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ASSESSMENT OF THE ECONOMIC EFFICIENCY OF AUTOMATION OF THE ASSEMBLY LINE PROCESS OF MACHINE-BUILDING ENTERPRISE

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Automation of production processes is a priority area in the development of Kazakhstan's industry within the framework of Industry 4.0 and economic digitalization. This article focuses on evaluating the economic efficiency of implementing automation in the assembly sections of machine-building enterprises. The research purpose is to justify the feasibility of automating assembly lines based on the assessment of economic and production indicators. The article outlines methodological approaches to calculating economic effects such as cost reduction, productivity growth, and improved product quality. The practical part of the research is based on one of Kazakhstan's machine-building enterprises. The findings confirm the importance of a comprehensive approach to automation as a tool for enhancing industrial competitiveness. Recommendations are provided for integrating automated solutions in accordance with state programs supporting industrial modernization. Special attention is given to the regional context using the example of Kostanay region, considering infrastructure, employment structure, and technical capacity–thus ensuring the applied nature of the research and the scalability of its results.

Key words: *automation, economic efficiency, performance, lifting mechanism, programmable logic controllers, machine-building industry.*

МАШИНА ЖАСАУ ЗАУЫТЫН ҚҰРАСТЫРУ ЖЕЛІСІНДЕГІ ӨНДІРІСТІК ПРОЦЕСТІ АВТОМАТТАНДЫРУДЫҢ ЭКОНОМИКАЛЫҚ ТИІМДІЛІГІН БАҒАЛАУ

Санду И.С. – экономика ғылымдарының докторы, профессор, АӨК ғылыми-техникалық дамуының экономикалық мәселелері бөлімінің меңгерушісі, «Аграрлық экономиканы және ауылдық аумақтардың әлеуметтік дамуын зерттеу жөніндегі федералдық ғылыми орталық – Бүкілресейлік ауыл шаруашылығы экономикасы ғылыми-зерттеу институты» федералдық мемлекеттік бюджеттік ғылыми мекемесі, Мәскеу қ., Ресей Федерациясы.

Наурзбаева К.Б. – «СарыарқаАвтоПром» ЖШС «Аллюр» зауытының жаңа жобаларды іске қосу тобының жетекшісі, Қостанай қ, Қазақстан Республикасы.*

Өндірістік үдерістерді автоматтандыру – Қазақстан Республикасының өнеркәсібін Индустрия 4.0 және экономиканы цифрландыру жағдайында дамытудың басым бағыттарының бірі. Бұл мақала машина жасау кәсіпорындарының жинақтау учаскелерінде автоматтандыруды енгізудің экономикалық тиімділігін бағалауға арналған. Зерттеудің мақсаты – экономикалық және өндірістік көрсеткіштерді бағалау арқылы жинақтау желілерін автоматтандырудың орындылығын негіздеу. Мақалада шығындарды азайту, еңбек өнімділігін арттыру және өнім сапасын жақсарту секілді экономикалық тиімділікті есептеу әдістері қарастырылады. Зерттеудің практикалық бөлімі Қазақстандағы бір машина жасау кәсіпорнының негізінде жүргізілген. Нәтижелер автоматтандырудың кешенді тәсілі өндірістік бәсекеге қабілеттілікті арттырудың тиімді құралы екенін дәлелдейді. Мемлекеттік қолдау бағдарламаларын ескере отырып, автоматтандырылған шешімдерді енгізу бойынша ұсыныстар берілген. Зерттеуде Костанай облысының инфрақұрылымдық жағдайы, еңбек нарығы және техникалық әлеуеті ескеріліп, өңірлік ерекшеліктерге ерекше назар аударылған. Бұл зерттеудің қолданбалы мәнін арттырып, алынған нәтижелерді масштабтауға мүмкіндік береді.

