СЕКЦИЯ «АКТУАЛЬНЫЕ ВОПРОСЫ В ОБЛАСТИ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ И ЭЛЕКГРОННОЙ ЭКОНОМИКИ» (НА ИНОСТРАННЫХ ЯЗЫКАХ.

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1. USING INTERNET OF THINGS TO IMPROVE MANUFACTURING PROCESS

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Annotation. This article explores the benefits of introducing the Internet of Things into the production spheres, the IoT technologies and platforms used to optimize the manufacturing process, the barriers and perspectives for the implementation of the Internet of Things, in particular, in the Republic of Belarus.

Keywords. Internet of Things (IoT), IoT platforms, real-time data, artificial intelligence, sensors, cloud computing, analytics.

Manufacturing processes require various types of machinery and equipment, which generate large amounts of data. However, this data is often underutilised and results in inefficiencies in the manufacturing process. The Internet of Things (IoT) offers a solution to this problem by providing a platform to collect, analyse, and utilise this data to optimise the manufacturing process. This article explores the benefits and implementation of IoT in the manufacturing process, presents case studies demonstrating the advantages of IoT in the manufacturing industry.

The implementation of IoT in the manufacturing process can lead to various benefits, including cost savings, reduced downtime, and increased productivity. IoT can help reduce costs by optimising production processes, reducing waste, and improving inventory management. Furthermore, IoT can help reduce downtime by predicting and preventing equipment failures, ensuring timely maintenance and repairs. Increased productivity is another benefit of IoT, as it provides real-time data on production processes, enabling businesses to identify and rectify bottlenecks in the process. Table 1 outlines the main advantages of IoT adoption in production.

Table 1 - Benefits of IoT in the manufacturing process

Benefits	Description
Cost Savings	Optimises production processes, reduces waste, improves inventory management, and reduces operational costs.
Reduced Downtime	Predicts and prevents equipment failures, ensures timely maintenance and repairs, and minimises downtime.
Increased Productivity	Provides real-time data on production processes, identifies and rectifies bottlenecks, and improves overall efficiency.
Improved Quality Control	Monitors and controls the manufacturing process, detects defects, and improves product quality.
Enhanced Safety	Monitors and controls hazardous manufacturing processes, improves worker safety, and reduces the risk of accidents.

In manufacturing contexts, industrial Internet of Things is important for a number of reasons. One of the most important is IoT analytics. Manufacturers need data to understand what the status of their performance is and what is slowing them down. From there, they can make decisions to improve the efficiency of their business. This process can even be automated by combining IoT systems with artificial intelligence [1].

Several IoT technologies can be utilised to optimise the manufacturing process, such as sensors, cloud computing, and analytics. Sensors can be used to monitor equipment performance, collect data on production processes, and detect any abnormalities. Cloud computing can provide a platform for storing

and analysing data, allowing businesses to access real-time information on production processes. Analytics can be used to analyse the data collected from sensors and provide insights into the manufacturing process, enabling businesses to optimise production processes and improve product quality.

The implementation of IoT in the manufacturing process requires a comprehensive strategy that includes planning, integration, and testing.

There are many IoT platforms designed for use in manufacturing processes. Below there are examples of some of them:

- Siemens Mindsphere is a platform that allows to collect and analyse data from various sources to optimise production processes;
- IBM Watson IoT is a platform that allows to collect, analyse and manage data generated by IoT devices in production processes;
- Microsoft Azure IoT is a platform that provides tools for building and managing IoT applications in the manufacturing environment.

In figure 1 it is shown that IoT is widely used in different spheres:

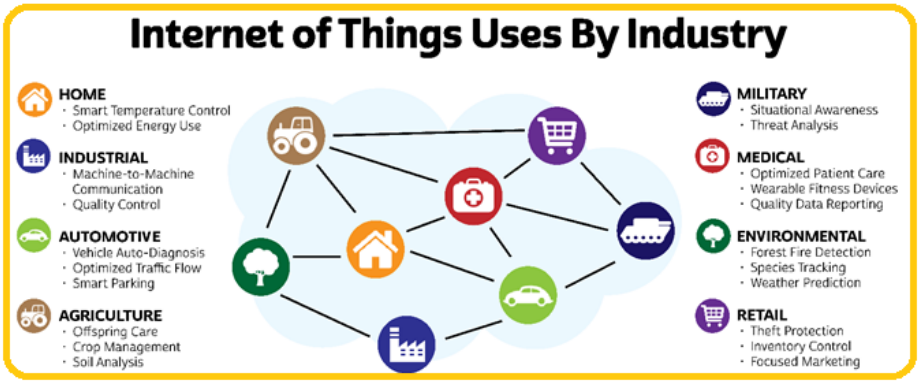

Figure 1 – Application of IoT in different spheres

Examining the demand for IoT by industry and implementation goals, it should be stated that the Boston Consulting Group estimated that roughly half of all IoT spending in 2020 was in just the following industries: discrete manufacturing, logistics, and transportation and utilities. In 2020 Gartner calculated the amount of equipment connected to the Internet of Things and got the following figures. Of the 5.81 billion end points, 3.16 billion are in three industries: utilities (1.36 billion), government (0.7 billion), and physical security systems (1.09 billion).

