Methodological basis for using artificial intelligence technologies in a construction company

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Abstract. Increasing requirements for information systems have recently caused interest in the development of artificial intelligence. The direction of development of artificial intelligence covers various fields of science, spheres of life. Artificial intelligence is a promising area, the development of which is being carried out by leading educational, technological, and consulting organizations. An extensive set of AI tools, its types and methods allow us to encourage positive trends in the development of enterprises, increase productivity, minimize costs, as well as the overall development of the economy. In order to ensure the accelerated development of artificial intelligence in the Russian Federation, a strategy for the development of AI has been developed until 2030, which regulates the increase in the growth of proposals for competitive Russian products (services) created using artificial intelligence. Analysis of the achievements of the development of artificial intelligence made it possible to determine the current directions of development.

1. Introduction

Relevance of the research topic
Today, artificial intelligence is one of the highest priority research areas. The field of application of artificial intelligence affects many areas, artificial intelligence technologies are widely used in discrete and process manufacturing, as well as in the electric power industry. Many systems exploring the application of artificial intelligence methods in areas new to the industrial sector are in the early stages of development. The relevance of the work lies in the fact that at the moment, due to digitalization, rapidly developing e-commerce, open database technologies, simple information systems cannot cope with the volumes of data that circulate in the enterprise. To work effectively with a large amount of information, it is necessary to use artificial intelligence technologies.

The purpose and objectives of the study.
The aim of the work is to analyze and select ready-made solutions for the use of artificial intelligence technology to improve the efficiency of a construction company in the chosen area of artificial intelligence activity. To achieve this goal, it is necessary to solve the following main tasks:
1. Analyze the varieties of artificial intelligence;
2. To classify the main directions of implementation of artificial intelligence technology at a construction enterprise;
3. Analyze the use of artificial intelligence systems in the construction industry;
4. Justify the choice of the main direction for the introduction of artificial intelligence technology;

Subject and object of research.
The object is a system for improving the efficiency of the enterprise, designed to select the most suitable artificial intelligence technology for the enterprise.

The subject of the research is an intelligent catalog and a ready-made solution for the selection of an artificial intelligence system for implementation at a construction enterprise.

**Research methods.** In the process of performing the work, theoretical, empirical and statistical research methods were used.

**Scientific novelty.** The novelty of the work lies in the fact that at the moment on the Russian market there are more than 100 programs using artificial intelligence systems in the construction field. But there is no such ready-made solution that would set itself the goal of analyzing and selecting programs using artificial intelligence systems for a specific construction company, in a chosen direction, in order to increase the efficiency of its functioning and the percentage of profit received.

2. **Text article**

The concept of artificial intelligence, like intelligence itself, is very vague. If we consider intelligence as the ability of the brain to solve tasks assigned to it by acquiring, memorizing and deliberately transforming knowledge in the learning process based on experience and adaptation to various circumstances, then the concept of “knowledge” becomes much broader than just information entering the brain. The implementation of intellectual activity requires the construction of an information model of the analyzed object in the knowledge system, in which the constituent parts of the object, their properties and relationships are not only displayed and remembered, but can also be deliberately changed [1].

Based on this, it is possible to transform the definition of intelligence as a universal or useful super-algorithm for all types of problems, which itself is capable of creating algorithms for solving certain problems. The defining characteristics of intelligence, which are manifested in the process of solving tasks, are the ability to learn, generalize, acquire knowledge and skills, and adapt to changing conditions in the process of solving problems. According to these properties of intelligence, the brain is able to solve various problems, as well as easily recover and switch from solving one problem to another.

Artificial Intelligence (AI). The problem with this term is that it is used in a wide variety of fields and means something completely different. As Andrew Moore, dean of Carnegie Mellon University of Computer Science, said, artificial intelligence is the science of how to create computers that behave in a way that only the human mind could behave according to the latest ideas [2].