Түйінді сөздер: *автоматтандыру, экономикалық тиімділік, өнімділік, жүк көтергіш механизм, бағдарламаланатын логикалық контроллерлер, машина жасау саласы.*

ОЦЕНКА ЭКОНОМИЧЕСКОЙ ЭФФЕКТИВНОСТИ АВТОМАТИЗАЦИИ ПРОИЗВОДСТВЕННОГО ПРОЦЕССА СБОРОЧНОЙ ЛИНИИ МАШИНОСТРОИТЕЛЬНОГО ПРЕДПРИЯТИЯ

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Автоматизация производственных процессов является приоритетным направлением развития промышленности Республики Казахстан в условиях перехода к Индустрии 4.0 и цифровизации экономики. Настоящая статья посвящена анализу экономической эффективности внедрения автоматизации на сборочных участках машиностроительных предприятий. Цель исследования – обоснование целесообразности автоматизации сборочных линий на основе оценки экономических и производственных показателей. В статье рассматриваются методологические подходы к расчёту экономических эффектов, таких как снижение издержек, рост производительности и повышение качества продукции. Практическая часть исследования выполнена на базе одного из машиностроительных предприятий Казахстана. Результаты подтверждают значимость комплексного подхода к автоматизации как инструмента повышения конкурентоспособности. Также предложены рекомендации по интеграции автоматизированных решений с учётом государственных программ поддержки промышленности. В работе особое внимание уделено региональному аспекту на примере Костанайской области, с учётом инфраструктурных условий, структуры занятости и технической базы, что обеспечивает прикладной характер исследования и возможность масштабирования полученных результатов.

Ключевые слова: *автоматизация; экономическая эффективность; производительность; грузоподъёмный механизм; программируемые логические контроллеры, машиностроительная отрасль.*

Introduction. The mechanical engineering industry plays a significant role in the economy of Kazakhstan, providing jobs and promoting the industrialization of the country. In the context of growing global competition, enterprises in this industry are faced with the need to increase efficiency, reduce costs and improve product quality. Global trends indicate the widespread introduction of automation technology into production processes, which allows achieving significant competitive advantages. For Kazakhstan's mechanical engineering enterprises, automation is becoming not just a desirable, but a necessary step to ensure sustainable development and competitiveness in the international market. The introduction of modern automated systems can significantly increase labor productivity, reduce production costs by reducing the influence of the human factor and optimizing the use of resources, and improve the quality of manufactured products. Growing competition in global markets dictates the need for continuous improvement of production processes.

According to the Ministry of Industry and Infrastructure Development of the Republic of Kazakhstan, in 2023, the volume of production of mechanical engineering products in Kazakhstan amounted to 2.3 trillion tenge, while the growth compared to 2022 was 18.7%. The industry employs over 66 thousand people, and the share of mechanical engineering in the manufacturing industry reached 15.4%.

Automation is increasingly recognized as a critical factor in increasing productivity and economic efficiency in various industries, especially in the mechanical engineering sector. Automation of production not only increases efficiency, but also contributes to the transformation of social structures and labor relations in the context of the Fourth Industrial Revolution [1]. Automation is one of the key tools that allows Kazakhstani companies in the mechanical engineering industry to meet international standards of quality and efficiency. The introduction of advanced technologies allows not only to optimize current operations, but also to create a basis for further innovative development. It is likely that government support for industrialization and technological development initiatives can become an important incentive for the wider implementation of automated systems in the mechanical engineering sector of Kazakhstan. Such support may include financial incentives, training and development programs for qualified personnel, as well as the creation of a favorable regulatory environment for the introduction of new technologies.

The integration of intelligent automated systems into production processes not only increases productivity and reduces costs, but also transforms organizational structures and requirements for personnel qualifications, which is especially relevant in the context of the transition to Industry 5.0. [2].

Assembly lines are a key stage in the manufacturing process in mechanical engineering, where individual components are assembled into finished products. Automation of this stage can lead to the most significant improvement in productivity and quality, since manual labor on assembly lines is often associated with monotony, a high probability of errors, and limited speed of operation.

Assembly lines are critical components of manufacturing, representing the planned and orderly movement of goods through the shop floor. Automation of these lines can lead to significant changes in production efficiency by reducing manual labor and speeding up production cycles.

Growing global competition in manufacturing is a powerful driver for automation, pushing companies to seek greater efficiency through technological advances. In a globally competitive marketplace, manufacturers are constantly under pressure to optimize their operations. Automation offers a direct path to achieving this goal, enabling faster production, fewer errors, and the ability to meet growing market demand. Ultimately, this leads to increased competitive advantage.

Assembly lines are vital components of production, representing the planned and orderly movement of goods through the workshop [3]. Automation of these lines can lead to significant changes in production efficiency by reducing manual labor and speeding up production cycles [4].

