Industry 4.0: the Role of Automation in Productivity

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Abstract

This paper examines the processes of automation and robotics as key directions of modern industrial and technological development. Automation and robotics play an important role in improving labor productivity, improving product quality, reducing production costs and minimizing the impact of the human factor. The article analyzes the basic concepts, principles and stages of implementation of automated systems and robotic complexes, as well as their impact on the efficiency of production processes. The advantages and limitations of automation, as well as the socio-economic consequences of its implementation, including changes in the employment structure and requirements for personnel qualifications, are considered. It was concluded that the development of automation and robotics is a prerequisite for increasing the competitiveness of enterprises in the digital economy.

Keywords: Automation; Robotics; Industrial production; Digital technologies; Information systems; Robotic complexes; Labor productivity; Production efficiency; Artificial intelligence; Industry 4.0

1. Introduction

The modern development of industry is characterized by the transition to the Industry 4.0 concept, based on the deep digitalization of production processes. In the context of increased global competition and growing requirements for product quality, enterprises are forced to introduce innovative technological solutions aimed at increasing the efficiency and sustainability of production.(Smirnova, 2023) The 1950s of the XX century in the field of technization of society are marked by the world famous the scientific and technological revolution, which gave the so-called impetus to the beginning of the stormy development of industry and, as a result, the global economy as a whole. So, was given start of mass automation of production (Klokotov, 2019). The key elements of Industry 4.0 are information technology, automation, and robotics, which enable production system intelligence and control optimization. Automation of production processes is becoming a strategic tool for the development of industrial enterprises, since it allows you to reduce costs, increase labor productivity and minimize the influence of the human factor. This paper examines the essence and features of industrial automation, as well as its role in increasing the efficiency and competitiveness of enterprises in the digital economy. (Shishmarev, 2013).

2. Theoretical Background

Industry 4.0 is characterized by a broad integration of information technology, automation and robotics into industrial production. The use of digital systems contributes to improving the quality of products, their standardization, as well as reducing the physical and cognitive burden on workers. The use of information technologies ensures the unification of product parameters and simplifies labor processes, increasing their accuracy and repeatability. Tools of IT systems open up opportunities that cannot be implemented in traditional industrial models. Computer technology allows you to perform routine operations with higher accuracy compared to manual labor, since their functioning is based on algorithms and software control. Industrial automation and robotics are applications of computing, control systems and digital technologies to control

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technological processes and equipment, which makes it possible to replace manual labor and increase the speed, quality and stability of production. Automation of production processes involves the introduction of a set of technical and software tools that ensure the transfer of functions previously performed by humans to automated systems. As a rule, automation is carried out comprehensively and is accompanied by a deep modernization of the production infrastructure, including equipment updates, the introduction of industrial robots, the integration of software and digital control platforms. The main goal of automation is to increase the profitability of an industrial enterprise. This goal is achieved by increasing labor productivity and reducing production costs. It should be noted that the introduction of automated systems is a long process, and its economic effect is not immediate. On average, investments in automation pay off within 1-3 years. At the same time, the development and implementation of automation projects requires taking into account the profile of the enterprise, the scale of production and the specifics of technological processes, which determines the individual nature of the tasks to be solved.

Table 1: Main tasks of production automation

Tasks of production automation
↓
Regulation of production processes
Reduce employee costs
Protect workers from injuries and hazardous substances
Reduce scrap, improve product quality
Increasing production volumes, expanding the range of
Increasing the company's reputation through environmental cleanliness of production Faster production
Increased productivity

The development of software solutions, regardless of the specifics of the enterprise, is based on universal principles and general functionality that ensures the integrity and consistency of the organization. In modern conditions, any technical changes and the introduction of new digital tools are impossible without a single database, which serves as the basis for the integration of all business processes and the interaction of departments. Such a database provides centralized storage, processing and exchange of information, eliminating duplication of data and reducing the likelihood of errors. Computer integration, implemented based on a common information platform, allows you to automate the processes of planning, accounting, monitoring and analyzing the activities of the enterprise. Thanks to this, management gets prompt access to up-to-date and reliable information, which significantly improves the quality of management decisions. In addition, integrated software solutions increase process transparency, optimize resource utilization, and improve cross-departmental coordination, ultimately increasing the efficiency and competitiveness of the enterprise as a whole (Leontiev, 2023).

