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# Internet of Things as a Significant Factor of Innovations in an Intelligent Organization

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**Abstract.** The network of things communicating not only with people, but communicating with each other generate a vast number of data called Big Data. Internet of Things (IoT) will open huge data streams of real-time action and response. Artificial Intelligence (AI) will help companies tap archival as well as fresh data insights for real-time, rapid-response decisions. The author shows the evolution of Knowledge Management in the organization at the beginning. In the next part, the author presents SMAC, IoT and AI technologies as a background of an intelligent organization. All considerations lead to presentation of modern business models built on a synergy between AI and IoT.

**Keywords:** Knowledge Management, Intelligent Organization, Internet of Things, Artificial Intelligence, Digital Transformation, Business Model.

## 1 Introduction

The role of information and communication technologies (ICT) is huge. Increasing usage of mobile devices and social media, the development of technical solutions based on network services and the progressing digitization are shaping the new socio-economic landscape. Until now, IT solutions have been used mainly to increase the effectiveness of an organization's operations by reducing costs and improving processes. Digitization and computerization were treated functionally as separate elements of company operations. Modern solutions, i.e. the Internet of Things, cloud computing or Big Data, are treated as the main factors of change. They affect not only savings and improvements, but also new sources of income and ways of operating the organization. These horizontal changes caused by new technological solutions are called the digital transformation of the organization. Their effects include using new business models, searching for new sources of profits, innovations and ways of competing, improving the enterprise management process and applying new performance measures.

The author also notices changes in the Knowledge Management process in the organization as a result of technological progress what lead to evolution in this area of the enterprise. Data, information and knowledge are treated as elements determining the success of enterprises and, at the same time as factors that significantly affect the

creation of competitive advantage by increasing the attractiveness and competitiveness of the company. Modern enterprises wishing to achieve a certain position on the market need to adapt to dynamically changing environment. Traditional production factors: land, labor, capital, are losing importance for the key resource that knowledge is in the creative functioning.

The first section of this paper elaborates increasing role of Knowledge Management and the essence of intelligent organization concept. Next covers the idea of Internet of Things (IoT) – digital transformation and evolution of the Internet, main IoT perspectives and the reasons for the success of this technology as a technological background of modern organization. In the third part of the chapter the author presents the power of IoT and AI synergy and its benefits for KM process.

## **2 Growing role of Knowledge Management in Modern Organization**

### **2.1 Knowledge Management in Modern Enterprise**

Data, information and knowledge are treated as elements determining the success of enterprises and, at the same time, as factors that significantly affect on the competitive advantage by increasing the attractiveness and competitiveness of the company [1].

According to the theory of knowledge-based organizations, knowledge by itself does not create a competitive advantage, and it is achieved through its application and integration with the company's business processes [2]. The author also emphasizes that simply providing knowledge is not a sufficient condition for its application. In practice, a more serious problem is the lack of use of knowledge when a company or individuals have it. It is a common problem especially when we consider rapid technology evolution and emergence of new, unstructured kind knowledge e.g from delivered by Internet of Things.

Knowledge Management (KM) is, in part, an attempt of the best possible use of knowledge, which is available in organization, creation of new knowledge and growth of knowledge understands [3].

Knowledge as a resource needs to be managed in appropriate way what leads to KM development and dissemination of intelligent organization concept.

### **2.2 Intelligent Organization Concept**

Intelligent organization is assumed that it is an organization bases its philosophy on Knowledge Management. This term has become so popular due to the rapid development of ICT, dynamically changing economic environment and increased market competitiveness. We can consider organization as intelligent when it is a learning organization with the ability to create, acquire knowledge, organize, share it and use it to increase efficiency and competitiveness on the global market [4].

The organization is treated as a complex organism, based on existing structures and implemented processes with a particular definition of the role of knowledge. Thanks to the knowledge and appropriate tools, all organizational components and staff are able to skillfully cooperate in achieving specific goals. The organization functions as a well-performing body in a competitive environment [5].

The growing volume of information used in the intelligent organization goes hand in hand with the increase of its meaning and can be considered as a valuable resource for the organization. Main resources of knowledge are data about clients, products, processes, environment, etc. in a formalized form (documents, databases) and non-codified (knowledge of employees). Knowledge becomes treated as resource itself. Resource equals land, labor, money etc. As the author shows at the picture below, growing number of usable data, knowledge treated as a valuable resource for business and KM development determine engine of modern, intelligent organization.