As noted in the textbook edited by V.A. Skryabin, reduction of time costs in production can be achieved by attracting additional resources or intensifying production processes or by combining them. In this case, intensification is considered the most effective way, which involves increasing labor productivity. The key tool for increasing productivity is automation. In the conditions of developed countries, where up to 80% of production costs are associated with wages, reducing the share of human participation in the production process becomes the main factor in reducing costs. Which, in turn, requires further automation of production [5].

Kostanay region is one of the most important centers of the machine-building industry in Kazakhstan, where a significant number of enterprises specializing in the production of a wide range of machines and equipment are concentrated. The high concentration of machine-building enterprises in this region makes it an ideal object for studying the impact of automation on production processes. Analysis of the economic efficiency of assembly line automation in Kostanay region will provide valuable information that can be applied in other industrial regions of Kazakhstan. Statistical data on the number of machine-building enterprises in Kostanay region, their production volumes and the number of employees could confirm the importance of this region for research.

The high density of mechanical engineering enterprises in the Kostanay region provides a unique opportunity to study the impact of automation in a specific regional context. Such a regional focus allows for taking into account local economic conditions and the specifics of the labor market and infrastructure, making the study more relevant and applicable to stakeholders. The results of the analysis conducted on the example of the Kostanay region can serve as a basis for developing recommendations for the implementation of automated technologies in the mechanical engineering sector of both this region and the country as a whole.

Despite the obvious advantages of automation, comprehensive economic assessments of its effectiveness in relation to assembly lines of mechanical engineering enterprises in Kazakhstan, especially in the regional context of Kostanay region, remain insufficiently studied.

Objective, tasks. Kostanay region is defined as a significant center of the mechanical engineering industry in Kazakhstan, which makes it a relevant object for this study. According to the statistics department of Kostanay region, in 2024, more than 30 large and medium-sized mechanical engineering enterprises operated in the region, providing jobs for over 5,000 people. The basis of the mechanical engineering sector of the region is formed by enterprises assembling agricultural machinery (for example, Agromash Holding and the car assembly Saryarka AvtoProm). This emphasizes the presence of large enterprises in the region manufacturing cars and agricultural machinery, which once again emphasizes its importance. The government of Kazakhstan is actively promoting industrial automation and robotics as key factors in achieving industrial development and economic growth. The government's emphasis on increasing the share of the manufacturing sector and its support for automation-related projects indicates a strategic direction. This support is likely to include initiatives aimed at modernizing production capacities and increasing the competitiveness of domestic enterprises.

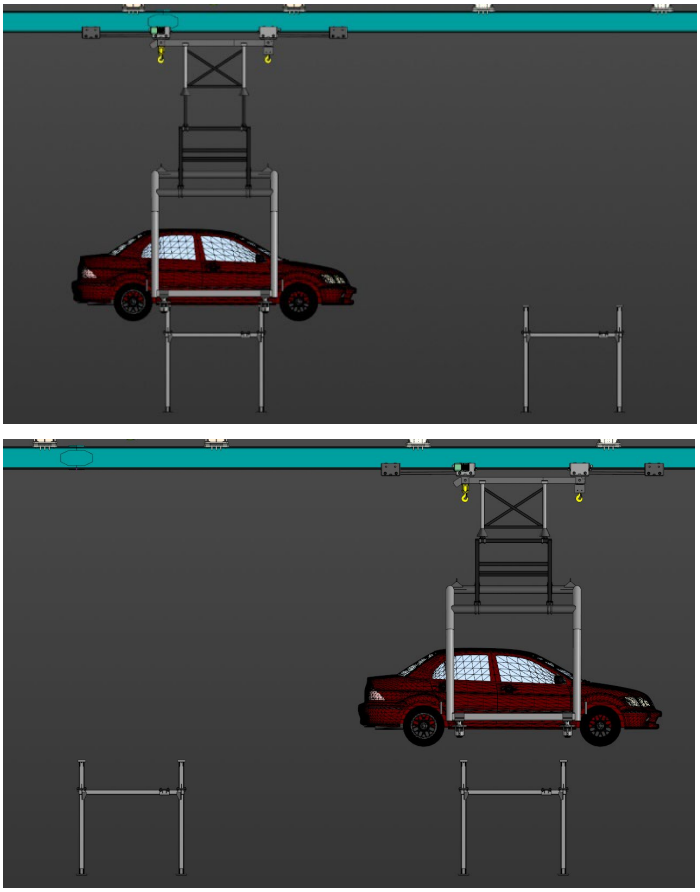
The purpose of the study is to assess the economic efficiency and automation of assembly production at a machine-building enterprise in the Republic of Kazakhstan, taking into account the regional characteristics of the Kostanay region.

