5. THE ROLE OF THE INTERNET OF THINGS IN FORMING SMART MARKETS: ECONOMIC EFFECTS, MARKETING TRANSFORMATIONS AND TECHNOLOGICAL PROSPECTS

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Introduction. In the current conditions of digital transformation of the economy, a new generation of markets is being formed, characterized by a high level of automation, integration of information and communication technologies and the use of data as a key resource for development. One of the basic technologies that determines these processes is the Internet of Things (IoT), which ensures the interaction of physical objects through digital networks and creates the prerequisites for the formation of smart markets.

The smart market is a new form of organizing economic relations, based on the use of digital platforms, automated management systems and real-time data analytics. In such conditions, approaches to doing business, marketing activities and logistics are changing, which necessitates a comprehensive study of the impact of IoT on economic processes.

The relevance of the topic is due to the need for a comprehensive study of the economic effects of IoT implementation, its impact on marketing processes and the prospects for the development of smart markets in the context of global digitalization. An interdisciplinary approach that combines economic analysis, marketing tools and technological aspects of IoT functioning is especially important.

The purpose of the article is to study the impact of Internet of Things (IoT) technologies on the formation of smart markets, determine the economic effects of their implementation, transform marketing approaches, and assess development prospects in the context of digitalization of the economy..

Literature review. The issues of the development of the Internet of Things and its impact on the economy are actively studied in the works of foreign scientists.

In particular, in the study of L. Atzori, A. Iera, G. Morabito, the Internet of Things is defined as a global network of interconnected objects capable of autonomous data exchange [1]. The authors focus on the technological component of the IoT and its potential in creating intelligent environments.

An important contribution to the study of the impact of digital technologies on markets was made by M. Porter and J. Heppelmann, who proved that connected "smart" products transform competition, creating new sources of value and changing the structure of industries [2]. This position is key to understanding the formation of smart markets.

McKinsey Global Institute reports emphasize that the economic potential of the IoT lies in creating significant added value through process optimization, increasing productivity and developing new business models [3]. Similar conclusions are contained in studies where the IoT is considered one of the drivers of the digital economy [6].

In the works of O. Vermesan and P. Friess, IoT is presented as the basis for the formation of smart environments, including smart cities, smart production and smart logistics [4]. This confirms the cross-sectoral nature of the impact of this technology.

Domestic scientists are also actively researching the problems of digitalization of the economy [6]. Thus, the studies of Ukrainian authors S.M. Ilyashenko, V.L. Karpenko and A.M. Shysh focus on the role of digital marketing, Big Data and innovations in increasing the competitiveness of enterprises [7, 8]. The issues of defining the essence and developing methodological tools for the concept of the Internet of Things are covered in the works of a number of scientists [9, 10].

At the same time, the issue of integrating IoT into the formation of smart markets requires further comprehensive analysis.

Thus, the analysis of the literature indicates significant scientific interest in the issues of IoT, but the issues of its impact on the transformation of market mechanisms in the context of the formation of smart markets remain insufficiently studied.

Results. The development of modern society is closely related to the widespread use of digital technologies in everyday life. Digitalization involves the implementation of deep transformations in both existing and new sectors of the economy, as well as the renewal of various spheres of life by modernizing them and increasing their efficiency in accordance with modern requirements [11].

The key guidelines for digital development are: stimulating dynamic economic growth and activating investment processes; increasing the competitiveness and efficiency of the functioning of individual sectors of the economy; implementing technological and digital modernization of the industrial complex with the formation of high-tech industries; ensuring broad access of the population to the opportunities and advantages of the digital environment; unlocking the potential of human capital, as well as supporting the development of digital industries and entrepreneurship [11].

The development of the Internet of Things (IoT) in general should be considered as a powerful factor that accelerates the processes of digitalization of the economy, stimulates the introduction of innovations into everyday practice, and

contributes to the growth of the competitiveness of states. These trends are fully relevant for the development of Ukraine [12].

The Internet of Things (IoT) involves the integration of physical objects into single digital systems capable of performing various functions and tasks. Its main concept is to interconnect the maximum number of devices, connect them to the network in order to collect information and further use this data to make informed decisions [13].

The functioning of such an environment creates fundamentally new conditions for the development of business, health care and environmental safety, and also significantly changes both individual and social aspects of life.

The directions of application of IoT technologies show their wide application (Fig. 1) [13].

