IoT & Digital Twins Concept Integration Effects on Supply Chain Strategy: Challenges and Effects

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Abstract- **IoT is set to revolutionize the supply chain—both in terms of its operational efficiencies and revenue opportunities—by making it transparent. This paper is devoted to the investigation of the challenges and effects of IoT and Digital Twins integration. The goal is to ensure the formation of a methodological basis for calculating the cumulative effect of the accelerated implementation of digital twins, which should become a source of reserved growth and increase the competitiveness of a modern industrial enterprise. Our study revealed that in the context of the modern digital transformation of industry, these concepts are mutually penetrating and complementary for two reasons: 1) Big Data being the basis of IoT implementation are not valuable in themselves, since they are characterized by the lack of systematization of huge data arrays presented in different metrics. Big Data gain value in solving specific business problems; 2) The digital transformation of industry determines the shift in the value of the assets of a company towards such a specific asset as Digital Twins. In this regard, IoT should be considered as one of the environments for creating the most valuable asset of companies in a digital economy - Digital Twins. From a methodological point of view, the integration of these concepts allows us to form several intermediate digital standardization forms within the continuum "standardization - technological breakthrough".**

Keywords- *Digitalization of Industry, Internet of Things, Supply Chain Management, Digital Shadow, Effects, Challenges.*

1. Introduction

The global supply chain management of the digital economy shows that the latest high technologies, such as the Internet of Things (IoT), Big Data Analysis, Artificial Intelligence, Robotics, Blockchain, significantly change the traditional business models of corporate, regional and country management. Technological innovations are challenges for the leadership of modern companies, which necessitates the development of a business management strategy taking into account the maximum use of social and economic benefits at the regional, national and global levels. Strategies for the digital transformation of companies, along with IT modules and platform solutions, should contain strategic tasks of network interaction between structures in the context of production sector digitalization. According to Deloitte estimates, the global market for hyped Digital Twins technologies using digital platforms will grow up to $ 16 billion by 2023, while the turnover of the Internet of things and machine learning market should double by 2020. Current supply chains will be reinvented as IoT-enabled systems allow unprecedented end-to-end visibility, remote tracking, and control [1]. According to the Internet of Things Association, the growth rate of the Internet of things will be 14-16% by 2024 [2]. In connection with the rapid pace of digital transformation of industrial production, it is advisable to study methodological issues that relate to the integration of the industrial Internet of things (IoT) and the development of Digital Twins. The purpose of this paper is to investigate the challenges and effects of integrating the IoT and the Digital Twins concepts. They consist of ensuring the formation of a methodological basis for calculating the cumulative effect of the accelerated implementation of digital twins. It is a source of reserved growth and competitiveness of a modern industrial enterprise.

2. Methods

In the present day, the supply chain is not just a way to keep track of your product, but also a way to gain an edge on your competitors by building your own brand. This paper is based on a systematic methodology for studying the digital transformation of modern industry based on the integration of the Internet of Things (IoT) and Digital Twins concepts. Using the smart-sourcing method to study successful IoT implementation cases allowed us to formulate challenges and describe the effects of the integrated development of the Internet of Things (IoT) and Digital Twins concepts in ensuring the growth in profitability of industrial corporations.