Objectives: To examine the challenges and potential drawbacks associated with automation, including high initial investment, increased maintenance requirements2 and potential job losses; to assess the specific context of the Kostanay region, including the current state of its mechanical engineering sector and the level of automation implementation. To identify key factors influencing the cost-effectiveness of assembly line automation in the target region.

Drawing 1 – Allur Plant car assembly line without automated equipment [6]

Kazakhstan faces particular challenges in implementing automation technology due to its limited infrastructure, highlighting the need for targeted research. Kazakhstan's unique economic and industrial landscape, as well as its specific development goals, require targeted research into the economic impact of automation in its key sectors, such as mechanical engineering. Kazakhstan's reliance on commodity industries and its efforts to diversify its economy mean that the economic impact of automation in its manufacturing sector, particularly in regions such as Kostanay with a strong mechanical engineering presence, will have distinctive features that merit special study.

Materials and methods. This work proposes to use a set of modern methods aimed at studying and increasing the economic efficiency of automation of assembly production in the machine-building industry of Kazakhstan. The object of the study is the assembly line of a machine-building enterprise in the Kostanay region, where a lifting mechanism is used that is not equipped with an automated control system (see Drawing 2-3).



Drawing 2-3 – 3D visualization of motion mechanics

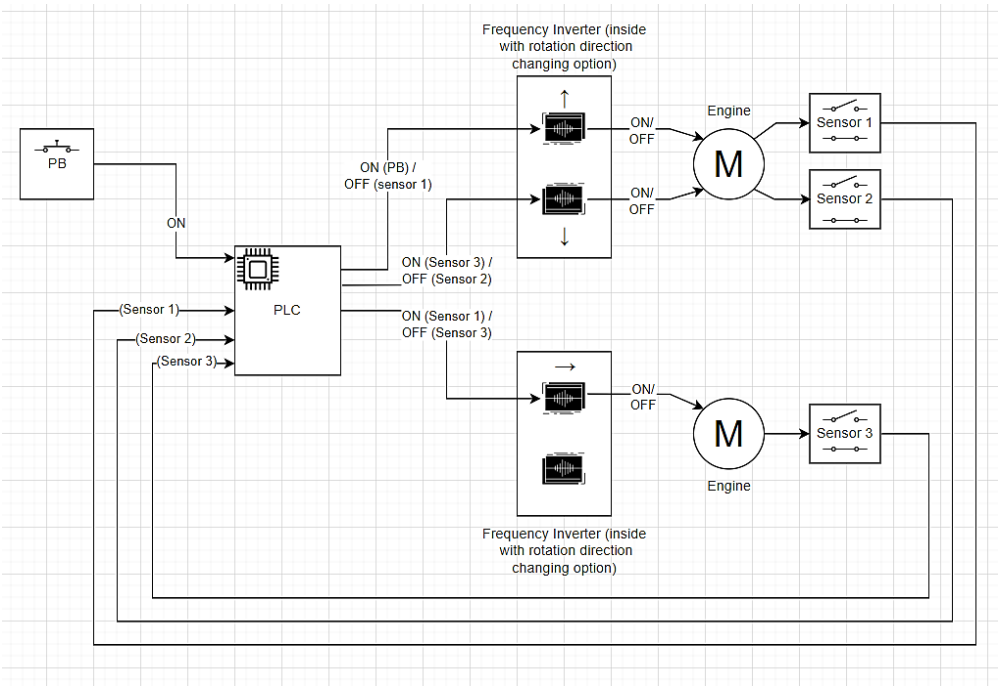
The methodological basis of the study includes: methods of technical monitoring and analysis of engineering subsystems of the control object; principles of construction of automated systems based on programmable logic controllers; use of principles of distributed intelligence to increase flexibility and adaptability of systems; system approaches to development and implementation of automatic control systems for production equipment; free programming methods for development of original PLC software; comparative analysis of various equipment configurations and control algorithms based on simulation modeling.