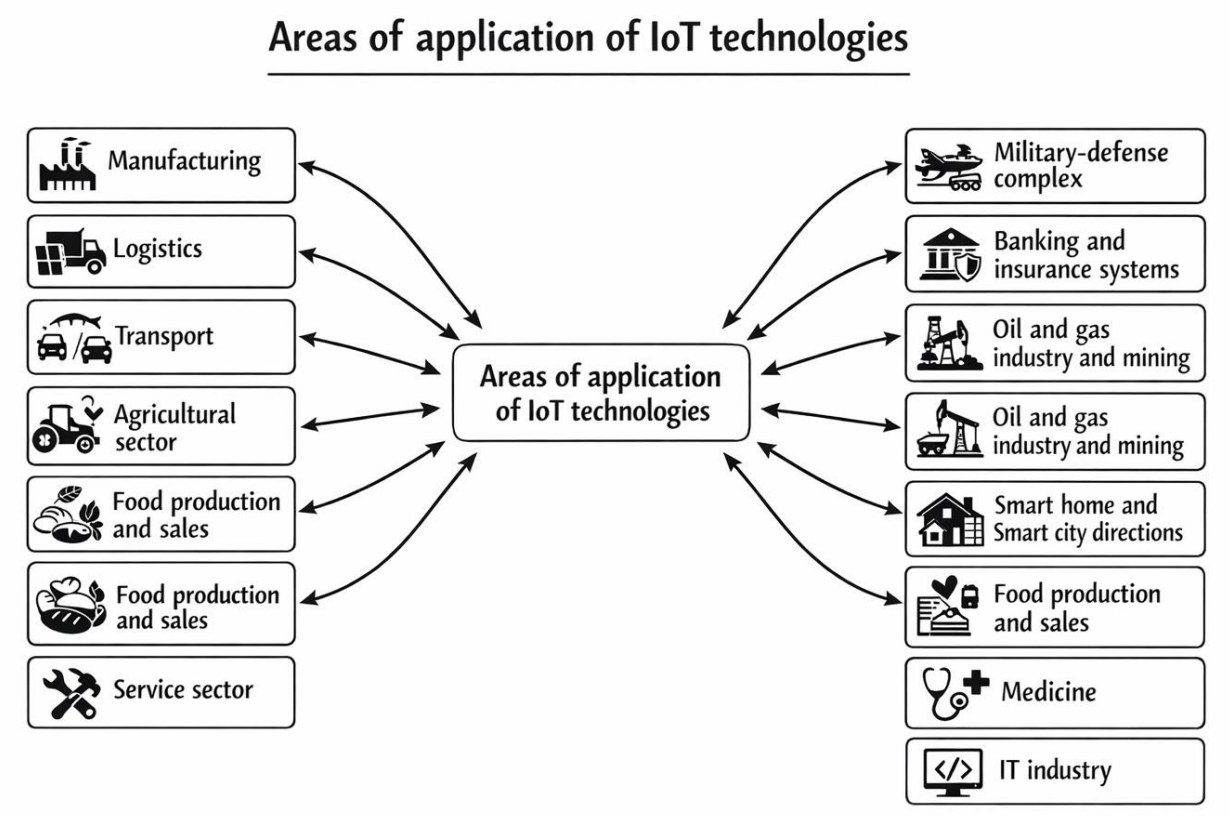

Figure 1. Areas of application of IoT technologies
Source: *author's development*

The benefits of using IoT in business are determined by the specifics of its implementation and the scope of the enterprise, but their essence boils down to expanding access to data. In particular, companies gain the opportunity to track information about their own products, internal processes, and the state of their systems in more detail [13].

The main advantages of implementing IoT:

1. The ability to receive complete data in a timely manner and predict the development of events.

2. Formation of a holistic view of production cycles and their management at all levels and stages.

3. Increasing the efficiency and accuracy of structuring existing information.

4. Increasing the competitiveness of the enterprise through cost optimization.

5. The ability to remotely monitor objects located at a considerable distance, which prevents serious accidents and production stops.

6. Analysis of customer data and conducting web intelligence. The experience of many companies shows that the real target audience of the product often differs from the ideas of sellers. By adjusting the characteristics of the product to real potential consumers, the effectiveness of marketing strategies can be significantly increased.

7. Ensuring the security of the company through remote video surveillance of processes in offices.

8. Automation of individual stages of ordering goods or services, which reduces manual data entry (full name, payment details, etc.) and helps in timely planning and reserving products in the warehouse.

