



The implementation of the IoT concept in the post-industrial economy

La aplicación del concepto de IO en la economía postindustrial

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ABSTRACT:

The Internet has been a daily reality for more than a quarter of the world's population for some decades. The purpose of our research is to study the IoT (Internet of Things) acceptance model, its impact on the economy and human capital. Our research is a conceptual framework that links ease of use and utility with social influence and other factors such as cost, trust, IoT knowledge, as well as security and confidentiality of services.

Keywords: Internet of things, information, services, security, UTAUT, IoT.

RESUMEN:

Internet ha sido una realidad cotidiana para más de la cuarta parte de la población mundial durante algunas décadas. El propósito de nuestra investigación es estudiar el modelo de aceptación de la IO, su impacto en la economía y el capital humano. Nuestra investigación es un marco conceptual que vincula la facilidad de uso y la utilidad con la influencia social y otros factores como el coste, la confianza, el conocimiento de la IO, así como la seguridad y la confidencialidad de los servicios.

Palabras clave: Internet de las cosas, información, servicios, seguridad, UTAUT, IOT.

1. Introduction

The Internet of Things is a new concept. It was first mentioned by Ashton in 1999 (Manyika & Roxburgh, 2011). The Internet of Things is defined as a network of physical objects with embedded sensors, mechanisms and devices which can collect or transmit information about the object (Uhl-Bien et al., 2007). It consists of three levels, which include hardware, infrastructure, and the level of application and maintenance (Cui, 2016).

As it has already been mentioned, previous studies (Islam et al., 2015; Yu & Xue, 2016) were mainly focused on technical issues of the Internet of things: architectural elements and attribute-based signature, wireless sensor network. However, less attention was paid to IoT users and their perception of technology. In addition, in previous studies, the Technology Acceptance Model (TAM) was used in order to assess the perception of users (Chan, 2015). Nevertheless, the Unified Theory of the Acceptance and Use of Technologies (UTAUT) turned out to be more informative to explain the difference in the acceptance of technologies better than any other theoretical models (Murray et al., 2016).

The literature review showed that there are more studies devoted to the technical issues of the IoT than to behavioral aspects and the acceptance of the Internet of Things by people. Several studies examined the acceptance of the IoT by consumers (Acquity Group, 2014; Murray et al., 2016). The purpose of our research is to study the IoT, as well as to draw conclusions on the implementation of the IoT and the acceptance of its services by consumers in a post-industrial economy.

Cisco defined the IoT as intelligent links to the Internet, which enables exchange of available data and provides information about users in a secure way (Acquity Group, 2014; Cisco, 2015).

Other definitions were focused on the IoT functionality and were expanded by the interested parties to involve government, companies, individuals, and society.

We agree with (Ajzen, 1991), who defines the IoT as a mechanism for automating consumer devices. The IoT describes objects that can exchange information through the Internet.

Such technologies as home automation, mobile payment, warehouse and production management are used in many cities of the world. Health care and private domains also use the IoT technology (Alharbi, 2014). It provides efficiency in many industries and brings significant benefits to consumers. For example, users can benefit from the IoT technology used in smart refrigerators that autonomously control the consumption of food and beverages and can send an order to a food supplier. These are also smart sensors in the fields monitoring soil moisture and soil saturation with useful elements; drones with cameras that make it possible to track an object or process of interest remotely; sensors in public transport and unified systems for monitoring city life, etc. In this context, the IoT technology influences consumer behavior in several aspects of their daily lives.

The Internet of things solves global problems through optimizing human everyday needs. Tracking of sudden health deterioration by mobile emergency units, which is actively implemented with the help of the IoT, reduces the number of deaths from failure to provide timely medical treatment. The IoT provides doctors with the access to their patient's health condition with a time lag of less than 5 ms. This allows doctors to monitor patient's condition during the exacerbation of chronic diseases and quickly respond to health crises. It also minimizes the need for a patient to stay in hospital, which increases the time seriously ill people can spend with family. Thus, the IoT has penetrated in the lives of people and contributes to the solution of global problems.

The researchers determined that security and confidentiality are the main problems for consumers to adopt IoT technologies. People are worried that technologies will enslave them or will be used against them (Akturan & Tezcan, 2012).

The authors (Alharbi, 2014; Alghamdi & Beloff, 2014) study the IoT architecture and describe the best practical results of previous studies aimed at the development and use of IoT technologies from the perspective of an organization or industry. However, little attention is paid to the acceptance of the Internet of things by consumers. In addition, the impact of social context, technological and individual characteristics of the Internet things when adopted by the consumer has not been sufficiently addressed in existing studies. Many researchers (Berdykhanova et al., 2010; Alolayan, 2014; Chang et al., 2015) tried to determine factors influencing customer acceptance of the IoT. For example, (Alolayan, 2014) investigated the factors influencing the acceptance of the IoT in China. In their research, they used the TAM model factors, such as ease of use and utility, trust, social influence, perceived pleasure and perceived behavior. The results showed that perceived utility, ease of use, social influence, enjoyment and control are important.