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3. Results

Effective development of various markets and industries in the digital economy is possible only if there are developed platforms, technologies, and trained personnel, institutional and infrastructural environments. It helps to improve the supply chain strategy and performance. The most important technological basis for the development of industrial digitalization is IoT. The information society development strategy in the Russian Federation for 2017-2030 approved by Decree of the President of the Russian Federation dated May 9, 2017 No. 203, has defined the "Internet of Things" as a concept of a computer network connecting things (physical objects) that are equipped with built-in information technologies for interaction with each other or with the external environment without human intervention (human-less interaction). In fact, IoT is a combination of inter-machine communication networks and big data storage / processing systems in which, by connecting sensors and actuators to the network, digitalization of various processes and objects is implemented. Using the data obtained allows optimising processes and objects based on new algorithms, and feedback from actuators allows this optimization to be implemented in practice without significant costs. The introduction of IoT allows costs to reduce and labour productivity to increase virtually in any industry through the digitalization of processes and facilities. The use of IoT in the production industry is more focused on Big Data analytics and is aimed at improving production efficiency, operational reliability and productivity throughout the supply chain [3, 4, 5]. To optimize industrial production, it is necessary to make timely decisions based on reliable information. This helps the use of IoT features such as machine learning, big data and automation technologies to create a "system inside a system". All these tools can accurately and consistently isolate, receive, analyse and transmit data to achieve greater efficiency, reliable management and improved quality control throughout any production chain. An example of the application of this approach to industrial production is the monitoring and maintenance of industrial equipment. The Industrial Internet is the main new technological mode of Industry 4.0 which is based on obtaining additional benefits from combining technological equipment and systems with information and communication systems. A large layer of tasks associated with industry relates to the logistics of materials, equipment and personnel. Organization of the effective movement of materials, equipment and personnel within a production process can significantly increase labour productivity and reduce costs by analysing the incoming data and controlling the full cycle of the production process. Typically, various narrow-band IoT wireless communication networks can be used for such applications. If a production process is localized within the territory of an enterprise, it is possible to deploy a private narrow-band wireless IoT communication network within the radio frequency bands used in a simplified manner. If it is necessary to arrange logistics and coordination of actions on the territory of a city or a constituent entity of the Russian Federation, it is necessary to use narrow-band IoT wireless communication networks with wide coverage and mobility in the radio frequency bands used in a general manner. An example of the industrial use of narrow-band IoT wireless networks in geographically dispersed infrastructures such as gas and oil pipelines is the control of dampers, temperature and pressure control, the detection of leaks, accumulations of gases and fires. The IoT concept represents a set of technologies for organizing the network interaction between industrial / production facilities connected to various applications, platforms, information and management systems at different levels. The goal is the mainly automatic collection, processing and transmission of information with the possibility of remote monitoring and control without human intervention, based on the scientific analysis of the received data (with the tools of Data Science, Big Data, Artificial Intelligence, machine/self-learning) in near real-time mode. IoT uses sensor readings for preventive equipment repair, development and testing of its modifications, online inventory and load monitoring of each production unit. For example, the use of vibration sensors in turbines of power plants and the collection of relevant big data allowed General Electric to save 35% for the maintenance of turbines around the world and introduce modifications to their design. Thus, the accumulation of data on the operation of the same type of equipment in various industries allows creating analytical models of equipment breakdown. The use of these models with the results of real-time monitoring of a specific equipment sample allows predicting a breakdown, as well as quickly determining its cause and eliminating it. In many cases, the features of the production process allow connecting equipment only over wireless channels using certain radio technologies [3-5]. The choice of radio technology substantially depends on the mode of collecting information. If it is necessary to receive data every second with a high guarantee of delay and quality, we must use communication networks based on Nb-IoT / LTE-eMTC or shift to high-speed cellular mobile networks (Order of the Ministry of Communications of Russia dated March 29, 2019 No. 113 “On approval of the Concept for the construction and development of narrow-band wireless networks of the Internet of Things in the Russian Federation” No. 113 dated March 29, 2019 - Access mode: https://digital.gov. ru / ru / documents / (appeal date: 08/05/2019).). If the transmission cycle and the amount of data are less critical, it is possible to use the full range of narrowband wireless IoT communication networks. We draw attention to the results of research by Russian scientists V.A. Krayushkin, I.E. Leshikhina and M.A. Pirogova, who rightly claim that the differences between IoT and the stack of machine-manufacturing technologies are insignificant, and we can talk about their convergence [6- 9]. The standards and methods for integrating industrial equipment, as well as the rules for building information infrastructure, differ from the IoT technology stack: the numerical growth of the “real” component in IoT relative to the “traditional” IT-stack of automated production is much higher and will continue to increase in the future. IoT will be distributed not only in all areas of application but also in all significant industries. Microsoft Corporation has published the results of studies on the effects of IoT implementation, which were obtained based on a survey of 3000 top managers and IT managers of leading corporations in the USA, Great Britain, Germany, France, China, and Japan. The IoT Signals report contains the following data [6]:

- 30% of company revenue in two years will come from IoT;
- 85% of respondents are ready to use IoT, of which three quarters plan to deploy IoT projects;
- 88% of companies that are willing to use IoT consider IoT to be critical to business success;
- The return on investment in two years will reach 30%, including due to cost savings and efficiency;
- Almost all IoT users (97%) have security problems, which do not interfere with the implementation of IoT.