IoT Analytics is an IoT analytics company. It analysed s1600 IoT implementation projects and found that in half of the projects (54%) cost reduction was the main driver for implementation. A third of the projects (35%) was implemented to increase revenue and a quarter (24%) was implemented to improve safety.

Below in Table 2 there are samples of application of IoT in different branches of production.

Table 2 - Application of IoT in different production spheres

Branch	Sample of IoT application
Electronics manufacturing	Monitoring and analysis of production processes
Automobile manufacturing	Optimising Equipment Usage
Food industry	Quality control
Chemical production	Equipment condition monitoring

Below some samples of usage of IoT in different spheres are examined.

First there is an example from public utilities. One of the most common housing problems is a broken water pipe. The introduction of the Internet of Things helps to quickly detect leaks and notify the utility service. The IoT solution consists of modems with sensors and valves. When the sensors detect a leak, they report it to the utility server. It gives the command to close the valve on the stop valves and informs the dispatcher about the detected leak. The response time of the system is only 5 to 7 seconds. Without the introduction of IoT, utilities would have learned about the accident at best in a few minutes, at worst - after a few hours. The IoT reduces incident response time. At the same time, the cost of repairing the damage is reduced.

There is another example of a pharmaceutical factory. Transporting medicines is not an easy task. Many drugs must be stored at a certain temperature. For example, the Sputnik V vaccine can be shipped at 2-8°C or -18°C. Unexpected fluctuations in temperature conditions, vehicle breakdowns and errors during delivery and acceptance can lead to damage to medicines and losses. The Internet of Things provides supply chain transparency. To do this, each batch of goods is supplied with a Radio Frequency

Identification-tag (RFID-tag) or transponder, which is called a Smart Label. This helps to control the destination of each batch and avoid re-grading. The movement of the cargo is monitored using the car's GPS tracker, and additional sensors control the temperature and humidity conditions and report deviations from the specified parameters in real time. After the completion of the transportation, all information about the delivery is accumulated in the report and helps to identify weaknesses that need to be improved.

The Internet of Things is said to be a significant technological advancement that will gain continuous popularity with time. It allows manufacturing sectors to automate processes, cut down costs by automating specific tasks, and improve the service delivery to customers providing transparency into transactions that have been made via connected devices. All these specifics are achieved without losing any functionality [2]. Because of these exceptional IoT benefits, the popularity of the IoT stays in the headlines, and the revenue of the Internet of Things is also escalating. A report by Statista states that in 2021 the global worth of IoT was $213,1 billion, and it is forecasted that this revenue will reach $621,6 billion in early 2030. That is illustrated by Figure 2 below:

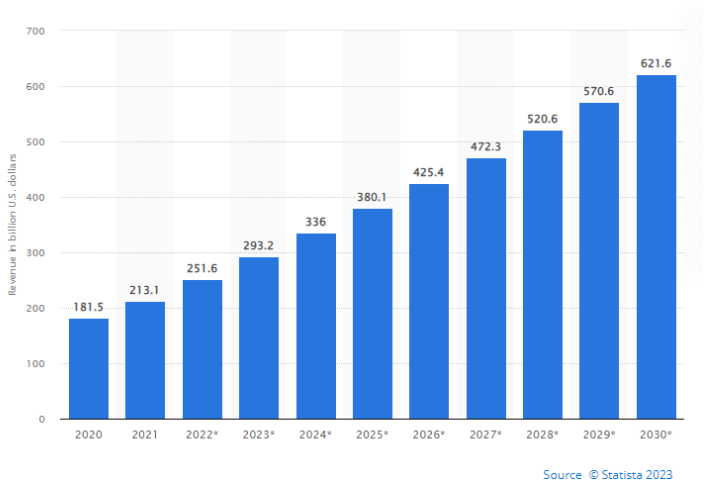

Figure 2 – Internet of Things (IoT) total annual revenue worldwide from 2020 to 2030 (in billion U.S.dollars) [3]

The global market of IoT for manufacturing is continuously expanding. This increasing popularity is made possible with the introduction of technological breakthroughs like smart sensors, virtual and augmented reality.

In a recent analysis of Allied Market Research on the subject of IoT for manufacturing [4], it is stated that the global market size of IoT for manufacturing is on track to reach a height of $483 billion by 2027 with a growth rate of 19%. This is shown in Figure 3.

