Experience in Implementation of Internet of Things Technologies in Management Practices: from Optimization to Innovation

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***Abstract**. This paper examines the experience of implementing Internet of Things (IoT) technologies in the field of management and examines their impact on optimization and innovative changes. Examples of successful IoT implementations are analyzed and specific cases of solving management problems using these technologies are provided. The paper reveals the technological landscape of IoT in management identifies changes in the management approach and considers the creation of adaptive and reactive management strategies. The difficulties of implementing IoT technologies in management practice are outlined and the ways of future research are indicated.*

***Keywords.** Internet of Things, Management, Innovation, Strategy.*

1 Introduction

In today's world, Internet of Things (IoT) technologies define new standards for effective management (Ashton, 2009) and development of enterprises. The implementation of IoT in management practices is becoming a necessity for enterprises that seek not only to optimize their activities (Brous et al., 2020), but also to achieve a higher level of innovation (El Khatib et al., 2023). The works consider important aspects of the experience of implementing IoT technologies in the field of management, exploring ways from optimizing routine processes to creating innovative strategies.

Noting the rapid and radical changes in the technology landscape, proposed paper examines how the use of sensors, communications and analytics enables enterprises to collect and analyze vast amounts of data in real time. Beyond traditional management, IoT adoption opens up new opportunities for automation, prediction, and integration, enabling adaptive and reactive management strategies.

The paper also examines practical examples of successful implementation of IoT technologies in large and medium-sized companies, demonstrating how these innovations can transform standard business processes and become a key factor for competitiveness. Thanks to a structured approach and analysis of important challenges, the article tries to identify the best practices of implementing IoT in management practices and determine the prospects for the development of this exciting and promising direction.

2 Technological Landscape of IoT in Management

The technological landscape of the IoT consists of three main components that interact to ensure efficiency and integration into management processes: sensors, communication and analytics (Figure 1).

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Sensors play a key role in collecting data from the environment. These small devices can measure various parameters such as temperature, humidity, pressure, movement and many others. Collection of this data in real time provides an opportunity to receive accurate and up-to-date information about the state of objects or processes being studied.

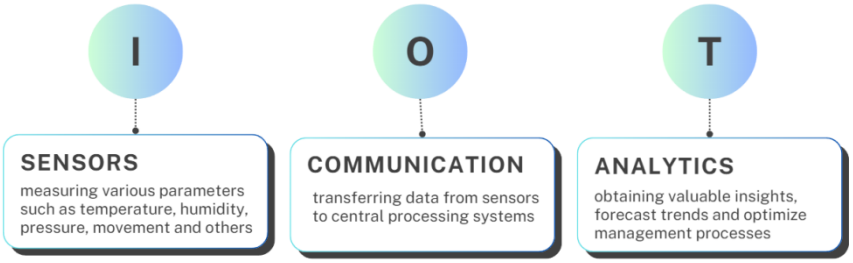

Figure 1. Internet of Things main components (Source: Authors' work)

Communication plays an important role in transferring data from sensors to central processing systems. Wireless communication technologies such as Wi-Fi, Bluetooth, NB-IoT, or LoRaWAN provide reliable and efficient information exchange between devices.

Analytics is the key stage of data processing. The application of various algorithms and machine learning tools allows you to use this data to obtain valuable insights, forecast trends and optimize management processes.

The emergence and spread of digital platforms have significantly changed traditional business models and interaction with consumers. (Aarne Viheriävaara, 2023) explores the key digital benefits that underpin the success of such platforms in today's economic environment. IoT technologies make it much easier to collect and analyze large amounts of data in real time. Instead of the traditional after-the-fact approach to data processing, IoT allows businesses to gain an instant view of the state of various aspects of their operations. In particular, manufacturing companies can use sensors on equipment to monitor its operation and predict possible breakdowns, allowing for maintenance before serious problems arise. In the field of logistics, the use of IoT allows for real-time monitoring of the movement of goods, optimization of routing and timely response to changes in the supply chain. Real-time data collection and analysis provided by IoT technologies is becoming a key competitive advantage for enterprises, allowing them to respond quickly to changes, improve business processes and ensure effective management.