It is envisaged to design several versions of the architecture of the automated system with different degrees of integration of PLC, sensors, converters and other components, with subsequent comparison according to the criteria of reliability, productivity and cost-effectiveness. In addition, it is planned to analyze the existing technical and organizational conditions of the enterprise to identify restrictions affecting the implementation of automation.

Results. As a result of the preliminary analysis, it was established that the current control system of the GPM at the enterprise under study is based on manual control, which increases production risks and reduces the overall reliability and efficiency of the assembly line. It is expected that the introduction of an automated control system based on PLC will allow:

- improve the safety of the production process by eliminating the human factor;
- increase labor productivity by reducing the time it takes to move truck bodies.
- reduce the likelihood of emergency situations and defects during assembly operations.
- increase the energy efficiency of the system through precise control of electric motors.
- reduce equipment operating costs by reducing wear and tear and increasing the service life of components.

The design simulation also includes testing several data transmission schemes - both wired and wireless - to ensure stable communication between the elements of the automated system. In particular, it is planned to implement a modified busbar adapted for work with PLC, as well as use a wireless data transmission channel as a backup or parallel solution.



Drawing 4 – Simple version of electrical circuit with PLC

Based on current productivity and downtime, the implementation of an automated control system is estimated to reduce the overall assembly cycle time by 20-25%, equivalent to a savings of up to 480 hours per month. This results in a reduction in unit costs by 9-12% and an increase in output per shift from 24 to 30 units.

Thus, the results of the theoretical stage indicate a high potential for automation of the assembly line using standard industrial components and original PLC software adapted to the conditions of a specific enterprise.

In order to determine the socio-economic context of the introduction of automation, it seems appropriate to analyze the key industry indicators of mechanical engineering in the Republic of Kazakhstan and Kostanay region (see Table 1).

Table 1 – Key indicators of mechanical engineering in Kazakhstan and Kostanay region

No.	Indicator	Meaning
1	Volume of production of engineering products in the Republic of Kazakhstan	4.6 trillion tenge
2	The share of mechanical engineering in the manufacturing industry of the Republic of Kazakhstan	19%
3	Number of machine-building enterprises in the Republic of Kazakhstan	3 800
4	Number of people employed in mechanical engineering in the Republic of Kazakhstan	118,000 people
5	Volume of production of engineering products in Kostanay region	1 184.4 billion tenge
6	The share of mechanical engineering in the manufacturing industry of Kostanay region	58%
7	Number of industrial enterprises in Kostanay region	917
8	Number of employees of industrial enterprises of Kostanay region	42,000 people
9	Number of machine-building enterprises in Kostanay region	4 large enterprises
10	Planned investments in mechanical engineering of Kostanay region by the end of 2025	17.8 billion tenge

The given statistical indicators confirm the strategic importance of the mechanical engineering industry both at the national and regional levels. In 2024, the volume of mechanical engineering production in Kazakhstan reached 4.6 trillion tenge, which is almost a fifth of the entire manufacturing industry. These data indicate the high contribution of the industry to the country's economy and emphasize the need for its technological modernization.

Kostanay region deserves special attention, where mechanical engineering makes up 58% of the entire volume of the region's manufacturing industry. Over one 1.1 trillion tenge of mechanical engineering production and more than 40 thousand people employed in industry indicate a strong specialization of the region. This makes the Kostanay region one of the centers of attraction for industrial investment and innovation.

It is also worth noting the high level of production concentration - only 4 large machine-building enterprises provide the bulk of output, which, on the one hand, allows for focusing efforts on automation, and on the other hand, increases the risks of failures in process chains. Therefore, it is here that automation of assembly lines can provide the maximum economic effect and become a driver for increasing sustainability.

The planned investments in the amount of 17.8 billion tenge in the development of mechanical engineering in the Kostanay region indicate a favorable investment environment and state support. Thus, the region has all the prerequisites for the large-scale implementation of automated control systems, including PLC, both within the framework of the modernization of existing production facilities and in the creation of new capacities.