The application of IoT in industry is particularly important. Networks of interconnected devices allow for the automation of production processes. Smart equipment and built-in sensors monitor the condition of machines, signal the need for repairs, and optimize work operations. This increases productivity, reduces energy consumption, and reduces the negative impact on the environment [14].

An important direction of IoT development is its use in household and urban infrastructure. Smart cities built on the basis of IoT make it possible to optimize energy consumption, organize efficient transport traffic, and automate various aspects of everyday life. Thanks to this, cities are transformed into interactive and adaptive systems capable of self-improvement.

Cloud technologies provide storage, processing, and analysis of large volumes of data without the need to maintain their own hardware infrastructure, which is a key factor in the development of smart economies. This opens up opportunities for companies from any corner of the world to use modern technologies without significant capital investments. One of the main advantages of cloud solutions is their scalability: businesses in a global economy can quickly increase or decrease computing power without the limitations associated with their own servers. This approach allows organizations to respond more quickly to changes in demand, adapt to new market conditions, and maintain competitiveness [14].

The Internet of Things is a key element of the digital infrastructure that ensures the transformation of traditional markets into smart markets. The main feature of such markets is the use of real-time data for making management decisions, which allows to increase the efficiency of economic systems.

Digitalization provides enterprises with the opportunity to significantly improve the efficiency of management processes, reduce operating costs and increase overall productivity. The use of digital tools, such as automated accounting systems, project management programs and artificial intelligence technologies, helps to reduce costs, improve the quality of customer service and adapt faster to market changes. Research [15] shows that the implementation of digital solutions also allows to

optimize production processes, increasing their efficiency and reducing the number of errors [16].

Digital solutions, such as supply chain management platforms, provide enterprises with the opportunity to optimize logistics processes, reduce inventory levels and shorten product delivery times. At the same time, they increase transparency at all stages of the supply chain, which helps prevent unforeseen disruptions and improve customer satisfaction [16].

Digitalization of management processes is a key factor in increasing the efficiency and competitiveness of enterprises in modern market conditions. The implementation of artificial intelligence technologies, cloud platforms and automation allows you to respond faster to changes, optimize internal processes and make more informed management decisions. At the same time, companies should take into account the high costs of implementing innovations and ensuring an adequate level of data protection [16].

Modern digital tools help enterprises improve management efficiency, optimize operational processes and ensure effective interaction between departments. Thanks to this, organizations can achieve higher results and strengthen their positions in the market [16].

The Internet of Things (IoT) provides the ability to collect and analyze data from a large number of devices in real time, which allows enterprises to control and optimize processes in production, logistics and the service sector [16].

The implementation of IoT provides a number of economic effects that can be systematized (Fig. 2).

