28]. Manufacturing industries hope to turn real-time data into effective decisions while integrating AI methods with traditional operational research approaches, IoT concepts and technologies, and cyber-physical systems. There is a great potential for AI in semiconductor manufacturing. Empirical study and real-world implementation have shown the validity of selecting models for predicting demand for semiconductor components and modules [28].

In [29], production systems consist of machines, robots, transporters, and ancillary activities (maintenance and material handling). Great emphasis is placed on the interaction of humans and robots due to the growing quantity and variety of robotic applications in manufacturing. Although the advent of robots has allowed humans to focus on cognition, adaptability, ambiguity, and flexibility activities, the advent of increasingly powerful AI/ML tools has led to a disturbance of this balance. In a smart factory consisting of many interconnected communicating devices, numerous security attacks on the system are possible. The authors in [30] introduce an approach to protect IoT devices from spam by using certain AI features and grouping in real-time. An approach to filtering and classifying incoming spam and phishing for IoT-based systems in Industry 4.0 is proposed. In this example, the AI mechanism collects and analyzes emails to detect features that identify classification patterns.

Intelligent manufacturing has become the foundation of high technology to increase overall competitiveness. The actual use of AI in smart factories is to solve problems that are difficult or not formulated in codes and can only be solved intuitively. As a subset of AI in production processes, ML methods are the topic of this paper [31].

ML is used in smart factories in parts related to production process planning, quality control, predictive maintenance, robotics, help and learning systems, process control and optimization, and training in learning factories. The extensive analysis of innovative technologies represented in Industry 4.0 conducted in [32] lists AI as a significant technology in modern manufacturing. The new generation of AI technologies will enable Cyber-Physical Systems (CPS) to learn autonomously, create new knowledge and make autonomous decisions in production. The authors recommend conducting research linking CPS and AI. Some of the challenges and problems that smart factories may face are low production efficiency, lack of product innovation, low accuracy in production. The solution to this is possible with the AI management system to improve product quality and production efficiency. Such a system consists of a data management system and an expert system [33]. AI can help European manufacturers become more efficient and bring factories back to Europe by using robots in production, optimizing sales channels, or predicting maintenance and breakdowns in smart factories on time. Intelligent manufacturing has become the foundation of high technology to increase overall competitiveness. To achieve industrial intelligence in the process industry, it is necessary to deeply integrate AI and industrial Internet and develop AI algorithms and AI systems that complement and improve the knowledge skills of workers [34].

#### **4. Conclusion**

AI and other technological advances will make it possible to improve the interaction between robots and humans. Although new technological innovations appear every day, AI is most promising, given that it has the predisposition to allow robots to handle uncontrolled and unexpected situations. This capability will be extended by 5G communication networks that increase mobile bandwidth and robot working radius. In addition to the above, it is essential to mention edge services, which are cloud-based networks and whose role, in this case, is to expand the computing power of robots and sensors. The rapid progress of AI has made it possible to help and improve healthcare in several high-income countries. However, there is much potential for use in countries without significant resources in health areas. In traffic, AI application is quite limited to specific ITS applications such as data analysis and forecasting future mobility.

More research and funding are needed to see AI's full potential in digital transport systems, healthcare, and manufacturing in the S5.0 environment. As AI research continues to evolve, it is possible to expect that the degree of confidence in this technology will take on an increasingly important role and attract more intensive research activities. This review paper will be used as a basis for further research into the AI and S5.0 environments. In further work, the focus will be on the technical characteristics of networking AI technology with other systems, networks, and technologies represented in the S5.0 environment. Also, the search for a systematic review of the literature will be expanded, and more extensive research will be done.

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**Rezime:** Tehnološki utemeljeno društvo prilagođeno svakom čoveku predstavlja okruženje Society 5.0 čiji je cilj nadogradnja postojećeg društva u svrhu poboljšanja svakodnevnog života čoveka. To se može postići značajnom primenom informacionih i komunikacionih mreža, tehnologija, usluga i korisničke opreme. Industrija 4.0 temelj je za razvoj okruženja Society 5.0 u kojem dolazi do izražaja usklađena koegzistencija ljudi i uređaja. Veštačka inteligencija je jedna od ključnih tehnologija za dalji rast i razvoj Society 5.0, čija je sposobnost da pretvori prikupljene podatke umreženih entiteta u vrednost. U ovom radu autori kroz sistematizovan pregled literature istražuju primenu tehnologije veštačke inteligencije unutar okruženja Society 5.0. Cilj rada je da prikaže mogućnosti i scenarije korišćenja veštačke inteligencije u različitim područjima okruženja Society 5.0, poput digitalnog transportnog sistema, zdravstva i proizvodnje.

**Ključne reči:** Digitalizacija, Robotika, Pametna fabrika, Industrija 4.0

## PRIMENA VEŠTAČKE INTELIGENCIJE U RAZLIČITIM SCENARIJIMA UMREŽENOG OKRUŽENJA SOCIETY 5.0

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