3 Changes in the Management Approach due to the Introduction of IoT

The advantages of using IoT, shown in Figure 2, lead to changes in management approach (Dr. Bhagwati et al., 2021).

One of the key benefits of implementing IoT technologies into management practices is the ability to automate and optimize routine business processes. Sensors located in different parts of the enterprise provide a constant flow of data, which allows you to effectively monitor and control various aspects of the activity. In the field of production, the implementation of IoT allows you to automate the monitoring of equipment, identify moments of increased energy consumption or possible breakdowns, thereby reducing downtime and the risk of accidents (Soori et al., 2023). In the field of logistics, sensors on vehicles and cargo allow for real-time tracking of location and transportation conditions, which contributes to more efficient route planning and inventory management. Such automation not only saves time and resources, but also reduces the likelihood of human error, improving the quality of management decisions and increasing overall productivity.

The implementation of IoT expands the capabilities of managerial forecasting by providing access to more accurate and complete information. Analytics, based on real-time data, allows you to create more accurate and reliable forecasts regarding the development of events, demand for goods, or the

state of equipment. In the retail sector, sensors on shelves can automatically monitor stock levels and highlight the need for replenishment. This avoids losses from lost sales or overpaid inventory. In finance, IoT adoption can provide banks and financial institutions with accurate information about payment transactions, helping to detect fraud and optimize customer service. This increase in the accuracy of management forecasts allows managers to make more informed and strategic decisions, and increases their ability to adapt to changes in the business environment.

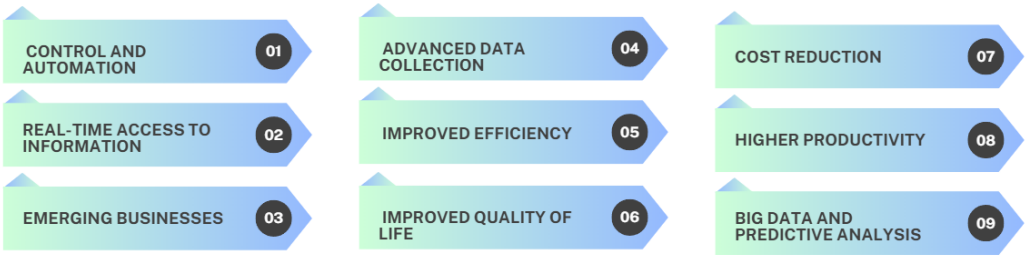

Figure 2. The most notable and apparent Internet of Things advantages (Source: Authors' work)

One of the important changes that the introduction of IoT technologies brings to management practices is the possibility of creating adaptive and reactive strategies. Data collected in real time allows companies to quickly respond to changes in the internal and external environment. For example, manufacturing companies can use data from sensors to instantly adjust production processes in response to changes in the work environment or market demand. In the service sector, the implementation of IoT allows to quickly adapt services to changing customer needs based on the collection and analysis of their consumer behavior. Also, real-time data allows enterprises to create reactive management strategies, because prompt receipt of information about events and trends allows effective response to challenges and opportunities. Real-time monitoring and data analysis systems can automatically detect anomalies or problems in work, notifying managers and employees of immediate measures to solve them. For example, in the energy industry, sensors can detect energy leaks or malfunctions in equipment, helping to prevent accidents and effectively manage resources.

However, for the successful implementation of IoT technology in the business model, it needs to be clearly defined (Sorri, 2023). Creating adaptive and reactive management strategies is a key aspect in the context of changes in the business environment. The integration of IoT technologies allows businesses to be flexible and quick to respond to changes, which is critical in today's environment of competition and uncertainty.