**Fig. 1.** The idea of intelligent organization.

Dynamic changes in the environment force changes in KM strategy and philosophy. KM is no longer an extra work to do. It is helpful to do our work in a real time.

**Table 1.** Evolution and Development of Knowledge Management

KM 1.0	KM 2.0	KM 3.0
<b>Collecting</b>	<b>Sharing</b>	<b>Using</b>
techno-centric approach	people-centric approach	productivity-centric

		approach
<ul style="list-style-type: none"> <li>– traditional organizational content/community approaches</li> <li>– command and control “KM is an extra work”</li> <li>– Focused on collecting knowledge „before it walked at the door”</li> </ul>	<ul style="list-style-type: none"> <li>– enriched with social media and ecosystem wide co-creation “KM is part of my work”</li> <li>– social “KM is a part of my work”</li> <li>– Focused on sharing knowledge by using web-enabled and Social Media tools</li> </ul>	<ul style="list-style-type: none"> <li>– KM augmented with AI</li> <li>– practical &amp; individual „KM is helping my to do my work”</li> <li>– Focused on using existing knowledge to help people get their job done</li> </ul>

It would not be possible without the continuous development of ICT technologies. The author, in the next part of the paper, focuses on the important role of IoT technology in the evolution of KM.

### 3 Technological Background of Digital Transformation

#### 3.1 Digital Transformation

The Internet of Things is currently one of the most-discussed topics in the context of the impact of modern information technology on the management and functioning of an organization. According to many authors, no topic has ever been so popular in scientific and post-scientific works. This may be result of its wide application in business, management, marketing and applies to almost every industry [6].

Organizations are facing new challenges, but for most of them digital transformation is one of the foundations for maintaining its position and further market expansion.

Digital transformation means changing the approach to the client and a comprehensive process of transitioning the organization to new ways of functioning using the latest IoT and SMAC digital technologies (social, mobile, analytics, cloud). The table below presents main benefits of each of these solutions.

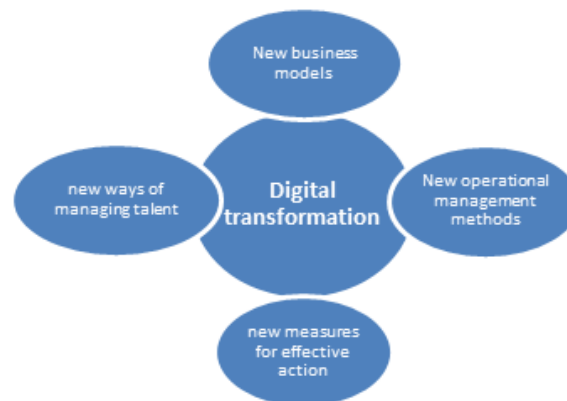
**Table 2.** SMAC foundations.

Social	<ul style="list-style-type: none"> <li>– Better interaction between business and clients.</li> <li>– Faster response to problem and building a knowledge base based on users preferences and behaviors.</li> <li>– Employees can share information faster and easier, which speeds up problem solving (collective intelligence).</li> </ul>
Mobile	<ul style="list-style-type: none"> <li>– Increase reach of companies to customers (multi-channel distribution)</li> <li>– Entrepreneurs must develop their internet marketing channels and</li> </ul>

	share mobile channels. – The offer for mobile devices is the basis to gain and maintain a high market position.
Analytics	– Understanding behavior and preferences of customers by using advanced algorithms and analytical tools (Big Data). – Making correct decisions based on current and aggregated information
Cloud	– Lowering ICT costs. – Breaking down geographical barriers. – Access to data anywhere, anytime.  The cloud combines all SMAC elements together.

The author points out that the key to success in the application of SMAC is the combination of the four technologies mentioned above, which by communicating with each other, allow for synergy. None of the four technologies are able to effect themselves. Only close cooperation allows and building a competitive advantage.

Digital transformation means horizontal changes caused by a new wave of technological solutions. The expression of these changes are, among others new business models, seeking new sources of profit, innovations and ways of competing, improving operational management of an enterprise, implementing new methods of talent management, and applying new measures of effectiveness. At the same time, the customer is being transformed and becomes a co-creator of values [7].



**Fig. 2.** Dimensions of digital transformation.

The digital transformation would not be possible without new technologies. The author wants to point out a few important solutions determining this process in the table below.