Experts note that most of the technologies for the implementation of artificial intelligence systems are used in discrete production. It includes aircraft construction, mechanical engineering and instrument making. This area includes 44% of the projects in the field of artificial intelligence examined in the study. In second place is process production: metallurgy, chemistry, petrochemistry, oil refining and oil production. In this area, 22% of projects for the implementation of artificial intelligence systems are being implemented. And 11% are in the power industry. The remaining 23% are in the early stages of development. These are mainly university scientific works, which investigate the application of artificial intelligence methods in areas that are new to the industrial sector. Figure 1 shows the main areas of practical application of artificial intelligence systems [3-5].
Nowadays, new artificial intelligence systems are widely used in construction. Four promising areas of application of machine learning technologies in large construction organizations were studied and identified, presented in Table 1.

Table 1. The main more promising areas of application of artificial intelligence systems at a construction enterprise.

| Management | Logistics | The control | Staff |
|------------|-----------|-------------|-------|
| – planning; – strategy. | – transport; – warehouse. | – quality control; – control of the workflow. | – training |

Table 2. Fragment of the catalog-list of ready-made solutions using artificial intelligence systems, in the main directions.

| Main stream | Direction branch | The name of the program | Description |
|-------------|-----------------|-------------------------|-------------|
| Logistics   | Transport logistics | Deepsystems            | Road fault detection. |
|             |                  | Indatalabs              | Supply and transport. |
|             |                  | Veeroute                | Improving the efficiency of transport logistics. |
|             |                  | Adeptik                 | Optimization planning systems for production, logistics and service. |
|             |                  | Efsol                   | Transport logistics automation program. |
|             |                  | Maxoptra                | Service for managing the logistics of urban delivery. |
|             |                  | Smart logistics         | Online service for the operational work of freight forwarding companies. |
|             |                  | Cyberlog                | Online business management system in the field of cargo transportation. |
|             |                  | Megalognist             | A program on the 1C platform for complex automation of transport logistics. |
| **Trucking** | The program for accounting of motor vehicles of its own fleet, documents related to accounting, formation and printing of waybills, accounting of repair work performed and then, accounting of fuels and lubricants, driver work, accounting of contractors and work with them, warehouse accounting. |
| **Logistician tools** | Simple, convenient and functional service for logistics optimization. |
| **4logist** | Multifunctional service for transport and logistics companies. |
| **Automobile transportation** | System based on 1C: the enterprise comprehensively automates all business processes of vehicle management at enterprises of any scale and industry. |
| **Abm rinki tms** | Cloud saas solution designed for automatic planning of delivery routes. |
| **Alfakit** | Freight transport and logistics automation program. Crm-system (tms-system), which will simplify the accounting of transportation and automate all processes of the transport company. |
| **Automarshal** | The system monitors the number of vacant places on the territory of the complex and limits the entry of the tenant's / owner's cars if the capacity is exhausted. |
| **Projectile** | Domestic product, taking into account the peculiarities of the organization of transport logistics management. |
| **Autograph** | A software package for transport and personnel management. |

According to research by the McKinsey Global Institute, less than 16% of companies in the logistics sector use artificial intelligence technologies in one way or another for the year, and in the next 3 years the cost of introducing artificial intelligence systems in this sector of the economy is expected to increase by less than 2% [1].

As a justification, the conclusions of scientific articles, studies and works in the study of the impact of improving logistics on the efficiency of the enterprise as a whole are given [6].

Based on the analysis of “Growth of Profits in the Construction Enterprise by Improving Logistics Performance” by DHL Group DHL Russia, it was found that the logistics industry of most construction enterprises needs improvement and efficiency gains [7,8,10].

The introduction of logistics models improves not only production performance, but also the efficiency of the planning process itself. Recently, many companies have moved from traditional planning committees and network diagrams to computer-aided design of control systems and resource and capacity management. With regard to logistics information support, it is necessary to highlight the method of synchronous operational planning of technological processes, focusing on the introduction of links with supply chains, taking into account the limitations and characteristics of a particular production [2].

