

THE IMPACT OF INDUSTRY 4.0 AND ARTIFICIAL INTELLIGENCE TECHNOLOGIES ON BUSINESS STRUCTURES

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ABSTRACT

Industry 4.0, described as the culmination of industrial revolutions, has brought about significant changes in both professional and social life through advancements in information technology. Changes in production methods, intelligent systems, and the integration of generative artificial intelligence with these systems have transformed business structures. In this new business structure, where speed and flexibility have become crucial, decision-makers have begun to utilize artificial intelligence much more extensively. Organizational structures and the activities carried out within them have begun to be designed with technologies that support competitive advantage. Many business functions, such as production management, human resource management, financial management, supply chain management, and marketing, have begun to operate through Industry 4.0 technologies and artificial intelligence. These new business structures, which operate based on reducing error rates and predicting potential problems in advance, enable more efficient and customer-focused work. This study examines the new business structures that have emerged within the context of Industry 4.0 technologies and artificial intelligence applications. In conclusion, it has been observed that hierarchical, fast, and agile structures have gained importance. Traditionally reactive and experience-based processes have transformed into proactive, predictable, and data-driven structures with the advent of artificial intelligence. Thanks to this transformation, error rates have decreased in key areas such as production planning, maintenance, quality control, and supply chain, while productivity and cost advantages have increased significantly. Furthermore, its positive impacts on energy management and resource utilization support sustainability performance.

Keywords: Industry 4.0, Artificial Intelligence, Business Structure

INTRODUCTION

Industry 4.0 technologies aim to bring together the information technology and industrial sectors. The main goal is to produce high-quality products with low cost, low energy consumption, small footprint, low heat generation, high-speed operation, and high efficiency. Real-time monitoring and reporting can be achieved through the use of artificial intelligence. Transparent production is possible thanks to smart factories equipped with unmanned and self-communicating machines (Yıldız Tonga and Tonga, 2022). The widespread adoption of online products and digital platforms has made all steps in production processes data-driven. These processes generate large amounts of raw data, providing new opportunities for continuous improvement and optimization (Xu, David,

and Kim, 2018). This wealth of data provided by the internet helps make production processes more flexible, faster, and cost-effective. Innovations such as artificial intelligence technologies and smart factories, in particular, play a significant role in the industrial revolution by reducing production costs and enabling personalized production (Barutcu, 2019).

Industry 4.0 involves the technical integration of cyber-physical systems in production and logistics. In practice, purchasing, production, maintenance, distribution, and customer service are interconnected via the internet with the support of artificial intelligence. Smart machines, storage systems, and production resources can independently share information, initiate actions, and control each other. This makes it possible to create strong value chains in industrial production processes (Kagermann, 2015). Industry 4.0 technologies and the use of generative artificial intelligence in this process have led to radical changes in business models. With the rapid change in technology, business models have changed, and new business processes in working life are now driven by smart systems, software, and artificial intelligence algorithms (Özışık and Erdil Şahin, 2022). In particular, data-based services and digital platforms make it possible to provide faster and more effective solutions to customer needs (Rüßmann et al., 2015). This is of strategic importance for companies that want to gain a competitive advantage. This study examines the changes that Industry 4.0 and generative artificial intelligence are bringing about in business processes.

INDUSTRY 4.0 TECHNOLOGIES AND ARTIFICIAL INTELLIGENCE

Many technologies are driving the fourth industrial revolution. Technologies such as big data, the internet of things, cloud computing, cyber-physical systems, smart robots, 3D printers, smart factories, modeling, augmented reality, and horizontal and vertical integration are seen as technologies that will change the field of the future (Davutoğlu, Akgül, and Yıldız, 2017).