**Table 3.** Solutions determining digital transformation.

Sensor systems	Devices that capture signals from the surrounding environment. Cooperating within larger networks with smart devices and applications. The costs of using them decrease over time.
RFID/NFC/Beacons	Tags, labels, cards capable of exchanging data with readers, using radio-based communication. Solutions introducing a number of facilities for clients for the benefit of enterprises, e.g. tracking consumer activity, improvements in logistics.
Inter-machine communication	Automation of machine work allows to optimize the production process and reduce maintenance costs.
Robotics	Practical solutions used include by car manufacturers and in the logistics industry.
Virtual and augmented reality	Solutions based on AI/AR allow to eliminate or reduce significantly maintenance costs, costs of designing and modeling new solutions offered to consumers. Huge potential in the entertainment, marketing and healthcare industries.
Artificial Intelligence / cognitive data processing / machine and deep learning	Machine and deep learning (computers learn on the basis of an advanced neural network) make computers learning based on historical data become capable of carrying out new tasks with high accuracy.

All of mentioned technologies are parts of the IoT engine. In the next part of the chapter the author explains its phenomenon.

### 3.2 IoT as a Significant Factor of Digital Transformation

Defining the concept of the Internet of Things is a difficult task. It is still a new, constantly evolving technology that covers other new fields.

This concept was first used by Kevin Ashton (2009), pointing out that "The Internet of Things can arise after adding radio identification and other sensors to everyday objects" [8]. The concept of the Internet of Things can also be referred to the ideas of Nikola Tesla, who 100 years ago pointed out that when wireless technologies will be fully developed, the Earth will transform into one big brain, and the devices that create its innervation will be very easy compared to the current phone [9].

M. Porter and J. Heppelman define the Internet of Things, referring to the technological sphere, indicating that they are intelligent products with Internet access, which consist of:

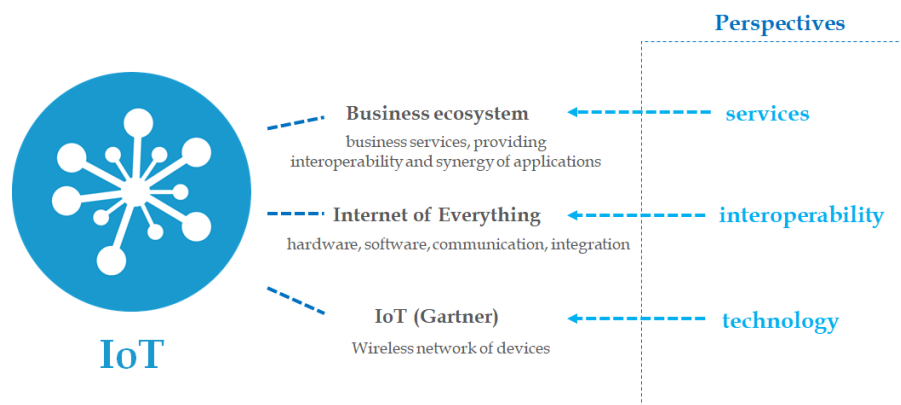


- physical, mechanical and electrical components,
- intelligent components - sensors, processors, data carriers, control mechanisms, software, operating systems,
- elements enabling communication, e.g. ports, antennas, data transmission protocols, communication systems.

A lot definitions, such as mentioned above, is strictly connected with technological aspects of functioning. The author notes that IoT can be considered in the other dimensions. IoT from different perspectives can be considered as [10]:

- business ecosystem,
- Internet of Everything,
- IoT (Gartner).

From a business perspective, IoT can be seen as a collection of services using objects that collect and process information (interactions), networked and ensure interoperability and synergy of applications.



**Fig. 3.** IoT dimensions.

Combining Internet of Things products / services allows a better understanding of the consumer, the environment, products and processes, identifying significant events and responding for immediate optimization or more accurate personalization.