The combination of high industry significance, a high share of employment and an active investment policy confirms the relevance of the research being conducted, and the Kostanay region is an optimal testing ground for pilot testing of solutions in the field of automation of production processes.

Discussion: Automation of production processes at machine-building enterprises is a priority area for increasing the efficiency and reliability of production activities. One of the key solutions in this area is the use of programmable logic controllers (PLC), which provide flexible control of technological operations and adaptation of systems to specific production conditions.

The technological implementation of automation is carried out by electronic engineers together with scientific specialists, which facilitates the integration of advanced engineering solutions with scientific approaches. Automation of production processes can be carried out both by creating new equipment and by upgrading existing equipment. The latter involves equipping the equipment with loading and unloading devices, interoperational transport and storage systems, as well as a single control system for monitoring diagnostics and blocking. Both cases require a significant amount of capital investment and, as a consequence, there is a need to calculate the conditions under which automation tools will be guaranteed to be effective. Production practice shows that the implementation of expensive automated systems is not always economically justified. The reason for this is often the desire for the maximum level of automation without taking into account the economic feasibility of solutions [6]. The automated system is based on original software aimed at simplifying the user interface and the transition from traditional programming to parameterization. This approach allows us to significantly reduce the development and implementation time, reduce the risk of errors during integration into the production process, and avoid significant costs associated with the implementation of expensive robotic systems.

The key advantage of programmable logic controllers is their ability to perform large-scale computing tasks in real time, which ensures high accuracy, stability and productivity of automated production complexes.

One of the key stages of the production process at the basic machine-building enterprise is the assembly of cars, which in most workshops is carried out mainly in a mechanized manner. Of the seven operating

assembly lines, only two are fully automated, while the rest continue to function with the active participation of operators.

In the context of this study, assembly equipment is considered to be a lifting mechanism - a specialized device designed to move large-sized and heavy objects in space. On the assembly line, the lifting mechanism is used for the linear movement of car bodies along the production route on a crane beam. The mechanism design includes two electric motors with a total capacity of about 3 kW, hoists and a crab used to grip and hold the body during movement.

In the existing mechanized control mode, movement is carried out manually - the operator makes decisions about the time and direction of movement. Such a control scheme, based on the human factor, significantly reduces the reliability of the process and is accompanied by high production risks. The mass of the moved load is approximately two tons, and any careless action of the operator can lead to serious consequences from injury to damage to products and equipment. It is important to note that the type of GPM under study has not been previously automated, while fully automated lines use devices similar in functionality, initially adapted for integration with automatic control systems and not involving direct human intervention in the process of operation.

The study considers automation of the GPM operation as the central concept. For this purpose, widespread industrial automation technologies based on programmable logic controllers are used [7]. The purpose of automation is to eliminate the human factor, increase the safety and reliability of the assembly process, and minimize the risks associated with the operation of heavy equipment. Unlike a person, an automated system is capable of functioning around the clock while maintaining stable productivity and without the need for physiological breaks, while simultaneously reducing the likelihood of errors in normal operating modes.

The automation system is developed from scratch. Complete PLC programming with the creation of several program code options, as well as the selection of electrical components compatible with the technical and electrical characteristics of the existing GPM. In addition, electrical diagrams are developed that describe in detail the connections between the PLC and equipment elements. The electrical base includes: frequency converters, encoders, circuit breakers, magnetic starters, control relays, various types of sensors, transformers, power supplies and terminal blocks to ensure signal exchange between the controller and system components.

Each version of the program code is developed based on a specific version of the electrical equipment configuration, which allows for a comparative analysis of the performance and reliability of various automation architectures. Calculations have shown that the cost of implementing a PLC system for one GPM is approximately 5.2 million tenge, including equipment, programming and installation. At the same time, the expected payback period of the project is 12-14 months at the current output volume and line load level. During the experimental debugging process, the PLC program code will be repeatedly modified to achieve the optimal result, taking into account risk factors and possible errors in the equipment operation.

The distinctive feature of the proposed approach is not the use of non-standard equipment, but an innovative way of integrating standard industrial components, adapted to the characteristics of an already functioning mechanism. The developed software solutions are original and unique, created in accordance with the specifics of the automation object under study and have no ready-made analogues.

