Internet of Things (IoT) in logistics

Galina V. Ivankova¹, Ekaterina P. Mochalina¹ and Natalia L. Goncharova²*
¹Plekhanov Russian University of Economics, Moscow, Russian Federation
²Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russian Federation
*E-mail: bonata1@rambler.ru

Abstract. The fourth industrial revolution (Industry 4.0) provides completely new resources to qualitatively change the way businesses and supply chains operate. This paper discusses one of the new technologies known as the Internet of Things (IoT) which has, along with other technologies of the fourth industrial revolution, such as artificial intelligence, cloud computing, "Big data", a unique potential that can cause significant changes in the world. IoT allows businesses to use innovative services more quickly, with less risk. Russia goes behind European countries in the development of the logistics industry, which shows the necessity for innovative methods of management and control of delivery flows. Due the problems in the development of informatization of the logistics sector in Russia and the global trend of transition to a digital economy, the authors considered it relevant to study foreign experience. The Internet of Things guarantees a massive revolution in logistics over the next decade. This creates new business benefits by minimizing the price of device components, increasing the speed of wireless networks, and expanding the ability to receive data on the network. Work focuses on the implementation of IoT in logistics, real-world examples of the use among transport companies and perspectives for the development of new technology.

Keywords: digital economy, logistics, internet of things, innovations

1. Introduction

The digitalization process is a large-scale project that aims to create a new network-information society, managed by information and communication technologies that find, collect, process, and distribute information through global telecommunication networks. Nowadays we observe so-called ‘Fourth Industrial Revolution’ (Industry 4.0). The term was introduced in 2011 as part of the Hi-Tech strategy in Germany. Industry 4.0 is characterized by the development of data exchange and automation and includes the introduction of cyberphysical systems, the Internet of Things, cloud computing, the use of unmanned vehicles and 3D printing [1,2].

Considering the digital economy through the prism of production, it is possible to note the introduction of new materials, the transition to new technologies for the manufacture of goods, automation of production processes and applying of innovations in the field of logistics as the main development trends. The main difference between the modern economy and the digital one is the degree to which forecasting is used in the economic processes [3]. Prior to the implementation of technologies companies have assessed the effectiveness of production process by calculating the corresponding results in fact, that is, after production.
Now there is a growing tendency for competent production planning in order to reduce costs and to allocate existing resources by the most efficient way. Along with traditional logistics (post offices or courier delivery), delivery of drones, robots, and unmanned vehicles are developing [4]. All these became possible with the advent of the Internet of Things technology. (IoT) [5].

2. Methods
The IoT concept and term itself had been presented by Kevin Ashton - the founder of the Auto-ID research group at the Massachusetts Institute of Technology in 1999. IoT integrates surrounding objects into a single network. They exchange information with each other and work without human in real time (see Fig.1).

![Fig.1 IoT](image)

The Internet of Things has become a reality thanks to the integration of several technologies, including wireless communications, microelectronic systems and, of course, the Internet. It moves the world into a new level. Its influence affects all the spheres of human life, from the process of driving a car to the way of making purchases and even the receipt and accounting of electricity at home. Smart sensors and chips embedded into the physical things around us every day are exchanged continuously among themselves by thousands of gigabytes of data [6].

There is a well-developed infrastructure of mobile and fixed networks for a long time, which means the widespread adoption of IoT is taking on a real embodiment. The system is able to work both for the mass consumer and to serve businesses in general. Undoubtedly, the trend of using the Internet of Things with the use of sensors, applications and platforms will only increase over time, since financial injections into this technology are relatively insignificant.

One of the main difficulties on the way to the development of the Internet of Things is the lack of single standards. This circumstance makes difficult to integrate wireless networks and objects into a single network. An ideal technology designed to combine three main features:

- energy efficiency
- stability
- safety

is still under developing. Moreover, there is a risk of cyberattacks on IoT system’s data and it disrupts the confidence to innovation. Therefore, improving the security system for all the devices participating in the network is one of the main tasks of the IoT market. The Internet of Things technology finds its application not only in the home environment, such as smart home appliances and personal digital devices, but also in commercial sectors, agriculture, healthcare, real estate and security, and is also rapidly gaining popularity in such industries as logistics.