It should be noted here that the IoT development is important not only from a technological but, above all, from organizational and managerial points of view. Analysts at McKinsey, E. Lamarre and B. May, in their recent study cite 10 trends in the transformation of modern business based on IoT [7]. Here are some of them that are basic for the development of industry: 1) IoT is a business opportunity, and not just a technical opportunity; 2) improving the efficiency of using IoT is determined by specific business tasks; 3) IoT is successfully used in heavy industry: in mechanical engineering, automotive and discrete manufacturing, power production, oil and gas and mining industries to optimize production and sales); 4) restriction of data access inhibits business development. Mckinsey experts consider two development scenarios are likely: companies will be open to exchange data with original equipment manufacturers (OEM); operators will monitor data to differentiate productivity (for example, mining trucks where operating conditions vary widely); 5) the level of costs determines the procedure for working with data. We are talking about economic feasibility calculations when choosing between a cloud solution and your infrastructure for storing data; 6) cybercrime will not stop the development of IoT, despite the growth of serious damage to companies as a result of attacks and hacks [7]. Consider the above-mentioned IoT development trends concerning the sources of growth in the profitability of industrial companies. According to American studies conducted on the basis of 146 companies using various business models, digitalization significantly affects the growth of company profitability [8]. According to the majority of McKinsey experts surveyed, such digital applications as remote monitoring, predictive maintenance and equipment efficiency most significantly affect the profitability of companies in the field of engineering and industrial automation (Fig.1).

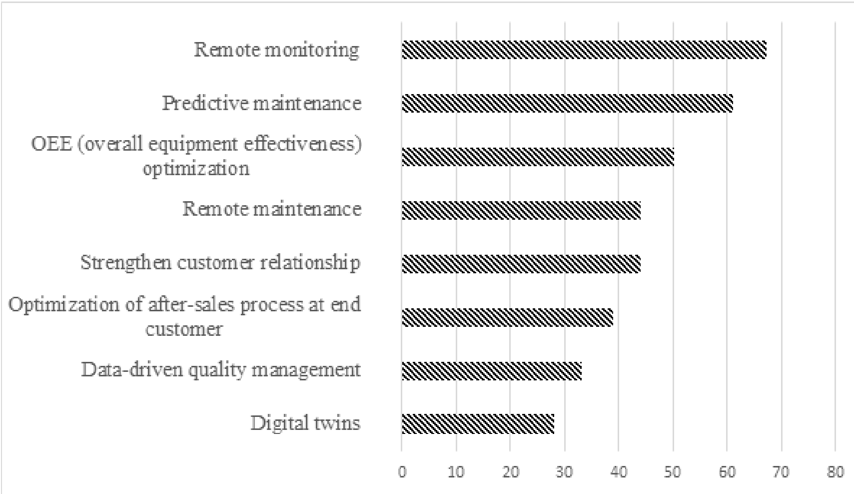

Figure1. The most important applications that impact on revenue of companies,%
Source: McKinsey Machinery & Industrial Automation survey [8]

Let us pay attention to the fact that in the presented McKinsey results, the least significant factor affecting the profitability of companies is Digital Twins (28%). At the same time, we are impressed by the approach of A. Auzan, who claims that digital twins are a source of guaranteed reserved development and growth of the company's competitiveness [10]. Taking into account the univariate approaches by the McKinsey analysts and A. Auzan regarding the prolonged effect of the digital twin action and their high level of riskiness, we note the importance of grounding the concept of Digital Twins on Big Data, which are the subject of IoT research (Fig.2).