Thus, we can conclude that the practical use of informatization in logistics through the introduction of artificial intelligence systems confirms the desire of various companies, including construction companies, to switch to digital goods management systems. At a higher corporate level, the massive
The introduction of computer technology is accompanied by the use of local area networks and high-speed telecommunication systems. The emergence of new information technologies also means a new evolutionary stage in logistics. Namely in the logistics industry of largest construction organizations [9, 12-14].

To compile an information catalog that allows you to choose the most suitable one for the needs of a particular enterprise from a variety of programs on the market, a table of comparative characteristics and main parameters of programs using artificial intelligence technologies was compiled [11, 15].

**Table 3.** Table 3 List of programs using artificial intelligence systems in the direction of "logistics" which are included in the intelligent catalog.

| Main direction | Direction branch | Name          | Characteristic                                                                 | Time and cost                                      | Payback |
|----------------|------------------|---------------|--------------------------------------------------------------------------------|----------------------------------------------------|---------|
| Logistics      | Warehouses logistics (storage and warehouses) | Yarus wms      | YARUS WMS automated WMS warehouse management system based on 1C: Enterprise platform. | from 3 months, cost from 2 million rubles, depending on plug-in modules | 3 years |
|                |                  | Datalytica    | The model incorporates unique company data, business processes and needs. When new goods appear, old products are withdrawn from production, demand changes, self-learning of the forecasting model is automatically carried out. | from 2 months, cost from 3 million rubles, depending on plug-in modules | 4 years |
|                |                  | Lead wms      | Full-featured adaptable warehouse management system. Management of all processes in warehouses for storing raw materials and materials. Manual and automated acceptance from production. Integration with conveyor equipment. Production accounting points. Tracking raw materials to finished products. | from 1.5 - 2 months, cost from 2 to 2.5 million rubles, depending on the plug-in modules | 2 years |
| Transport      | Automarshal      | The system increases the speed of the checkpoint, allows centralized control of several checkpoints from one workplace and provides full control of the entry / exit of vehicles even in the absence of an operator. | from 2 months, cost from 1.5 to 2 million rubles, depending on plug-in modules | 3 years |
|                |                  | Projectile    | The first domestic product that takes into account the peculiarities of organizing transport and logistics management in the Russian Federation. | from 3 months, cost from 2 million rubles, depending on plug-in modules | 4 years |
To determine the set of factors that determine the choice of an artificial intelligence system from the catalog, neural networks were built, shown in Fig. 2-4.

![Figure 2](image_url)

**Figure 2.** Neural network for the output parameter "Payback period".
Figure 2 shows that the payback period depends on the specific program, the percentage of cost reduction and the cost of implementing the program. The share of the influence of a particular program is 3 times higher than the rest. A relationship was also found between the list of programs and the cost of implementation.

![Diagram showing the payback period and cost reduction relationships](image)

**Figure 3.** Neural network with the output parameters "Percentage of cost reduction" and "Payback period".

Figure 3 shows that the percentage of cost reduction and the payback period depend on the country of the program manufacturer, the cost of the demo version, the availability of technical support after implementation, the implementation period and the integration with the enterprise programs. There is a relationship between the percentage of cost savings and the payback period. The country of manufacture of the program is directly related to the integration of enterprise programs, which is very logical. Since, depending on the installed information system at the enterprise, a program is selected based on the country of the manufacturer. The impact of the implementation time and cost of the demo version on the percentage of cost reduction is obvious.
Figure 4. Neural network with the output parameters "Cost of implementation" and "Payback period".

Figure 4 shows that the cost of implementation and the payback period depend on the country of the program manufacturer, the cost of the demo version, the availability of technical support after implementation, the implementation period and on the integration with enterprise programs. There is a relationship between the cost of implementation and the payback period. The impact of the implementation time and the cost of the demo version on the cost of implementation is obvious.

Based on the analysis, it can be concluded that it is quite possible to create an information system in the form of an intelligent catalog, which, through a self-learning mechanism, can, based on a certain set of input data, select a ready-made solution, which is an information system using artificial intelligence technologies, for implementation at an enterprise with aim of improving the efficiency of logistics.

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