New technologies being introduced are distributed throughout the value chain in logistics, namely: warehouse operations, cargo transportation and final deliveries. Also, thanks to
innovations, production efficiency, customer service and safety are improved. The Internet of Things helps solve operational problems using the best possible variant.

The "physical" Internet can be used in the form of directly connected devices (sensors, robots), as well as in the form of an Internet conductor between devices. This connection is provided by wireless technologies for data transfer, such as Bluetooth, RFID and Wi-Fi, as well as mobile 3G (4G) and LTE networks, combining all the many devices into a single network [7,8].

The implementation of IoT in logistics gives a quick and effective result. It is possible to track the status of assets, packages and people in real time throughout the entire value chain using this technology. There is an opportunity to make business processes automated to eliminate manual labor, improve quality and predictability, as well as reduce operating costs. Moreover, the Internet of Things allows to optimize the joint work of people and devices connected to a computer network, as well as provides monitoring and moves the process in the right direction [9]. Finally, analysis can be applied to the entire value chain to identify broader opportunities for improving and applying best practices [7].

There is an opinion that IoT carries a potential risk for workers, since innovation reduces the labor resources. Nevertheless, it should be considered as a tool to ensure the smooth execution of operations and maximizing of profits. This innovative technology guarantees improvements in the following areas:

- optimization of the applied assets;
- reducing security issues such as counterfeiting and theft;
- accurate monitoring of resources and workflow;
- clear visibility in real time and timely response to events;
- analysis of the flow of real data for adequate and quick decision making;
- reducing manual data processing to increase accuracy and to reduce time spent;
- identification of new opportunities based on the study of consumer behavior patterns;
- improving the quality of work with clients.

The process of globalization leads to the fact that supply chains are becoming increasingly complex and on an ever-increasing scale. Accordingly, the management of such chains and the storage industry are also influenced by this trend. The pressure on logistics is growing and the Internet of Things is becoming an increasingly important component in solving the problems of transport companies. Today, its goal is to satisfy the needs of a rapidly developing global economy [10,11].

Inventory management and warehousing are one of the most important parts of the associated logistics ecosystem. Stationing small inexpensive sensors will allow companies to easily track inventory, monitor their condition and location, and create an intelligent warehouse system. IoT sensors can be used to track stocks and provide data that will help in trending to predict future stock needs. This will help to avoid situations with insufficient stock and excess stock. Thus, the implementation of IoT technology will successfully prevent any loss, ensure safe storage of goods, as well as quickly find the right product. Therefore, human errors are minimized.

For example, the world-famous giant Amazon has made significant progress in automating warehouse management. In 2012 (!), Amazon had acquired robots in order to transport goods from one warehouse point to another. The key moment is that robots are designed to work in tandem with human warehouse workers. The company’s efforts are obviously aimed at automating the warehouse to create a cheaper and more efficient supply chain [12].
The implementation of drones in the logistic chain has become one of the leading tasks today for such giant companies as Google, Amazon and DHL, which have designed their own UAVs and are already conducting tests. Another major trading company, Walmart, intends to use UAVs inside logistics centers: drones will move around the warehouse space, making up to 30 photos per second, and this information will be used, for example, in the case of an inventory. Thus, the implemented Internet of Things system will reduce the time spent by warehouse workers on the inventory process several times, as well as reduce the risk of the human factor (for example, shortage of goods) during the procedure.

3. Results and Discussion

What is the main reason for using drones in the logistic chain? Is it profitable from a financial and economic point of view, or is it a new way to attract consumers? Or is droning the best method of delivering cargo in the last mile (the way from the warehouse / store to the end consumer)? An answer to this question is possible only by weighing the pros and cons of using drones in logistics. In addition to some of the benefits, such as environmental friendliness, cost savings and flexibility in the supply chain, there are several issues that will be discussed below.