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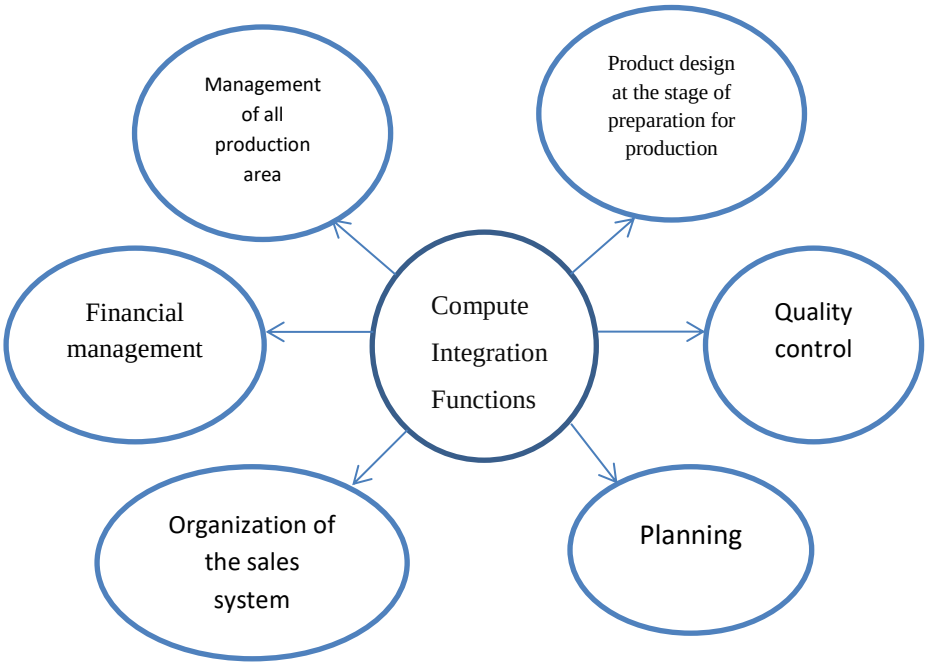

Figure 1. Functional aspects of computerization process

The development of projects of automated systems of wide functionality is individual for each organization. According to common features, they can be divided into several groups.

Types of automation:

1. Flexible - very convenient for a wide range of products, models and serial production. With this approach, it is easy to reorient equipment to the production of other types of products. The flexible system instantly affects the production process.

2. For enterprises producing one or more types of products in large volumes. With the stationary approach, the entire line for the production of homogeneous goods is programmed. It is not easy to transfer a strict sequence of technological operations from one product to another. A striking example of this is the production lines of mechanical engineering.

3. Programmable - suitable for the release of no more than several thousand batches. The equipment can be reprogrammed to make other types of products. It takes longer, but the devices are cheaper than the established approach. Full automation systems are available only for the largest manufacturers with a large capital turnover. Modern technologies make it possible to gradually switch to automated production processes. By making piecemeal changes, medium and small businesses increase productivity at a medium cost. (Titov, Serebrovsky, Shirabakina, Ubaidullaeva, 2019)

Table 2: Application levels of mechanization and automation in production (Galina, 2018)

Stage	Properties
Zero automation	Uses mechanical or manual devices that do not have software control. Operations are fully performed by employees. Software is not applicable. Zero approach is possible under the following conditions: Lack of financial resources needed to acquire technology solutions Plant features make it impractical to implement automation of the production process
Partial automation	Partial automation Transfer of permanent work to machines - conveyors, sensors, alarms. Automation of certain types of devices, Most processes are carried out by employees.

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Complex automation	Main processes using automation. However, the presence of people is the same, but in other aspects: control, troubleshooting, logistics, emergencies. All process cycles are automated. The equipment is a single system. Control is carried out by the operator.
Full automation	Gradually achieved, initially the company goes through all the previous stages. As part of the stage, a complete transition to technological solutions will be carried out. Robotic machines monitor and control technological operations with minimal human intervention.

Process automation aims to eliminate repetitive manual operations by implementing digital solutions and control systems. Robotization, in turn, involves the use of autonomous physical machines. The technological effect, as a rule, is expressed in increasing production because of automation, which is often associated with a decrease in raw material costs at the same time as improving the quality of products. The introduction of robotics is especially effective at high temperatures, high speeds or in production segments that are dangerous to humans. For example, in the ceramic and porcelain industries, the use of robotic arms in processes such as moving tiles, loading and unloading into high-temperature furnaces ensures safety and uninterrupted production. International experience shows that at enterprises where robotization is introduced, production costs have decreased by 12-18%, and the level of defects has decreased by 20-30% (Klokotov, 2019).