4. Practical Examples of Successful Implementation of IoT

Large corporations around the world have already shown great interest in implementing Internet of Things technologies to optimize production processes, increase productivity and improve competitiveness.

One example is General Electric (GE), which has implemented an IoT-based equipment monitoring system in its factories (Parris). Sensors located on the equipment send data about the state and operation of the machines in real time. This allows GE to detect problems and perform routine maintenance before major failures occur, reducing downtime and saving on repair costs.

Another example is IBM, which is implementing IoT-based smart building (Peterson at. al., 2018) and energy efficiency management systems. Sensors measure energy consumption, temperature and other parameters, which allow you to effectively manage air conditioning and lighting systems, as well as identify places where you can save energy.

Medium-sized enterprises are also showing an active interest in the implementation of Internet of Things technologies, finding effective solutions for their industry. For instance, farmers use IoT to optimize agricultural processes. A sensor system in the field measures soil moisture, temperature and

other parameters and sends the data to a cloud server. A farmer can remotely monitor and control irrigation, optimizing water use and increasing yields. Figure 3 shows the amount of investment in each application of IoT in agriculture, as per Statista (Vailshery, 2022):

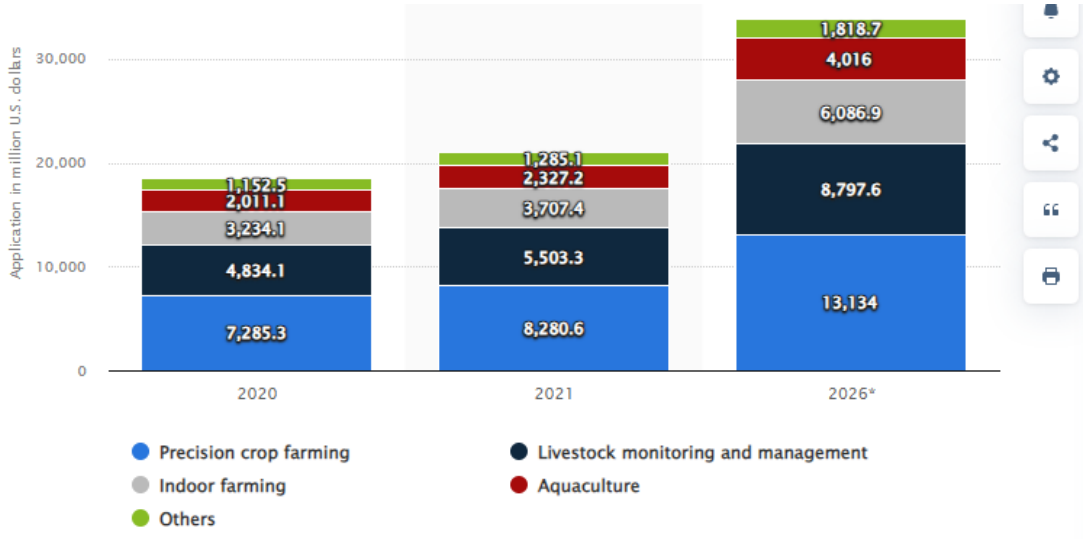

Figure 3. Application of IoT in agriculture (Source: Vailshery, 2022)

In the field of retail trade, the company Zippin implemented a cashless payment system based on IoT (Milam, 2023). Sensors and cameras in the store automatically track the products that the customer puts in the cart, and after leaving the store, the payment is automatically withdrawn from his account. This not only speeds up the shopping process, but also reduces queues and improves customer convenience.

The development of the Internet of Things has created new opportunities for platform businesses, and (Jung et al., 2021) examines the mechanics of platforms, bringing together the perspectives of IoT, platforms and ecosystems, using the example of three successful IoT platforms (Airbnb, Amazon and Google) to show that platforms are not only available to digital players, and highlights key success factors for IoT platform development and management.