1. Smart Factories: A smart factory is defined as a machine and equipment-based business environment where all processes are automated, and self-improvement is possible. In other words, a smart factory is a highly intelligent organism capable of exchanging data to ensure the integration of the physical and virtual worlds (Şekkeli and Bakan, 2018). In smart factories, which are at the heart of Industry 4.0, artificial intelligence is used very intensively in the production process where automation and digitalization are taken to a very high level (Yılmaz and Öncel, 2023). In smart factories, one of the most important applications of the Industry 4.0 revolution, there are safe, new work environments where all tasks are monitored via the internet network within machine-to-machine interaction, and artificial intelligence-supported robots that perform planned tasks on time, accurately, and completely (Demiral, 2019).

2. Cyber-Physical Systems: Cyber-physical systems transfer the data generated by the mechanisms that make up the physical world to the production process with the help of various sensors and artificial intelligence. Cyber-physical systems connect the physical world with the virtual computing world through sensors and generative artificial intelligence. Through artificial intelligence, objects in the physical system interact with each other, enabling the simulation of real-world objects in a virtual environment (İşler, 2018: 3).

3. Cloud Computing: Cloud computing is a service-based technology that operates cyclically and systematically over the internet and intranet (Çelik, 2021). Cloud technologies are the main driving force behind digital transformation because they enable the rapid processing of large volumes of data.

4. Big Data and Analytics: Big data is a concept used to describe very large amounts of both structured and unstructured data that are difficult to process using traditional database and software

techniques (bulutistan.com, 2026). With the use of the Internet of Things, one of the most important elements of Industry 4.0, continuous connectivity between machines, human-machine interactions, or human interactions is emerging. The data provided by this connection can be processed by artificial intelligence and used to make accurate decisions that give businesses a competitive advantage in the market (Pala, 2019).

5. Intelligent Robots: Robots with advanced artificial intelligence applications can evaluate environmental conditions according to the current situation, make decisions, develop effective action plans, and recreate these plans according to changing conditions (Franceschetti, 2018). Robots can also report problems related to the production process through networked systems.

6. Simulation: Simulation is a tool used in many stages, from the overall operation of the system to the improvement of the production process, from making performance predictions to determining the impact of changes on the system (Ergüt, 2019). The purpose of simulation is to observe probabilities in the virtual world in advance and to plan the necessary preparations. A successful simulation is possible by modeling all the data of the physical system in a digital environment (Çelen, 2017). AI-supported simulations enable the detection of errors before production begins. In this way, it is also possible to see how products will react under different conditions.

7. 3D Printers: 3D printers are devices that convert digital design files found on a computer into physical objects (Yıldız Tonga and Tonga, 2022). 3D printers can be used in a wide variety of sectors such as health, automotive, technology, entertainment, defense, and education (Demir et al., 2016). For production using three-dimensional printers, designing with generative artificial intelligence ensures highly accurate designs. Artificial intelligence technologies, which eliminate potential errors and allow for previewing the final product, increase the efficiency of 3D printers (Cem, 2020).

8. Internet of Things: The Internet of Things consists of three basic layers: “application, sensing, and networking.” The Internet of Things, encompassing technologies used for various purposes, finds application particularly in systems such as wireless sensor networks, ZigBee, RFID, Bluetooth, and IPv6 (Şimşek, 2020). Sensor networks are generally used in applications such as smart home systems and industrial automation. Data obtained through interaction with sensors or tags placed on objects can be transformed into meaningful data and reports using artificial intelligence-supported systems.

9. Cybersecurity: Cybersecurity refers to preventive methods used to prevent information theft, breach, or attack (Dalenogare, Benitez, Ayala, and Frank, 2018). The most important aspect of cybersecurity is the violation of data privacy. In the context of artificial intelligence, the most criticized issue is the concern about the misuse of personal data. Cyber threats can emerge in ways that make them difficult for people to detect (Tunca, 2019). Cybersecurity protects the data of organizations and individuals by using various methods to prevent threats to information. Comprehensive measures are taken in areas such as critical infrastructure, network, and cloud security, and importance is also given to raising awareness and educating users. In this way, an effective defense line against cyber threats is created with the support of artificial intelligence.