One of the key tasks in the implementation of an automated system based on a lifting mechanism is the organization of an effective and stable process of data transfer between the elements of the system. This is due to the need to coordinate actions between several automated ones in real time, which, in turn, ensures the continuity and high dynamics of the production cycle. Reliable data exchange between mechanisms is the basis for their synchronous operation, increasing overall efficiency, minimizing risks and ensuring the safety of the production process.

However, when automating mobile equipment such as the GPM, traditional wired data transmission methods - including twisted pair, coaxial or fiber optic cable – are technically inapplicable. This is due to the need for a stationary support structure for laying cables, while the GPM is in constant motion along the line. In similar cases, trolley busbars are often used in industry, but their use is incompatible with the selected control architecture based on a programmable logic controller.

The study involves the use of an alternative, innovative data transmission method based on an adapted busbar system modified for operation with a PLC. The development of this system will be carried out in stages during experimental testing. In parallel, it is planned to implement a wireless data transmission channel with the possibility of integrating both solutions to achieve maximum reliability, flexibility and performance.

For each of the communication systems under consideration, a separate version of PLC software will be developed, ensuring correct operation with the corresponding equipment configuration. Conducting a comparative analysis of various approaches to data transmission will allow us to determine the most effective or combined version, optimal in terms of technical characteristics, reliability and cost-effectiveness.

The creation of an intelligent automated control system for lifting and cargo equipment of an assembly line of a machine-building enterprise will help solve a number of urgent problems: increase energy efficiency through rational use of electrical energy; increase labor productivity by eliminating manual control; increase

the level of safety and reduce the likelihood of emergency situations; improve the quality of manufactured products and technological operations in general.

Conclusion. Thus, the conducted analysis showed that the existing organization of control of lifting mechanisms at the machine-building enterprise is not effective enough and requires modernization using modern automation tools. The developed concept of an automated control system based on programmable logic controllers using the principles of distributed intelligence and a systems approach has high potential for increasing production efficiency, reliability and safety.

The proposed technical solutions are aimed at implementation using standard industrial components and open source software, which makes the project economically feasible and adaptable to the conditions of a specific enterprise. The implementation of such a system will not only optimize the assembly process, but also create a basis for further digitalization and intellectualization of production lines.

The predicted reduction in accidents on the line after automation is estimated at 70%, which corresponds to international practice in the transition from manual to automated control of heavy equipment. According to calculations, the increase in energy efficiency will be up to 15% due to the use of frequency regulation of electric drives and optimization of movement algorithms.

Further stages of the research will involve the development of a prototype system, experimental testing of its operation and evaluation of the achieved economic and technological effect.

REFERENCES:

1. **Szeszák BM, Kerékjártó IG, Soltész L, Galambos P. Industrial Revolutions and Automation: Tracing Economic and Social Transformations of Manufacturing.** *Societies*. 2025, 15(4):88. https://doi.org/10.3390/soc15040088.

2. **Jiang H, Ge Y, Yang C, Yu H. How automated machines influence employment in manufacturing enterprises?** *PLoS One,* 2024, 19(3):e0299194. DOI: 10.1371/journal.pone.0299194. PMID: 38442127; PMCID: PMC10914295.

3. **Assembly line. Automation, Efficiency & Productivity. Britannica Mone**y. Available at: https://www.britannica.com/money/assembly-line (accessed 18 May 2025).

4. **Assembly Line Automation Solutions. INEA**. Available at: https://www.inea.eu/assembly-line-automation/ (accessed 18 May 2025).

5. **Skryabin V.A., Shirtladze A.G., Zverovshhikov A.E., Mashkov A.N. Avtomatizaciya proizvodstvenny'h processov v mashinostroenii** [Automation of production processes in mechanical engineering]. Moscow, KURS, INFRA-M, 2023, 320 p. (In Russian)

6. **Allur plant Kia start of production.** 2021, available at: https://www.kia.ru/press/news/261/ (accessed 18 May 2025).

7. **Ivanov A.A. Avtomatizaciya tehnologicheskih processov i proizvodstv** [Automation of technological processes and production]. Moscow, FORUM, INFRA-M, 2018, 224 p. (In Russian)

8. **Forsberg K., Mooz H. The Relationship of Systems Engineering to the Project Cycle**. First Annual Symposium of the National Council On Systems Engineering (NCOSE), 1991, 12 p.

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