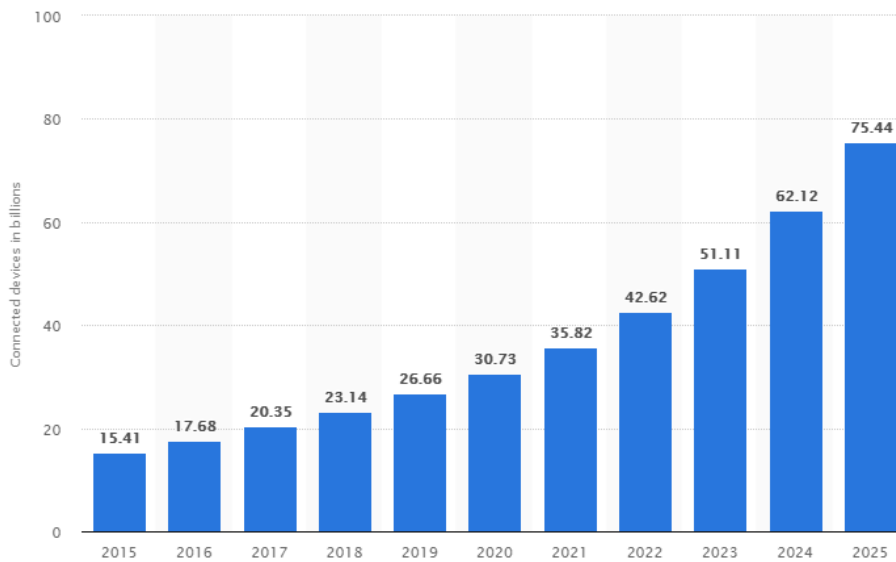
The architectural perspective (Internet as Everything) is a concept that enables the cooperation of various ICT systems that support various domain applications and is based on four layers:

- Equipment - sensors, actuators, controllers, smartphones, computers that are able to communicate and process data without human involvement or limited interaction with it.

- Communication - telecommunications infrastructure and telecommunication network, working on any data transmission standards (Internet)
- Software - IT systems for IoT devices and software for data exchange, processing, system management and security.
- Integration - sets of defined IT services ensuring software interoperability at all levels of architecture.

Gartner's definition has been presented in the paragraph above.

All perspectives show how huge potential is generated by IoT. Also the numbers confirm this fact. As it presented at the picture below, the number of devices that make up the Internet of Things is still growing.



**Fig. 4.** Internet of Things (IoT) connected devices installed base worldwide between 2015 and 2025. Source: <https://www.statista.com/statistics/471264/iot-number-of-connected-devices-worldwide/>, last accessed 2020/04/21.

Experts predict rapid growth on the IoT market. In the years 2015 to 2025, the number of devices connected to the Internet of Things is predicted to be almost five times higher. This is a huge potential for business due to the amount of generated data.

Three features distinguish IoT from other technologies. They are context, ubiquity and optimization. Objects provide data, e.g. in terms of physical condition, location, or weather conditions, by using M2M (machine to machine) interaction. The ubiquity is illustrated by the fact that today there are more such intelligent things than their users connected to the network. Optimization comes down to so-called expression of functionality, which brings every object based on built intelligence and resulting new synergistic properties. Therefore, the real value of IoT is not merely having data, but

combining business processes with deliveries, orders and production, or the work schedule being implemented [11].

## **4 Internet of Things and Artificial Intelligence – Opportunities for KM and Innovations in Business**

### **4.1 Why IoT needs AI**

Artificial Intelligence (AI) and the Internet of Things (IoT) are terms that project futuristic, sci-fi, imagery; both have been identified as drivers of business disruption. But in fact they are more real today than any time in the past. However in order for companies to realize the full potential of IoT, they need to combine IoT with rapidly-advancing Artificial Intelligence (AI) technologies, which enable ‘smart machines’ to simulate intelligent behavior and make well-informed decisions with little or no human intervention.

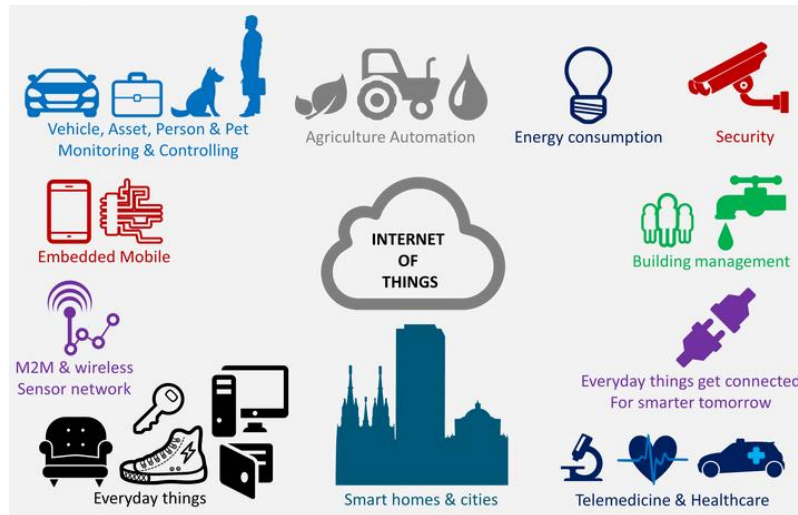
AI, on the other hand, is the engine or the “brain” that will enable analytics and decision making from the data collected by IoT. In other words, IoT collects the data and AI processes this data in order to make sense of it. You can see these systems working together at a personal level in devices like fitness trackers and Google Home, Amazon’s Alexa, and Apple’s Siri.