10. Augmented Reality: Augmented reality is a type of virtual reality that preserves reality but enriches it by adding extra virtual elements. From this perspective, augmented reality stands out as a type of virtual reality that preserves and expands reality (Bingöl, 2018). In augmented reality, the existing reality is preserved. Augmented reality, which enables a clearer perception of

environments, can be used in many fields, from education to the healthcare sector (Altınpulluk and Kesim, 2015).

THE IMPACT OF INDUSTRY 4.0 AND ARTIFICIAL INTELLIGENCE ON BUSINESS STRUCTURE

Industry 4.0 technologies and generative artificial intelligence can significantly affect the structure of a business. Within the framework of Industry 4.0, an organic organizational structure is developed, high-value-added innovations emerge, and employees can better realize their potential. In order for business functions to be adapted to Industry 4.0 technologies, it is necessary to develop various management practices that will enable the development of organizational capabilities, as well as a learning and innovation environment. Focusing on innovation, developing new skills, and utilizing artificial intelligence in these processes is an important issue for strategic success (Asar and Esen, 2021). The interaction of skilled labor with machines leads to an increased need for highly skilled labor. As a result of the increased use of generative artificial intelligence in production systems, thanks to Industry 4.0 technologies, the amount and skills of human resources needed for the programming and management of these technologies are also changing (Gürün, 2019). Although Industry 4.0 operates without human intervention, it requires a skilled workforce with comprehensive planning skills, advanced programming knowledge, the ability to manage algorithms, and the capacity for maintenance and repair in the background (Aksoy, 2022: 78).

Digitalization and artificial intelligence support economic growth by increasing production efficiency. In addition, smart cities and digital infrastructures improve the quality of social life and contribute to sustainability goals (Xu, David and Kim, 2018). Digital technologies make supply chains more transparent and traceable, thus increasing efficiency in logistics processes (Okumuşoğlu, 2022). Furthermore, flexible supply chains that can adapt more quickly to global market dynamics help companies maintain their competitive advantage (Çiçek and Bay, 2007: 105). The effects of Industry 4.0 and artificial intelligence are felt across a wide range of areas, from production to the workforce, from economic structures to social dynamics. This transformation process not only increases production efficiency but also creates new business models and economic opportunities; however, it also brings various challenges. Therefore, understanding and managing the impacts of Industry 4.0 is of strategic importance for both businesses and governments.

Industry 4.0 and the use of artificial intelligence are bringing about radical changes in economic parameters from different perspectives and at different levels. Smart manufacturing systems used in the production process are gaining importance in this process. The increasing desire of companies to produce smart products using smart systems will lead to an increase in consumer demand for these products. AI-supported smart manufacturing systems play an effective role in reducing costs by efficiently regulating the amount of raw materials used by machines (Gilchrist, 2016). One of the most significant effects of Industry 4.0 is that it makes production processes more efficient and flexible. With Big Data Analytics, the Internet of Things (IoT), automation, and robotics technologies, the production process is optimized while product quality is also improved. Thanks to these technologies, production processes can be monitored and optimized in real time. Especially in sectors such as automotive and electronics, the integration of these technologies reduces production costs and increases quality.

The technology and changes brought about by the fourth industrial revolution are increasing the importance of integration in economic processes and limiting the success of delayed

integration (Dikkaya, Aytekin, and Gençer, 2018). These effects will impact the national economy at the macro level, as well as all individuals and organizations operating in every sector at the micro level. Artificial intelligence is expected to impact productivity and economic development in the near future. The aim of using artificial intelligence in the production process is to increase production flexibility and richness through the introduction of smart factories, enabling the production of unique and personalized products that accelerate economic development (Çakır, 2018).