The first problem is vandalism. The drone can be stolen or damaged, which will cause the company to gain losses.

The second problem is nature: drones cannot withstand harsh environmental conditions. In Russia, one company took the Amazon example and began delivering pizza using drones. This method of delivery had to be stopped because the birds crashed into the drone and caused harm not only to animals, drone itself, but also to cargo also.

The third problem is related to the law. Both in the USA and in Russia, there are several restrictions provided by law, which limit the logistics processes using drones, which can significantly reduce costs. For example, in Moscow, within the internal MKAD border, flights of any aircraft, including unmanned ones (copters, drones, aircraft models and others), are prohibited by order of the Ministry of Transport of Russia No. 451 of December 17, 2018 [13].

There is also a privacy and security issue. This problem requires especially strong attention in densely populated areas and large cities [14].

Logistic problems are most pronounced in metapolicies and in each country, they are solved differently depending on socio-economic characteristics. They are associated not only with the storage of products in warehouses and their transportation, but also with the organization of traffic throughout the city. So, IoT also received a significant push in the organization of traffic due to the massive use of smartphones (which drivers take on the road). Thus, traffic monitoring systems were built on Yandex, Google and other maps. Currently, there are entire ecosystems of software solutions around mobile devices in cars (for example, Uber, Yandex Taxi, Get Taxi, etc.) [11].

A good example is a taxi. To stay on the market, industry representatives were forced to reconsider their tasks and include advanced technologies in the services provided. IoT connected all these processes (scheduling, communication, fast service and payment) in a centralized cloud network in real time. Scheduling guarantees the client timely pickup, regular updating of driver information, estimated time of arrival and travel management. All these factors create a positive impression and thereby improve the business climate. The implemented solutions have greatly influenced the taxi market in megapolesicies.

All the services above are not limited on the taxi industry, but applied to the entire logistics sector: like UberCargo and Trucker Path, startups GoCargo and iCanDrive (based on IoT) have appeared in Russia. The GoCargo service has created a convenient platform for connecting the shipper with the carrier and it is the IoT system that allows to create perfect pairs by taking into account volume, weight, temperature and other parameters. Processing up to 10 thousand orders a day, GoCargo demonstrates the successful implementation of the “physical” Internet in the field of transport.
IoT also found its application in tracking the technical condition of the car and driving manner in real time. Information about location, speed, direction and traffic violations becomes visible to the transport manager. Thus, control over fuel consumption, timely detection of machine malfunctions and reduction of emissions to increase the performance of “green”, that is, the environmentally friendly activities of the company.

The most equipped intelligent vehicle tracking systems were implemented thanks to the installation of remote vehicle tracking systems based on GLONASS / GPS sensors and fuel consumption monitoring systems. Using GPS systems and RFID sensors it possible to control the geolocation, temperature and other forms of data on specific elements. As a result, security will be enhanced, thefts will be minimized, and timely deliveries are guaranteed. Understanding the functioning of the logistic chain will be an integral part for further decision [7]. Thus, technology helps significantly reduce costs, control the operation of transport, analyze and optimize routes, which is extremely important for the logistics of enterprises of various sizes.

Note that IoT is used both for external transportation and within the organization itself: for example, Severstal monitors the mass and movement of goods, the paths and routes of forklifts at all its plants.

Many manufacturers of remote tracking devices have already appeared in Russia – Omnicom, AvtoGRAF, GALILEO, Fort, Naviset, Mercury, Shtrikh-Takhorus, Granit Navigator, M2M Cyber. There are also many programs on the market that allow to evaluate the received data and to optimize the operating costs [15,16,17] .

The development of Logistics 4.0 gives push to significant changes within companies. Automation, digitalization and networking will play an increasingly important role in the industry. The main forces in the development of logistics will be directed, first of all, to the transparency of logistics processes, data security and risk management, as well as to minimize costs and reduce the time for the provision of services by transport companies [18, 19].