With more connected devices comes more data that has the potential to provide amazing insights for businesses but presents a new challenge for how to analyse it all. Collecting this data benefits no one unless there is a way to understand it all. This is where AI comes in. Making sense of huge amounts of data is a perfect application for pure AI.

By applying the analytic capabilities of AI to data collected by IoT, companies can identify and understand patterns and make more informed decisions. This leads to a variety of benefits for both consumers and companies such as proactive intervention, intelligent automation and highly personalised experiences. It also enables us to find ways for connected devices to work better together and make these systems easier to use.

This, in turn, leads to even higher adoption rates. That’s exactly why we need to improve the speed and accuracy of data analysis with AI in order to see IoT live up to its promise. Collecting data is one thing, but sorting, analyzing, and making sense of that data is a completely different thing. This is why essential to develop faster and more accurate AIs in order to keep up with the sheer volume of data being collected as IoT starts to penetrate almost all aspects of our lives [12].

Security, energy adoption, building management, smart homes and cities, telemedicine, embedded mobile, agriculture automation, vehicle, person & pet controlling and everyday things – these are only a few examples of IoT usage in everyday life.



**Fig. 5.** IoT in everyday life. Source: <https://www.supinfo.com/articles/single/4235-internet-of-things>, last accessed: 2019/06/06.

The author intentionally omitted aspects of running an organization. They will be presented in the next part.

#### 4.2 Business models – unlocking value from technology

As it was mentioned at the beginning of the chapter, rapid digital revolution forces organization to constant changes. Changes in their philosophy and way of doing business. New technologies allow to reach a wider group of customers through new channels (mobile devices), obtain from them data on their preferences, thanks to which the offered products are closely tailored to their needs.

A modern value chain should start with the customer. The customer is here the first link, the driving force that touches all links, needs and priorities [13]. Data on the new structure requires tools that will allow you to find out what customers need and understand the various sources of customer intelligence, so as to use those that will allow them to get closer to them [14].

New opportunities resulting from IoT solutions translate into business models that are the essence of innovation in these systems. The following solutions can be indicated here [15]:

**Table 4.** Business models determined by IoT

Model	Specification/Example
Anything as a service	Observed migration processes from the purchase of a product by the customer to one in which the producer infringes the ownership of it, while the consumer uses it, paying only for its real use.

	E.g.: AI as a service
New form of outsourcing (cloud computing)	Remote monitoring of real estate, airports or hotel chains.
Big Data Analytics	Forecasting consumer traffic based on geolocation data downloaded from smartphones.
Intelligent Products	Products that are a source of additional benefits for the customer, e.g. by remote monitoring and optimizing the use of construction machinery and equipment. Eg. Caterpillar machines and construction equipment equipped with sensors to track machines condition in real-time.
Behavioral profiling	In the scope of Progressive insurance company setting rates, based on analyzing the vehicle driver's driving style on the basis of mounted telemetric devices.
Additional services related to physical products	Rollce-Roys offers airlines a Power-by-Hour engine model. Users pay for the time of real use of the engine instead of incurring one-off costs associated with its purchase and additional costs associated with its servicing.
Hybrid solutions	Solutions that compromise between Product-as-a-Service models and traditional customer purchasing. Their sale can be combined with various service contracts based on remote monitoring of equipment functioning.
IoT platforms	Apple HomeKit systems that allow home devices from various manufacturers to be controlled via a smartphone application.

The business models presented in table above can translate into organizational changes. They may result primarily from the need for a new approach to data management aspects, creating new solutions related to the products and services offered, and a new approach to customer relationship management. This may mean the need to create new functional departments in organizations dealing with, for example, managing large amounts of data collected from the IoT (undifiend data organization) ecosystem and analyzing them [16].

An example of an innovative IoT business model due to the possibility of full insight into the way users use products is the Rolls-Royce sales model. This means offering products in the form of services, which translates into changes in the activities of sales and marketing departments.

## 5 Summary

The spread of the Internet of Things means that solutions in this field become the norm, an integral part of every product. Sensors, processors and their specialized software are integrated into their functionality and combined with advanced data analytics. This leads in a straight line to the creation of new and improved products (services), which allows a noticeable jump in economic efficiency.

