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## Key directions of automation of petrochemical production

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**Abstract.** The article reveals the role of automation of the main systems of petrochemical production: technological processes, security systems, information management, and electrical equipment. The purpose of the article is to determine the main directions of automation in the petrochemical complex. Based on the study, it is shown how industrial automation affects gross national product growth by optimizing production and logistics operations, labor efficiency, increasing equipment productivity, improving research and development and product development. For example, if the cost of reconstruction is 2-6% of the total cost of a petrochemical enterprise, the resulting effect of automation is estimated at 15-30% of the increase in operational efficiency. It is concluded that integrated control automation systems regularly design, upgrade, and provide comprehensive support for the availability of complex technical systems throughout its life cycle.

### 1. Introduction

Automation plays a significant role in improving the efficiency of petrochemical production, as the petrochemical industry has high requirements for production safety.

The availability of a large amount of information requires the introduction of modern means of data collection and analysis, process management, which represents a new, higher level of development of the automation system. Although the introduction of automation systems significantly increases costs, there are a number of advantages:

- increasing the economic efficiency of production;
- improving the efficiency of technological processes (speeding up operations, improving product quality, etc.);
- increasing the degree of security.

The introduction of modern industrial technologies in large petrochemical enterprises provides a high demand for the automated systems sector. Domestic and foreign organizations provide a high level of service and carry out the development, production and implementation of these products. Some companies specialize in certain types of products and services, while others try to cover all areas of automation.



Currently, automation can be divided into the following main functional systems with different specifics and content of certain specialized elements:

1. Automatic control systems of technological processes. Automation provides control of technological processes and increases the accuracy of control, which in turn leads to increased technological efficiency.

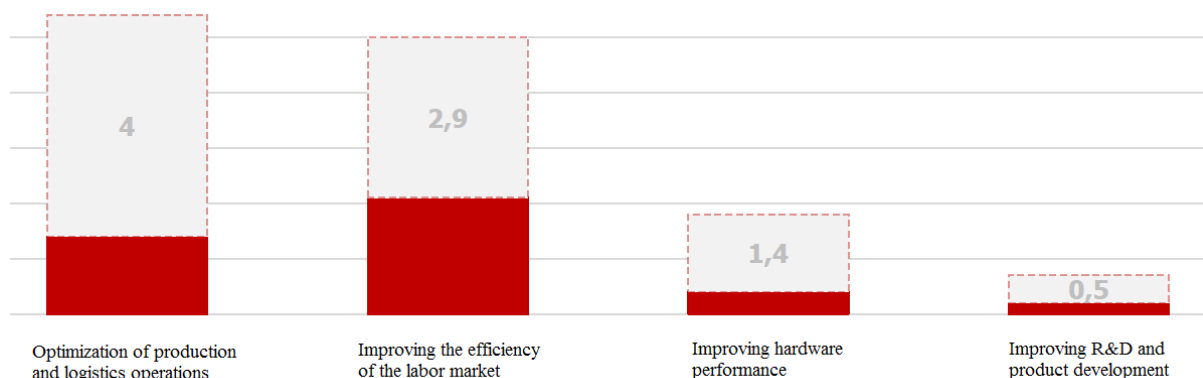
2. Automatic security systems. The petrochemical industry, unlike other sectors of the economy, is subject to increased safety requirements, since this complex has the risk of emergency situations when working with explosive and fire-hazardous hydrocarbon raw materials, which can lead to large-scale disasters with tragic consequences. In this regard, the largest Russian oil companies are paying more and more attention to improving the level of security at their enterprises.

3. Information management systems that integrate the management of individual functional systems. These include communications tools, physical media (microprocessors and other related hardware), and software. This sector of the market is the most dynamically developing in the world, and in recent years, our country has also started its active growth.

4. Electrical and power equipment. It is obvious that modern industrial automation systems that use complex high-tech equipment as elements require, in turn, the introduction of modern developments in the field of electrical and power equipment.