Figure2. The spectrum of assets in the digital economy [10]

Big Data is a collection of huge data arrays unsystematized in different metrics that companies need to work with. However, Big Data alone is not of significant interest. They acquire value in solving specific business problems. If Digital Shadow reflects the dynamics of the present, then Digital Twins is the asset of the future for a modern company. In this regard, IoT should be considered as one of the environments for creating the most valuable asset of companies in the form of a digital company - Digital Twins. According to one of the leading experts in the implementation of digital twins C. Miskinis, the combination of IoT with Digital Twins will lead to the progressive development of a management system based on the optimization of business processes [12]. Using Digital Threads, IoT devices can be modelled using their platforms and the data necessary for designing digital twins [11]. Therefore, IoT development should not be linked solely to the service industry. The important role of IoT processes in the creation and management of digital twins [12]. The well-known Russian scientist-researcher A. Borovkov emphasizes that the Digital Twins is a driver technology, an integrator technology of basic "end-to-end" digital technologies and most subtechnologies, which development and application can make the most significant contribution to the creation of globally competitive new generation products in the shortest possible time [13]. Digital twins allow companies to create as soon as possible globally competitive products of the new generation [14]. However, for their development, along with new approaches and methods, world-class multi-disciplinary engineering competencies are required, one of which is a specialized CML-Digital platform. CML-Bench ™ is a system of activity management in the field of digital design, mathematical modelling and computer engineering (SPDM, Simulation Process and Data Management system) [15]. We highlight the following effects of integrating IoT and Digital Twins concepts in terms of ensuring profitability for companies:

- Digital Twins, as the company's most expensive specific asset, provides "guaranteed reserved development" [10] in the context of the digital transformation in the sphere of material production;
- Ensuring technological superiority in the global market of technologies and services;
- Creation of competent demand among industrial companies to identify sub-technologies;

- Reducing the number of various types of product tests (technical, rating, operational, etc.).

Along with the effects of the IoT and Digital Twins development, we highlight many serious challenges:

- Interoperability of data, lack of a single protocol for the development of approaches to digital solutions in the global market;
- Lack of a single digital platform and standard architectonics;
- A high level of technical complexity that impedes the deployment of IoT solutions;
- Landscape change for a business to enter the services market;
- Lack of highly qualified engineering personnel;
- A high level of risk and high cost of creating Digital Twins, as well as IoT projects. According to statistics, almost a third of IoT projects fail at the stage of concept verification, which is caused by the high cost of implementation and the uncertainty of benefits;
- The absence in Russia of a library of case studies of successful practices/business models of the cost-effective introducing IoT and Digital Twins into company activities;
- Development of standards and digital certification; standardization of data exchange processes.
- Calculation of the economic effect from digital solutions in the implementation of Digital Twins, etc.

4. Conclusions

The research identifies market drivers and restraints, offers strategic recommendations, and forecasts IoT revenues in the digital supply-chain management sector until 2024. The research also lists a variety of use-case scenarios across the various segments in supply-chain management. In the course of our study devoted to the prerequisites for the integration of the IoT and Digital Twins provisions and concepts, we revealed that in the context of the modern digital transformation of the industry, these concepts are mutually penetrating and complementary for two reasons: 1) Big Data, being at the heart of the IoT implementation, are not valuable in themselves, since they are characterized by unsystematization of huge data arrays presented in different metrics. Big Data gain value in solving specific business problems; 2) The digital transformation of industry determines the shift in value in the company assets towards such a specific asset as Digital Twins. In this regard, IoT should be considered as one of the environments for creating the most valuable company asset in a digital economy, Digital Twins.

Formulation and consideration of the effects and challenges due to the implementation of IoT and Digital Twins allow us to conclude that methodologically the integration of these concepts allows generating many intermediate forms of digital standardization in the "standardization - technological breakthrough" continuum. Indeed, in the conditions of fierce digital competition, a winner is not the one who more fully and faster complies with the standards, but the one who creates the Digital Twins faster. Standardization is extremely important, but standardization leads to a decrease in customization, which leads to the risk of losing the opportunity for a technological breakthrough.

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