Digital transformation significantly changes the approach to the basic macroeconomic principles of market mechanisms. ICT solutions based on SMAC systems are playing an increasingly important role. This allows making fundamental structural changes by combining new models with the decomposition of value sources into digital components that, when reconfigured, translate into the emergence of new variations of business models.

This leads to the need for constant changes in the organization. Such activities include the creation of new functional departments dealing with data management in an organization headed by a person located at the level of top management (Chief Data Officer). It may also be necessary to create an organizational unit that integrates cooperation between ICT, R&D and production departments. This means necessary changes in the organizational culture in terms of accepting decision-making based on business analytics (data-driven decision making), or sharing information. These are the essential elements of Knowledge Management in an intelligent organization.

The coming years will be marked by the growing importance of IoT-based solutions. The development of analytics is a key direction for IoT transformations, because it will increase the intelligence range of devices and systems. Machine learning processes will make it possible to reduce human involvement in problems that are not particularly complicated. The future of IoT involves creating better and better tools to support people and sometimes replace them during simple analyzes. Artificial Intelligence and prediction algorithms will allow you to eliminate downtime associated with failures, and intelligent products will be better adapted to the needs of consumers.

Each enterprise is a kind of combination of resources and / or possibilities of acquiring them, skills, information and knowledge, determining a specific level of competence in the desired market position.

In the past, the strategy was to achieve lasting competitive advantage. The idea was to find something that could be done better than other companies in the industry. In the current, changing environment, companies need a more adaptive approach, so they can constantly improve strategy and goals. Instead of achieving excellence in one, enterprises are deepening their competences in new and diversified areas, focusing on the customer.

To make it possible organizations need to launch new business approaches strictly connected with innovative Knowledge Management based on IoT & AI solutions.

## References

1. Jashapara A.: Knowledge Management. An Integrated Approach. Pearson Education Limited, London (2004).
2. Kowalczyk A., Nogalski B.: Zarządzanie wiedzą. Koncepcje i narzędzia. Difin, Warszawa (2007).
3. Przysucha L.: Knowledge management in corporations—synergy between people and technology. Barriers and benefits of implementation. In: Artificial Intelligence for Knowledge Management, pp. 1-11. Springer Cham, Melbourne (2017).
4. Domagała P.: Internet of Things and Big Data technologies as an opportunity for organizations based on Knowledge Management. In: Proceedings of 2019 IEEE 10th International Conference on Mechanical and Intelligent Manufacturing Technologies (ICMIMT 2019), pp. 199-203. IEEE Press, Cape Town (2019).
5. Senge P.M.: The Fifth Discipline. The Art and Practice of the Learning Organisation. Random House Business Books, London (2006).
6. Atzori L., Iera A., Morabito G.: Understanding the Internet of Things: definition, potentials and societal role of a fast evolving paradigm. Ad Hoc Networks (56), 4 (2017).
7. Mazurek G., Tkaczyk J.: The impact of the Digital World on Management and Marketing. Poltex, Warszawa (2016).
8. Ashton K.: That “Internet of Things” thing. RFID Journal 22(7), 97-114 (2009).
9. Tesla A.: Teleautomation, USA (1926).
10. Digital Poland Homepage, <https://www.digitalpoland.org/assets/publications/iot-w-polskiej-gospodarce/iot-w-polskiej-gospodarce-raport.pdf>, last accessed: 2019/06/06.
11. Gajewski J., Paprocki W., Pieriegud J.: Cyfryzacja polskiej gospodarki I społeczeństwa – szanse I wyzwania dla sektorów infrastrukturalnych. Instytut Badań nad Gospodarką Rynkową, Gdańsk (2016).
12. BBVA OpenMind Homepage, <https://www.bbvaopenmind.com/en/technology/digital-world/why-iot-needs-ai/>, last accessed: 2019/06/06.
13. Janasz W., Kozioł-Nadolna K.: Innowacje w organizacji. PWE, Warszawa (2011).
14. Customer Intelligence: What It Is and Why It’s Important, <https://www.cmnty.com/blog/customer-intelligence/>, last accessed: 2019/06/06.
15. Heppelman J., Porter M.: How Smart, Connected products are Transforming Companies. Harvard Business Review (October 2015), 96-106 (2015).
16. Kaczorowska-Spychalska D., Sułkowski Ł., Internet of Things. Nowy Paradygmat Rynku., pp. 66-77, Difin, Warszawa (2018).