## 2. Materials and methods

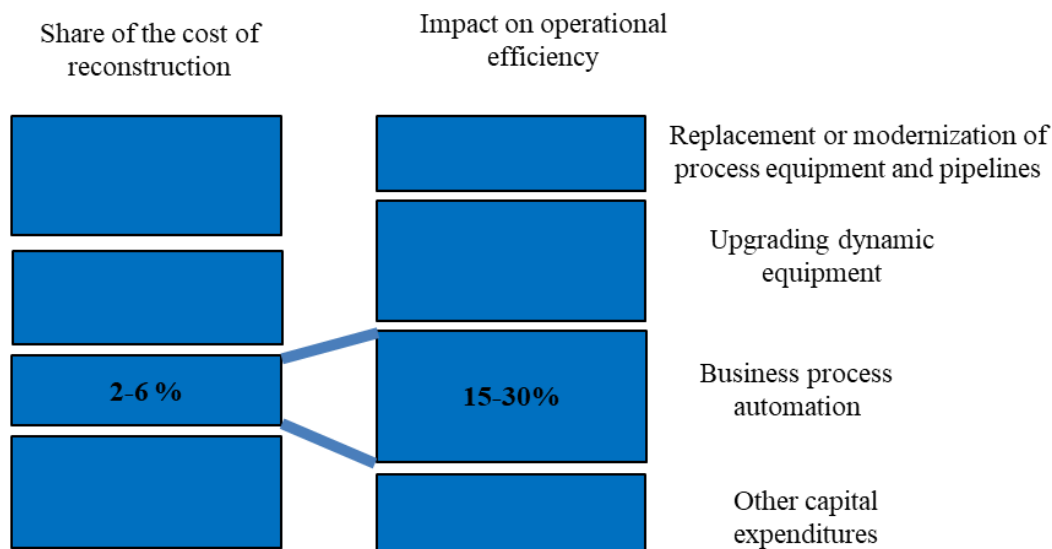
Digitalization of industry is a means of obtaining integrated production that brings results to customers and profits to business owners. The concept of digital industry includes production management, evaluation and achievement of the required level of reliability of the production system, planning, dispatching and analysis of production processes. According to the Federal state statistics service of the Russian Federation, the World Bank, McKinsey Global institute [1], the potential increase in the gross national product of the Russian economy from the digitalization of industry in 2025. it will make up 19-34%, of which an increase of 4 percentage points is predicted due to optimization of production and logistics operations, 2.9-due to the efficiency of labor resources, 1.4 percentage points-due to an increase in equipment productivity and 0.5 percentage points - due to an increase in research and development and product development productivity (figure 1).



**Figure 1.** Potential increase in the Russian economy's GDP from digitalization of industry [1].

According to the report of the analytical service of Gazprom-Neft, annual operating losses at petrochemical plants from inefficient processes are calculated in the following terms: unplanned equipment downtime – \$ 8 million. per year, the loss of plant productivity and energy is \$ 7 million. per year, unused production capacity – \$ 5 million per year, return on quality – \$ 4.4 million. per year, staff training – \$ 4 million. per year. At the same time, the ratio of costs and the resulting economic effect from the automation of processes at petrochemical enterprises shows a significant return. For example,

if the cost of reconstruction is 2-6% of the total cost of a petrochemical enterprise, the resulting effect of automation is estimated at 15-30% of the increase in operational efficiency (figure 2).



**Figure 2.** Influence of reconstruction costs on the operational efficiency of a petrochemical enterprise (based on the data from the Federal state statistics service of the Russian Federation).

The intensity of use of digital technologies in the petrochemical industry is one of the highest among economic activities. Thus, in the business sector as a whole, the intensity of use of digital technologies was as follows: broadband Internet – 80.5% of organizations (in the manufacturing industry – 91.3% of organizations), "Cloud" services – 20.5% (in the manufacturing industry – 23.2%), RFID-technologies – 5.8% (in the manufacturing industry – 8.7%), ERP-systems – 17.3% (in the manufacturing industry – 22.1%), electronic sales using special forms posted on the website / in the extranet, EDI-systems – 12.8% (in manufacturing industry – 19,3%) (data from the Federal state statistics service of the Russian Federation). Thus, for all types of information and communication technologies used, the manufacturing sector shows a higher intensity than the business sector as a whole. However, it should be noted that the use of RFID technologies, ERP systems, and EDI systems is relatively low. On average, the intensity of use of RFID technologies, ERP systems, and EDI systems in industrialized countries varies from 15-54% on average.

The use of software tools in organizations in the petrochemical sector is as follows: 68.9% have an electronic document management system, 70% of organizations use special software tools to perform financial calculations in electronic form, 64.8% - to solve organizational, managerial and economic problems, 65.4% – electronic reference and legal systems, 51% – to manage purchases and sales of goods, works, services, 31.4% – to provide access to databases through global information networks, 40.5% – for the management of automated production and / or individual technical means and technological processes, 30.9% – for design, 16.5% – training programs, 14.6% – editorial and publishing systems, 5.7% – for scientific research.

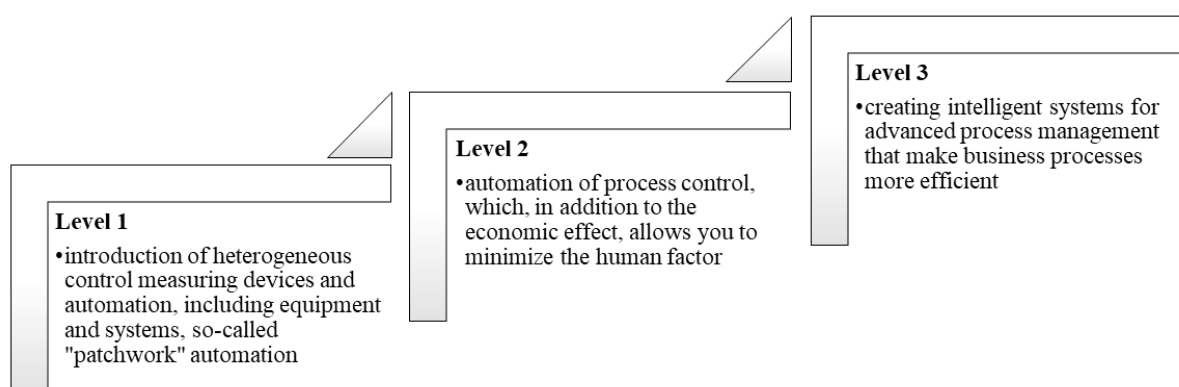
In the petrochemical sector, 22.1% of organizations use ERP systems, 15% of organizations use CRM systems, and 5.6% of organizations use SCM systems, which is generally higher than in the business sector as a whole, with the exception of supply chain management technologies.