Key Trends in Digital Transformation of Logistics:
1. The use of information and communication technologies in the field of logistics in order to reduce the cost of services provided and increase the efficiency of activities both from the point of view of the service provider and from the point of view of consumers.
2. The development of digital platforms in order to expand the boundaries of activities, as well as to increase the speed of cargo delivery.
3. The introduction of digital tools at all stages of the provision of services, including the use of unmanned drones, robotic equipment, etc.
4. Spreading the practice of joint use of warehouses and vehicles by various participants in the logistics services market in order to increase the efficiency of each of them and the market.

Under the pressure of new technology, the logistics market can change dramatically. Studies by PricewaterhouseCoopers show that in the next five years, more than 90% of the logisticians surveyed expect an increase in the importance of information and its processing [20, 21]. The analysis of large data sets opens truly unlimited possibilities in logistics. This will serve as push to modernize the effectiveness of providers and improve the level of service.

Providers are built into the value chain for customers and using new forecasting systems they can improve the efficiency of assets using and better plan delivery routes. Cloud technologies will also lead to the creation of platform solutions, and they, in turn, to new business models, such as virtual delivery. The innovations discussed above will also contribute to scalability and standardization of processes. For this reason, global logistics companies plan to invest about 5% of their turnover in the digitization of logistics.

4. Conclusions
All the reports of authoritative international organizations, analytical and consulting agencies and IT companies give the optimistic forecasts for the development of the Internet of Things in the world as a whole and in Russia in particular. The Internet of Things, which is
recognized by PwC as one of the most powerful technologies in the modern world (along with artificial intelligence), is just beginning to develop. Today, about 85% of devices that are potentially ready to connect to the Internet of Things, remain unconnected [4]. Based on the study, it is possible to conclude that the IoT technology in Russia is developing unevenly.

The potential of the IoT is huge and in logistic it is especially clear, but it is important to understand that this is a technology that requires not only serious investments, but also changes in the way of thinking: many Russian logistics companies develop the company by opening new branches and warehouses, but there is no any optimization of logistics flows!

So, after overcoming this obstacle the IoT guarantees a massive revolution in logistics over the next decade, as it creates new business benefits by minimizing the price of device components (sensors, actuators and semiconductor devices), increasing the speed of wireless networks, as well as expanding the ability to receive data.