3. Results and Discussion

Despite the obvious advantages, automation has a number of limitations. The main problems include high initial investment, staff resistance to change, insufficient readiness of corporate culture and lack of management support. The success of automation projects directly depends on strategic planning, phased implementation and training. Automation increases the transparency of production processes, accelerates management decision-making and contributes to the sustainable development of enterprises in the digital economy. Benefits of using industrial robots: increased productivity; product quality improvement; lower labor costs; reduced risk of industrial accidents.

Table 3: Advantages and disadvantages of automation

Automation advances	Automation disadvantages
1. Improving efficiency. (Automation allows tasks to be completed faster and with fewer resources.)	1. High initial costs. The introduction of automated systems will require significant investments in software, equipment and personnel training.
2. Reduction of operating expenses. (the use of automated systems can significantly reduce the cost of managing labor, material resources and processes.)	2. Personnel resistance. Any innovation, including automation, can cause a negative reaction from employees who may be afraid of losing their jobs or changing their usual processes.
3. Improving the quality of products and services. (automated processes ensure high accuracy and consistent quality, which reduces errors and improves the final product or service).	3. Unavailability of corporate culture. Implementation of automation will require changes in business processes, and if the corporate culture is not ready for such changes
4. Transparency and control. Automation will allow real-time monitoring of all stages of the production process.	4. Lack of management support. If the project is not completed at the management level, there is a risk that it will not be implemented.
5. Speed up decision making. Automation systems can provide management with real-time analytics and reports to help them respond and adapt to changes faster.	5. The threat of excessive democracy. In automation projects, it is important to make decisions quickly and individually. If the process involves a huge number of stakeholders with equal authority, then due to disagreements, the project may be at an impasse.

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4. Conclusion

Automation provides significant opportunities for enterprises to improve overall efficiency by increasing labor productivity, improving the quality of products and reducing operating and management costs. In the context of Industry 4.0, automated and digital technologies are becoming not only a tool for optimizing production processes, but also an important factor in strategic development and increasing the competitiveness of enterprises in the domestic and international markets. At the same time, practice shows that the effectiveness of automation initiatives is determined not only by the level of technological equipment, but also by a combination of organizational and managerial factors. A key role is played by the readiness of the corporate culture for change, the presence of a clearly formed digital strategy, as well as active and consistent support for automation projects from senior management. An equally important aspect is the ability of the enterprise to effectively manage changes, including overcoming staff resistance, developing digital competencies of employees and creating a motivational environment focused on innovation. Insufficient planning, a fragmented approach to implementing automation, and a lack of engagement with key stakeholders can significantly reduce the expected economic and technological impact. In such conditions, the risk of non-compliance of the implemented solutions with the real needs of production, increasing the timing of project implementation and exceeding the planned costs increases. In this regard, a systematic and phased approach to automation, based on a thorough analysis of business processes, economic feasibility and long-term goals of the enterprise, is of particular importance. Comprehensive planning, investment in training and retraining of personnel, as well as the use of modern change management strategies minimize the risks of implementing automated systems and ensure sustainable economic benefits. Thus, automation in the context of Industry 4.0 should not be considered as a one-time technical event, but as an ongoing process of organizational and technological transformation aimed at achieving long-term competitive advantages.

References

Galina, L. V., Kornipaev, M. A., Ovechkin, M. V., & Proskurin, D. A. (2018). *Automation fundamentals: Introduction to specialty* (Tutorial). Orenburg: Orenburg State University.

Klokotov, I. Yu. (2019). *Development of automation and robotics in the modern world*.

Leontiev, S. M. (2023). Robotics and process automation: New advances in building robots and their impact on production and maintenance. https://cyberleninka.ru/article/n/robototehnika-i-avtomatizatsiya-protsessov-novye-dostizheniya-v-sozdanii-robotov-i-ih-vliyanie-na-proizvodstvo-i-obsluzhivanie

Shishmarev, V. Yu. (2013). *Diagnostics and reliability of automated systems* (2nd ed.). Moscow: Yurayt. https://urait.ru/book/diagnostika-i-nadezhnost-avtomatizirovannyh-sistem

Smirnova, L. I. (2023). *Production automation: Modern approaches and technologies* (Textbook). Moscow: Higher School of Economics. https://cyberleninka.ru/article/n/vliyanie-avtomatizatsii-i-robotizatsii-na-rynok-truda

Titov, B. C., Serebrovsky, V. I., Shirabakina, T. A., & Ubaidullaeva, S. R. (2019). *Automation: Textbook for students of higher educational institutions*. Bukhara: Publishing House BF TIIIMSH.

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