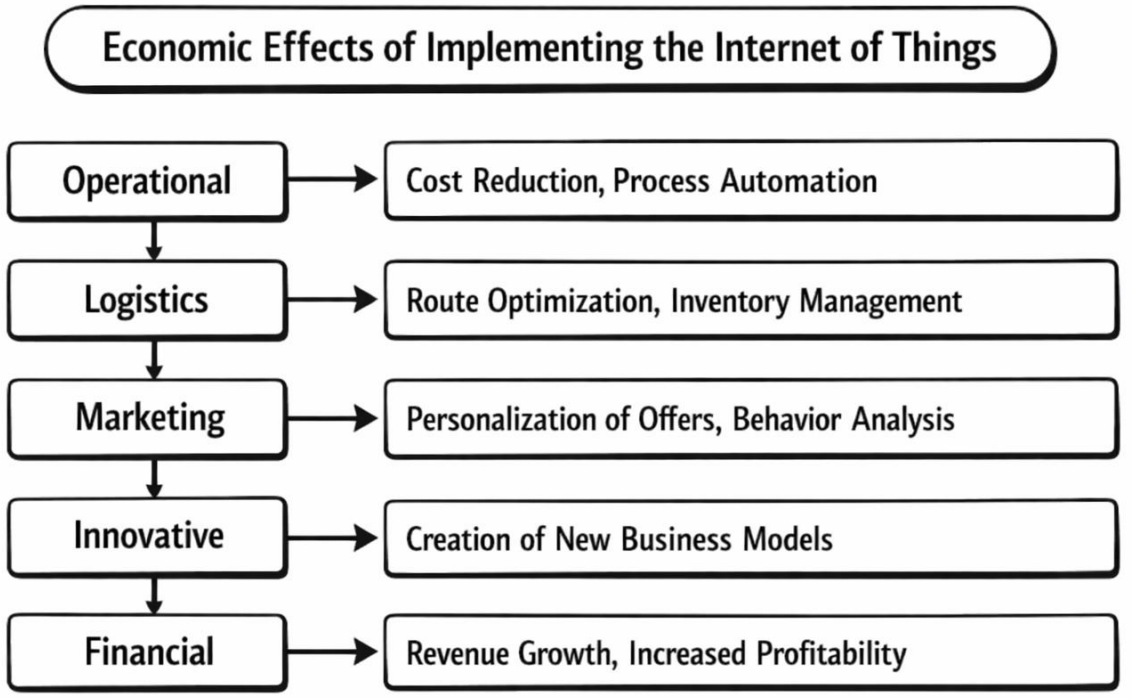

Figure 2. Economic effects of implementing the Internet of Things
Source: *author's development*

As McKinsey research indicates, the use of IoT can reduce enterprise costs by 10–30%, depending on the industry [3].

The main challenges of actively implementing the Internet of Things (IoT) in enterprise marketing activities include the following:

1. Developing the technological capabilities of devices to effectively solve key marketing tasks.

2. Integrating heterogeneous devices with the enterprise's internal information systems.

3. Ensuring the security and confidentiality of consumer data during its collection and transmission from devices.

4. Adhering to ethical standards when processing, using, and storing information obtained from IoT devices.

5. Improving the professional competence of marketers to work with Internet of Things technologies.

6. Implementing analytical systems into enterprise marketing processes, in particular those based on artificial intelligence technologies [9].

To effectively solve key marketing tasks at the enterprise level, it is necessary to implement a set of organizational measures that involves the formation of an ecosystem of the digital marketing space and the establishment of regulations for the collection, processing and use of data on consumer behavior. At the same time, the integration of Internet of Things technologies into digital marketing practices remains a relevant topic of scientific research. Particular attention is paid to the impact of these technologies on the theoretical and methodological foundations of marketing, the improvement of the categorical and conceptual apparatus and conceptual foundations of marketing science, as well as the transformation of professional functions and competencies of marketers. All this contributes to the development of scientific areas in the field of digital marketing related to the use of IoT [9].

The Internet of Things is significantly changing approaches to marketing activities. Thanks to real-time data collection, companies are able to:

- analyze consumer behavior;
- generate personalized offers;
- forecast demand;
- automate communications.

This contributes to the transition from mass marketing to individualized, which increases the efficiency of interaction with consumers.

The formation of smart markets is based on the integration of IoT with other technologies:

- Big Data - processing of large volumes of data;
- artificial intelligence - forecasting and automation;
- edge computing - data processing at the network periphery;
- 5G - ensuring rapid information exchange.

This integration creates conditions for the formation of digital ecosystems in which producers, consumers and intermediaries interact.

The formation of smart markets is the result of the complex integration of the Internet of Things (IoT) with other advanced digital technologies that provide real-time data collection, transmission, processing and use. Such synergy creates a fundamentally new technological basis for the functioning of markets, characterized by a high level of automation, adaptability and intellectualization of business processes [1, 15].

The key technological components of this process are Big Data, artificial intelligence, edge computing and next-generation communication networks (5G), each of which performs a specific function in the formation of smart market infrastructure.

Big Data technologies provide accumulation, storage and processing of large arrays of structured and unstructured data generated by IoT devices, digital platforms and users [3,5]. In the context of smart markets, Big Data plays the role of a key resource that allows:

- to carry out in-depth analysis of consumer behavior;
- to identify hidden patterns of demand;
- to forecast market trends;
- to optimize the assortment and pricing.

A feature of the use of Big Data is the ability to process data in a mode close to real time, which ensures the efficiency of management decisions. As a result, the market is moving from a reactive to a proactive model of functioning [3].

Artificial intelligence (AI) is a key element in transforming data into value. In combination with IoT and Big Data, it provides automation of analytical processes and the formation of intelligent management systems [2, 5].

Within smart markets, AI is used to:

- predict demand and consumer behavior;
- dynamic pricing;
- automate marketing communications;
- manage supply chains;
- detect anomalies and risks.

The use of AI contributes to the transition to self-learning systems that are able to adapt to changes in the market environment without direct human intervention [5].

Edge computing involves processing data directly at the device level or near the source of its generation, rather than in remote data centers. This is critical for smart markets because it:

- reduces data transmission delays;
- increases the response speed of systems;
- reduces the load on central servers;
- increases the level of data security [4].