References
[1.] Lukashevich, N., Svirina, A., Garanin, D. Multilevel prognosis of logistics chains in case of uncertainty: Information and statistical technologies implementation (2018) 4 (1), статья № 2, DOI: 10.1186/s40852-018-0081-8
[2.] [Electronic resource]: Extreme Automation and Connectivity: The Global, Regional, and Investment Implications of the Fourth Industrial Revolution // UBS White Paper for the World Economic Forum Annual Meeting. – 2016. – January.http://www.tadviser.ru/images/b/b7/Extreme_automation_and_connectivity_The_global%2C_regional%2C_and_investment_implications_of_the_Fourth_Industrial_Revolution.pdf (date of the application: 30.09.19)
[3.] [Electronic resource]: The problems of using unmanned aerial vehicles (drones) in logistics // Russian UAVs. 2018. https://russiandrone.ru/publications/problematika-ispolzovaniya-bespilotnykh-letatelnykh-apparatov-dronov-v-logistike/ (date of the application: 29.09.19)
[4.] [Electronic resource]: // URL: https://www.logistics.dhl/global-en/home/insights-and-innovation/thought-leadership/trend-reports/internet-of-things-in-logistics.html (date of the application: 28.09.2019)
[5.] Dimitrov I. D. The impact of the digital economy on the development of the transport industry in Russia // Transport of the Russian Federation. 2017. № 6 (73). С. 50–53.
[6.] Egorova N.E. Scenarios of the RTS Index dynamics during the after-crisis rehabilitation of the Russian stock market // Egorova N.E., Bakhtizin A.R., Torzhhevskiy K.A. // Economics and mathematical methods / Russian Academy of Sciences. Moscow, 2011. V. 47, No. 2, Pages 54-58.
[7.] Macaulay J., Buckalew L., Chung G. Internet of Things in logistics. // A collaborative report by DHL and Cisco on implications and use cases for the logistics industry. 2015. C. 1-29.
[8.] Demidenko, D.S., Malevkaia-Malevich, E.D., Dubolazova, Y.A., Victorova, N.G. Optimization of the innovation process management at a manufacturing enterprise (2018) pp. 996-1003.
[9.] [Electronic resource]: // URL: https://iot.ru/ (date of the application: 28.09.2019)
[10.] Goncharova, N.L., Bezdenezhnykh, T.I. Employing the elderly in the service sector in conditions of electronic and fourth innovation and technology revolution: Industry 4.0 Proceedings of the 31st International Business Information Management Association
Conference (2018) pp. 2330-2336.
[11.] Electronic resource: Where in Moscow you can launch quadrocopters and drones //https://www.mos.ru/otvet-transport/gde-v-moskve-mozhno-zapuskat-kvadrokoptery-i-drony/ (date of the application: 29.09.19)
[12.] Kalinina, O., Balchik, E., Barykin, S. Innovative management neural network modelling based on logistic theory (2018) 239, № 04021, DOI: 10.1051/matecconf/201823904021
[13.] Rudskoy, A.I., Borovkov, A.I., Romanov, P.I., Kolosova, O.V. Ways to reduce risks when building the digital economy in Russia. Educational aspect. Vysshee Obrazovanie v Rossii 2019, 27 (1), 151-162.
[14.] Trostinskaia, I.R., Safonova, A.S., Pokrovskiaia, N.N. Professionalization of education within the digital economy and communicative competencies. In Proceedings of the 2017 IEEE VI Forum Strategic Partnership of Universities and Enterprises of Hi-Tech Branches (Science. Education. Innovations) (SPUE); St. Petersburg; Russian Federation, 15 - 17 November 2017; Shaposhnikov S. (ed.); 2017; pp. 29–32.
[15.] Electronic resource: https://i40-self-assessment.pwc.de/i40/landing/ (date of the application: 28.09.19)
[16.] Andreas Schumacher, Selim Erol, Wilfried Sihn A Maturity Model for Assessing Industry 4.0 Readiness and Maturity of Manufacturing Enterprises, Procedia CIRP, Volume 52, 2016, Pages 161-166 Elsevier, 2016 https://doi.org/10.1016/j.procir.2016.07.040
[17.] Lane Thames, Dirk Schaefe, Software-defined Cloud Manufacturing for Industry 4.0, Procedia CIRP, Volume 52, 2016, Pages 12-17 Elsevier, 2016 https://doi.org/10.1016/j.procir.2016.07.041
[18.] Electronic resource: Fourth Industrial Revolution – Popular about the main technological trend of the 21st century. Tadviser. 2017 // URL: http://www.tadviser.ru/index.php/Статья:Четвертая_промышленная_революция_(Industry_Индустрия_4.0) (date of the application: 27.09.19)
[19.] Electronic resource: Evstaf’yev D. Chetvertaya promyshlennaya evolyuciya:propagandistskij mif ili «znak bedy»? [The Fourth Industrial Revolution:Propaganda Myth or «Sign of Trouble»]. Invest-Forsajt. Delovoy zhurnal, 2017, Oktober 12. (In Russ.). https://www.if24.ru/4-Promyshlennaya-revoluiya-mif/ (date of the application: 30.09.19).
[20.] Tipping A., Kauschke P. Shifting patterns. The future of the logistics industry. // PwC’s future in sight series. 2016. C. 1-20.
[21.] Electronic resource: Impact of the Fourth Industrial Revolution on Supply Chains. System Initiative on Shaping the Future of Production. World Economic Forum, Geneva, 2017. http://www3.weforum.org/docs/WEF_Impact_of_the_Fourth_Industrial_Revolution_on_Supply_Chains_.pdf (date of the application: 30.09.19)