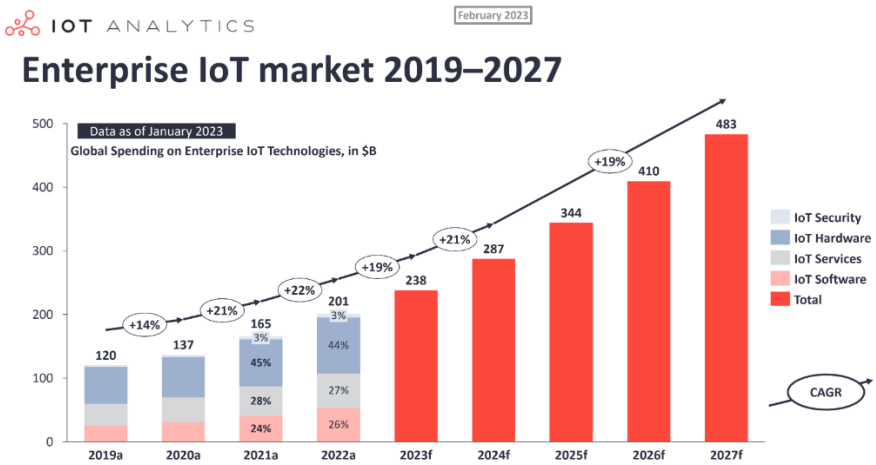

Figure 3 – Global spending on Enterprise IoT Technologies (in billion U.S.dollars) [5]

Despite existing benefits of IoT implementation into manufacturing, this process is connected with necessity of overcoming barriers. The structure of these challenges is presented in Figure 4.

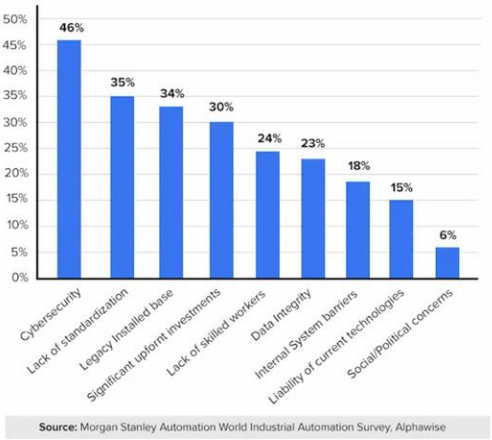

Figure 4 – Barriers to the implementation of the Internet of things into production process

Emily Maxie in her article [6] outlines three main IoT implementation challenges for manufacturing:

1. Security. In the event that an IoT pilot program is successful, manufacturers will almost certainly want to scale the solution to the rest of the company. Adding more complexity to an IoT solution in the form of additional devices and networks, however, also creates more challenges in terms of security.

2. Cost of Integration. Custom IoT work is almost always more of an initial investment than purchasing devices or software off the shelf. A third-party IoT development partner will charge for costs such as testing and custom features that aren't an option (or added expense) when opting for an off-the-shelf solution.

3. Lack of Standards. The lack of standards in IoT, especially for hardware, is a major challenge for implementation. Many embedded developers and designers have idiosyncratic ways of doing things, making the hardware industry highly fragmented. Tools and best practices common in software development, such as unit testing, are still largely absent from IoT hardware design.

At the end of the article the usage of IoT for increasing efficiency in production sphere in Belarus is considered. For spreading IoT in our country there are already enough things on the Belarusian market: IoT devices, communication networks and data centers, but there are not enough software products, aimed at solving business problems - ready-made services. There are sources of big data, means of collecting and storing big data, however, systems of analyses of these data are still not well developed. In the Belarusian production practice, the introduction of technologies Industry 4.0 is local.

Today in Belarus there is a successful experience of using Industrial Internet of Things enterprises. For example, JSC "BelAZ" equips its products with wear sensors, which allows, on the one hand, carry out timely maintenance of complex technical products, plan the purchase of spare parts and repairs, on the other hand, taking into account the information received on the operation of machines, make necessary changes to design solutions, thereby increasing product quality.

In the Republic of Belarus, MTC company is developing NB-IoT (Narrow Band Internet of Things) technologies, which allows remote data exchange in real time. NB-IoT is a mobile communication standard for data exchange between hardware and software systems, for example, metering devices for electricity and other resources, various "smart" sensors. NB-IoT allows to work in hard-to-reach places and does not require external power. The technology now covers the territory of the country, where more than 70% of the population lives. The principle of operation is to connect the various devices used by the enterprise at work into a single NB-IoT network, and then manage the devices remotely, collect, process and analyse information in real time.

NB-IoT has been widely used in gas supply. Digital sensors in gas control points collect the necessary information and transmit it to controllers that are equipped with SIM chips. Through the operator's secure NB-IoT network, information is sent to the control room. Thus, everything is automated, there is no need to make detours. Gas workers quickly receive information and can respond to emergencies. And this means that the solution also increases security. By the way, in case of loss (for example, theft), the complex will transmit information for another month, and it will be very easy to find it.

Summarizing the paper, it should be noticed that the use of IoT technologies in production processes can increase the efficiency and quality of production, improve equipment management and reduce production costs. Examples of the use of IoT technologies in various industries and platforms for their use show that this technology is already widely used and is promising for further development.

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