The economic changes and impacts that will arise from this new AI-supported production style and processes can be listed as follows: AI technologies will increase the speed and flexibility of the production process, which will reduce production costs and increase efficiency. Quality control in production will be facilitated by the interaction of AI-supported machines. With artificial intelligence, industrial organizations will use natural resources more efficiently, reducing their carbon footprint and the damage they cause to nature. The competitiveness of companies and countries that adapt to this process will increase. Different business sectors will be created with artificial intelligence. By using artificial intelligence, potential problems that may arise later can be prevented before a project or investment is implemented, and efficiency will be increased (Bağcı, 2018).

Table 1. Examples of Artificial Intelligence Use in Production Processes

Company	AI Application Area	Description	Implementation Method	Contribution
Siemens	Predictive Maintenance	Predicting machine failures in advance	Sensor data analysis, machine learning	Reduced unplanned downtime, lower maintenance costs
BMW	Quality Control	Detection of product defects	Image processing, deep learning	Reduced defect rate, increased quality
Toyota	Production Planning	Optimization of production processes	Demand forecasting, data analytics	Reduced inventory costs, increased efficiency
Universal Robots	Robotic Automation	Human-robot collaboration	Collaborative robots (cobots)	Workforce efficiency, workplace safety
Google	Energy Management	Optimization of energy consumption	Big data and AI analysis	Energy savings, reduced carbon emissions
Amazon	Supply Chain Management	Improvement of supply processes	Demand forecasting, route optimization	Shorter delivery times, cost advantage
General Electric	Product Design	New product development processes	Simulation, generative design	Reduced R&D time, increased innovation

(Source: Created by the authors.)

Examining company examples reveals that artificial intelligence (AI) applications serve similar purposes in different sectors, but vary according to their application areas. Industrially focused companies like Siemens and General Electric use AI primarily in production efficiency, maintenance, and design processes, while automotive companies like BMW and Toyota focus on quality control and production optimization. On the other hand, technology and service-oriented companies like Amazon and Google effectively utilize AI in supply chain management, data analytics, and energy management. This demonstrates that AI is not a single, uniform application, but a flexible tool that adapts to the needs of the sector. The common thread across all examples is that AI contributes to increased efficiency, reduced costs, improved quality, and sustainability goals. In this context, AI is considered not only an operational tool for businesses but also a strategic element that creates a competitive advantage.

Table 2. The Impact of Artificial Intelligence on Business Processes

Business Process	Traditional State	Post-AI State	Impact
Production Planning	Manual planning, limited data use	Dynamic planning with data analytics and demand forecasting	More accurate production, inventory, and cost optimization
Maintenance Management	Reactive maintenance	Predictive maintenance	Reduced downtime, lower costs
Quality Control	Human-based inspection	Automated inspection with image processing	Reduced error rate, increased quality
Supply Chain	Rigid structure	Flexible management with real-time data	Shorter delivery time, cost advantage
Human Resources	Experience-based decisions	Data-driven analysis and evaluation	Better recruitment, higher efficiency
Energy Management	Uncontrolled consumption	AI-based optimization	Energy savings, improved sustainability
Production Process	Standard, inflexible	Smart autonomous systems	Increased flexibility and speed
Decision Making	Intuitive decisions	AI-supported data-driven decisions	Faster and more accurate decisions
Customer Demand Management	Historical data-based	Real-time analytics	Demand-aligned production, customer satisfaction
Risk Management	Post-problem response	Anomaly detection, early warning	Proactive risk identification

(Source: Created by the authors.)

When examining the impact of artificial intelligence (AI) on business processes, a fundamental transformation is observed in businesses. Traditionally reactive and experience-based processes have evolved into a proactive, predictable, and data-driven structure with AI. Thanks to this transformation, error rates have decreased in key areas such as production planning, maintenance, quality control, and supply chain, while productivity and cost advantages have significantly increased. At the same time, AI provides businesses with flexibility and agility, enabling them to quickly adapt to changing market conditions. Furthermore, its positive effects on energy management and resource utilization support sustainability performance. However, this transformation is not only a technological change but also represents a strategic transformation process requiring adaptation in organizational structure, employee competencies, and management approach.