### 3. Results and discussion

The production system of a stable enterprise is subject to constant quantitative and qualitative changes caused by market requirements and technology development. In this regard, the mechanism for improving the efficiency of the organization of production systems should implement the functions of

developing, selecting and implementing measures that will ensure the effectiveness of systems, using the means and methods of organizing production by automating it and then digitalizing it as a higher level of development in the process of implementing the information management paradigm. Digitalization is a transformation of the enterprise management system based on the use of digital technologies to optimize the production processes of the enterprise based on the target performance of the organization and on this basis, customer satisfaction. The primary level of digitalization is automation.

Automation levels in the petrochemical complex can be divided into three levels, which are shown in figure 3.



**Figure 3.** Levels of automation of production process control at petrochemical enterprises (developed by the author).

In advanced process control systems (Advance Process Control system), the same mathematical apparatus is used, which is why they are used in any continuous technological processes. In petrochemicals and large-capacity plants, a slight increase in labor productivity and the production of new products has a significant impact on the company's profit, so the use of improved process management in these industries of the petrochemical complex is particularly relevant.

Implementation of complex programs for automation of production processes at the largest petrochemical companies contributes to [2]:

- increasing the productivity of the technological process;
- improving the quality and environmental friendliness of products through more precise and rapid process control;
- reducing the time of transients;
- increasing the time to maintain the optimal process mode;
- reducing energy consumption;
- improving the efficiency of working processes and operational readiness of petrochemical enterprises;
- reducing operating costs and developing the level of production automation;
- improving production safety and reliability and meeting regulatory requirements;
- centralization of control and management of the oil refining process, which allows for operational control and management of equipment operation modes;
- technical accounting of consumed and produced products;
- ability to analyze the conditions of the process of refining etc.

The choice of priority areas for accelerated development and improvement of production systems should be focused on first, the advanced development of fundamentally new high-tech sectors and markets; second, the deep technological modernization of traditional industries and industries [3, 4, 5].

The long-term aspect of the life cycle in complex and expensive production systems constantly requires quick decisions regarding economically complex transformations, upgrades, and innovations. All this requires knowledge of stable and more frequent and revolutionary facts from science and technology related to the growing need for computer technologies, new information and testing technologies, etc. All this is necessary for fast and economical operation, and it is much more difficult to achieve the required quality without an automated integrated approach.

As for the relevance of the transition to higher levels of digitalization of production compared to automation, we can use data from the McKinsey Institute [1], which estimated the potential for additional revenue from the introduction of digital technologies at 40% of the additional value created, but in the conditions of digital interaction between two or more production systems, and in the industry this share is 36%, which is provided by data exchange between equipment and other interaction, the content of which is indicated in the framework of the methodology proposed by us.

#### 4. Conclusions

Advanced process Control systems (APC – Advance Process Control), which are gaining popularity in Russia at petrochemical enterprises, help to follow the set parameters of oil production and production of petrochemical products and, if they deviate from the target ones, to inform the process control center promptly. The use of in-line analyzers allows you to control the physical and chemical characteristics of raw materials, semi-finished products, intermediate consumption and finished products. Adjacent installations are combined into complexes, which allows you to synchronize technological processes and manage them from a single center.

The synergistic effect of implementing automated control systems in the petrochemical industry is significant and can lead to [6, 7]:

- to accelerate the implementation of research and development results-by 30–40%;
- to reduce the cost of purchasing new complex technical systems – up to 30%;
- to reduce the time of purchase and delivery of spare parts to 20%;
- to reduce the time required for project implementation by 9 times.

The integrated management model includes cost reduction, product quality improvement, flexible delivery, and after-sales service. The use of new logistics methods and tools allows you to reduce costs, increase productivity, improve the quality of products and services, and ultimately gain a competitive advantage in the market [8]. Information methods and management tools for petrochemical enterprises are supplemented with digital tools. The inclusion of the Internet in the logistics environment helps to accelerate the functioning of the supply chain and reduce costs by sharing information and logistics synchronization between trading partners and service providers, which leads to the transformation of the market from traditional logistics concepts to digital logistics.

Thus, competent management of automated systems is fundamental in improving the efficiency of the organization of production in the petrochemical industry. Integrated control automation systems regularly design, upgrade, and provide comprehensive support for the availability of complex technical systems throughout their life cycle.

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