In areas such as logistics or industry, the speed of information processing is a determining factor in the efficiency of market functioning.

The development of fifth-generation (5G) networks creates the necessary infrastructure for large-scale implementation of IoT [17]. The main advantages are:

- high data transfer speed;

– minimal delays;
– the ability to connect a large number of devices;
– stability of communication.

This ensures effective interaction between all elements of the smart market.

The synergy of IoT, Big Data, AI, edge computing and 5G creates the prerequisites for the formation of digital ecosystems within which producers, consumers and digital platforms interact [2, 17, 18].

In such ecosystems:

– all stages of value creation are integrated;
– the transparency of market processes increases;
– a new level of interaction is formed;
– digital platforms become key market coordinators.

This allows us to consider the smart market as a self-regulating system that operates on the basis of data and algorithms.

Modern researchers note that the implementation of IoT in marketing activities creates numerous opportunities, while at the same time generating certain risks and challenges. On the one hand, it stimulates the development of digital marketing practices, and on the other hand, it creates problems of a technological, organizational, personnel and ethical nature that require effective regulation and minimization of negative consequences [9].

Therefore, the practical application of IoT covers various industries (Fig. 3).

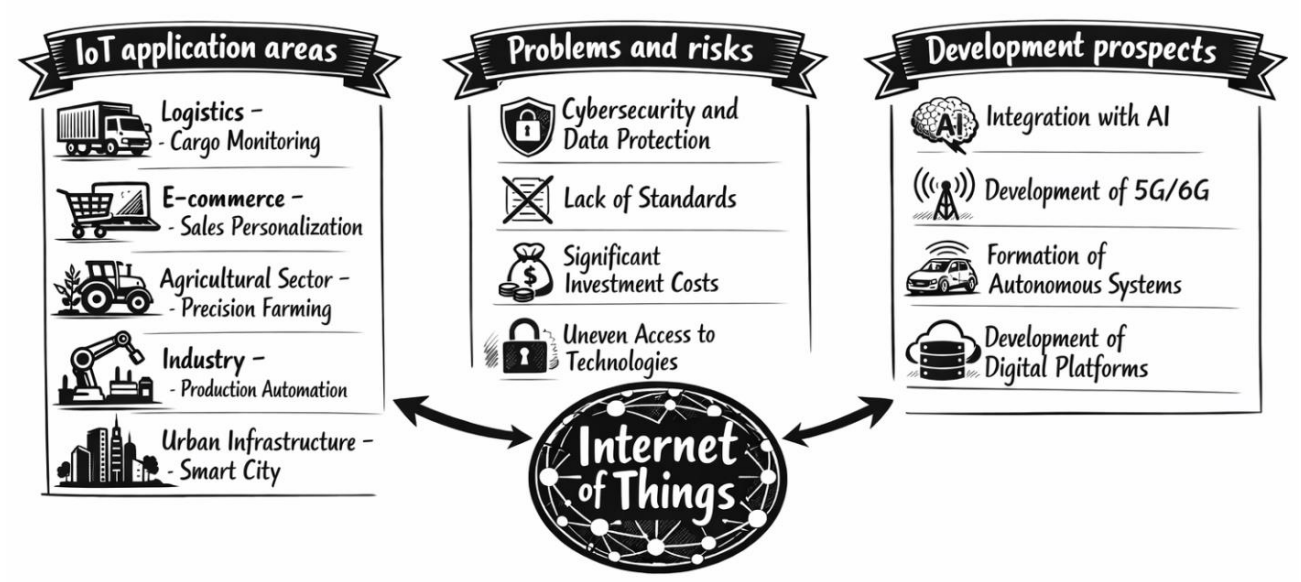

Figure 3. Practical application of IoT, problems and risks and development prospects

Source: *author's development*

Despite significant benefits, the development of IoT is accompanied by a number of challenges, and security issues are one of the key barriers to the

development of IoT [4]. Further development of IoT will contribute to the formation of fully integrated smart markets.

Conclusion. The Internet of Things is a key factor in the formation of smart markets and the transformation of economic relations. Its implementation ensures increased efficiency of enterprises, the development of new business models and improved interaction with consumers.

It has been established that the economic effects of IoT are manifested in reducing costs, increasing productivity and creating added value. Marketing transformations are associated with personalization and the use of data in real time.

At the same time, for the full development of smart markets, it is necessary to solve the problems of security, standardization and availability of technologies. Further research should be aimed at assessing the impact of IoT on macroeconomic processes and developing effective models for its implementation.

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