Table 3. The Impact of Artificial Intelligence on Organizational Structures

Dimension	Impact	Description
Decision-Making Processes	Acceleration and data orientation	AI enables faster and more accurate decisions through big data analysis.
Organizational Structure	Reduced hierarchy	More horizontal, flexible, and network-based structures emerge.
Human Resources	Workforce transformation	Routine tasks are automated while demand for digital and analytical skills increases.
Productivity	Increase	Automation significantly improves operational efficiency.
Communication	Digitalization	Interdepartmental communication becomes faster and more effective with AI systems.
Innovation	Acceleration	Product and service development processes are completed faster.
Cost Structure	Decrease	Labor and operational costs decrease through automation.

(Source: Created by the authors.)

The table above generally presents the impact of artificial intelligence on organizational structures within a multi-dimensional and transformation-oriented framework. The acceleration and data-driven approach observed in decision-making processes indicate a shift from intuitive to analytical management within organizations. This makes managerial decisions more objective and predictable. The emphasis on reducing hierarchy and shifting towards more horizontal structures shows that artificial intelligence is not only a technological but also a structural transformation tool. This transformation encourages more flexible, responsive, and network-based work models within institutions. In terms of human resources, the most critical change is the reduction of routine tasks through automation and the evolution of the employee profile towards digital skills. This necessitates a reshaping of the workforce and the need for continuous learning. The increase and acceleration seen in productivity, communication, and innovation demonstrate that artificial intelligence optimizes operational processes and strengthens internal organizational coordination. The acceleration of innovation processes, in particular, is a significant outcome in terms of competitive advantage.

Conclusion and Recommendations

Industry 4.0 and artificial intelligence technologies are considered not only a technological innovation in the business structure, but also a comprehensive transformation process that reshapes all processes from production to management. This transformation has enabled businesses to shift from a traditional, hierarchical, and experience-based decision-making structure to a more flexible and dynamic structure based on data analytics, automation, and AI-supported predictive systems. In particular, the use of intelligent systems in production processes has increased productivity, reduced error rates, and made resource utilization more efficient. Furthermore, the deployment of AI applications in critical areas such as maintenance, quality control, supply chain management, and production planning has increased the operational excellence level of businesses. Moreover, the impact of Industry 4.0 on the business structure has not been limited to the operational level but has also profoundly affected the organizational structure. Changes have occurred in employee roles; routine and repetitive tasks have been transferred to automation systems, while employees have shifted towards more analytical, creative, and decision-support roles. This situation has increased the need for a qualified workforce in businesses and has also led to digital competencies gaining strategic importance. However, the widespread adoption of artificial intelligence technologies, while increasing the competitiveness of businesses, has also brought new challenges such as data security, ethical use, and adaptation costs. Overall, Industry 4.0 and artificial intelligence have become a fundamental, transformative element providing sustainable competitive advantage for businesses. For the successful integration of Industry 4.0 and artificial intelligence technologies into the business structure, businesses must first establish a strong digital infrastructure and develop a strategic transformation plan for these technologies. In this process, not only technology investments but also the development of human resources play a critical role. Continuous training programs, reskilling, and advanced skill development applications aimed at increasing employees' digital skills should be implemented. In addition, the effectiveness of artificial intelligence applications in businesses is directly related to the ownership of this process by top management and their view of digital transformation as a strategic priority. The organizational culture needs to be adapted to a change-oriented, innovative, and learning organizational structure. Furthermore, establishing standards on data security, cyber risks, and ethical artificial intelligence use is an important requirement for sustainable digital transformation. At the macro level, shaping public policies to facilitate access to Industry 4.0 technologies will accelerate the inclusion of SMEs in this transformation process. Increased R&D incentives, digital transformation support programs, and university-industry collaborations will significantly contribute to the widespread adoption of AI-based business structures. In this context, it can be said that Industry 4.0 is an inclusive transformation tool not only for large-scale businesses but for the entire economic structure.

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