The introduction of Internet of Things technologies has a significant impact on business processes and the competitiveness of companies. Reducing costs, increasing efficiency and being able to quickly respond to changes in the environment make these technologies a key factor for business success in today's world. Large and medium-sized companies, having successfully implemented IoT, observe increased productivity, improved service quality, as well as the opportunity to enter new markets and attract new customers. As a result, the competitiveness of enterprises increases, and their business processes become more flexible and adaptable to changes in the modern business environment.

5. Challenges of Implementation IoT Technologies into Management Practices

One result of the challenges associated with the implementation of IoT technologies is the provision of cyber security (Alazzawi et al., 2020). The increase in the number of connected devices creates new entry points for phishing attacks and cybercriminals. It is important to ensure security measures at every stage of implementation, starting from sensors and ending with data processing on servers. Companies must actively work to develop and implement modern cyber security measures, encryption and incident detection systems to protect data privacy and integrity. It is important for platforms to combine the digital and traditional worlds, while remaining reliable and secure for further growth strategy (Stange, 2022).

Another challenge is the integration of IoT technologies with the existing IT infrastructures of the enterprise. Many companies have various systems developed at different stages of business development. The implementation of IoT may require significant changes and adaptations in already existing technical solutions. Data integration, protocol standardization, and the development of specialized application programming interfaces (APIs) are key aspects of successful IoT integration with existing systems. Lack of consistency can lead to inconsistencies and system failures. The implementation of IoT is accompanied by a significant increase in the volume of collected and processed data. Managing these large volumes of information can cause problems related to their storage, processing and analysis. Effective scaling of data processing systems, use of cloud computing, and development of data analysis algorithms are key aspects of addressing this challenge.

One of the key challenges faced by enterprises when implementing IoT technologies into management practices is the high costs of the implementation process itself and staff training. The costs of acquiring and installing sensors, data collection and transmission equipment, and deploying the relevant infrastructures can be significant. In addition, investments in the development of adapted software solutions and ensuring cyber security are a necessary step in the implementation of IoT. Also large costs are associated with the need to update existing systems and integrate new technologies into the already existing business stack. It may require significant effort and financial resources to ensure the compatibility of new technologies with existing systems.

In response to these challenges, businesses must carefully plan their investments, ensuring a balance between costs and expected benefits. The relevance and popularity of such technologies as the Internet of Things lead to the study of new rules of platform ecosystem strategies (Hanelt et al., 2020).

6. Prospects for Development and Tasks for Future Research

In the context of the introduction of IoT technologies into management practices, broad prospects for development are opening up, but there are a number of tasks that should be taken into account for further research and improvement of this direction.

One of the key perspectives for future research is the development and improvement of methods for ensuring cyber security and data privacy in IoT systems. As a large volume of data is transmitted and processed in real time, this places increased demands on systems for protecting against cyber threats and ensuring the privacy of personal information. Research in the development of new encryption methods, authentication, and protection against attacks will provide greater security for IoT systems and make them more popular for widespread use in various industries.

Further research should be aimed at improving management and analytics systems in the context of using IoT data. The development of more efficient algorithms for processing large volumes of data, as well as the expansion of machine learning and artificial intelligence for analyzing and predicting the state of systems, will allow businesses to obtain more accurate and useful insights.

7. Conclusions

Consequently, the introduction of IoT technologies into management practices has a significant impact on increasing efficiency, optimizing business processes and increasing the competitiveness of enterprises. Automation, real-time data collection and analysis empower managers to make informed and strategic decisions. Also, it is important to consider the challenges that arise when implementing IoT technologies. In particular, the costs of implementing and training staff, ensuring cyber security and addressing data privacy issues are identified as major challenges that require attention and investment. Future research should address these challenges, as well as the development of new technologies that will ensure the sustainability and improvement of IoT systems

Therefore, Internet of Things technologies are already playing an important role in shaping modern business, and their influence on management practices will only grow in the future. Proper implementation and effective use of these technologies can be the key to the success of enterprises in a rapidly changing world.

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