The problems associated with the acceptance of IoT by customers are considered in (Berdykhanova et al., 2010). Two thousand customers were interviewed in the USA. The results showed that technology awareness, utility, cost, security and confidentiality are the main customer requirements. Since the concept of the IoT is still being developed, researchers tried to carry out qualitative research to identify factors that have an impact on the intention to use the new technology.

The studies conducted in Spain, USA, and Germany showed that consumers find usefulness, ease of use, confidentiality, knowledge and awareness of technology to be the most important. But in the social context, the cost of this technology is at the forefront. For example, a smart refrigerator technology is simple and useful, but not everyone can afford it. On the other hand, due to the development of renewable energy and electricity markets, a smart refrigerator that works more intensively at night accumulating cold for more economical work during the day (daytime rate is higher) can not only provide convenience to the consumer, but also save money.

A consumer finds the IoT to be an entertainment rather than a necessity. The industrial economy infrastructure, which is still actively used by the information society, does not require the IoT technology in most cases.

The implementation of specific customer requests arising in the above-mentioned state of affairs along with the classical marketing complex is required to attract customer attention to the IoT generators of high-tech products. The new needs of consumers of such products are related to the issues of energy consumption and battery life, the possibility of long-term operation without recharging, the resumption of data transmission sessions in the event of a network failure without data loss, fundamentally updated security principles of information storage and the impossibility of unauthorized access to the device.

Producers compete with each other to meet new consumer needs, because safety and human life depend on the quality of the interaction of technology, device and consumer. The IoT has evolved from micro devices to complex equipment management and autonomous cars. Therefore, it is crucial to adhere to the ecosystem principles that are necessary for the implementation of the technology.

We agree with (Chang et al., 2015) that the IoT is one of the fastest growing trends in the information technology industry. According to the report (Cisco, 2015), the development of the Internet of Things will have a particularly damaging effect on retailers as it considerably transforms not only personal and social aspects, but also businesses and, as a result, entire industries.

The concept of the Internet of Things is being extensively studied in Russia. The authors of (Pinchuk & Maltsev, 2016) studying the IoT concept developed a model taking into account the technological and system aspects (Fig. 1). We agree that it is necessary to analyze all factors and aspects affecting the development of the Internet of Things.

Figure 1
The Internet of Things concept from the perspective of business



Source: (Pinchuk & Maltsev, 2016)

We believe that the IoT technology provides an opportunity for the development of retail infrastructure. A mobile phone, a shopping cart, store shelves, a digital display, and even a "smart product" allow a real-time interaction with customers both in the physical store and in the virtual one.

Some researchers argue (Davis, 1989; Coughlan et al., 2012) that despite its promising characteristics and the expected growth in the next decade, the IoT will not be accepted in retail. However, according to the results of the study (Dimitrova et al., 2006) (more than 2000 US consumers were surveyed with regard to their behavior and IoT preferences), there is a lack of perceived value and this is one of the main obstacles to customer acceptance of the IoT devices, such as mobile phones, smart watches and tablets.

According to (Ding, 2013), smart products appear everywhere and the IoT changes everything. The authors emphasize that the third wave of IT will not only increase business efficiency, but also improve human abilities to meet many needs of business and people. We agree that the IoT has the potential to offer a wide range of opportunities for both consumers and customers.

However, previous studies did not examine real-time characteristics that the IoT can offer to customers. There isn't a study devoted to the impact of the Internet of Things on the economy. For example, real-time information may be based on the expiration date of the product, sensor data, as well as on the aggregated similar values (for example, storage temperature, shelf life, transportation), real-time estimates of the value characteristics. Thus, the purpose of our research is also to broaden the understanding of how the IoT can create value for customers and how it affects the economy.

2. Materials and Methods

The research is an empirical study. We studied and systematized the information on the implementation of the concept of the Internet of Things in a post-industrial economy.

Many studies devoted to this issue do not properly address the acceptance of the Internet of things by consumers. We have reviewed the studies and surveys on the acceptance of the Internet of things by consumers in different countries and systematized the conclusions on the acceptance factors.

The studies were based on the statistical data of the countries. The assessment was carried out using the methods of analysis and expert assessments. We also used the methods of mathematical statistics to obtain generalized results on the place and impact of the Internet of Things on the economy.

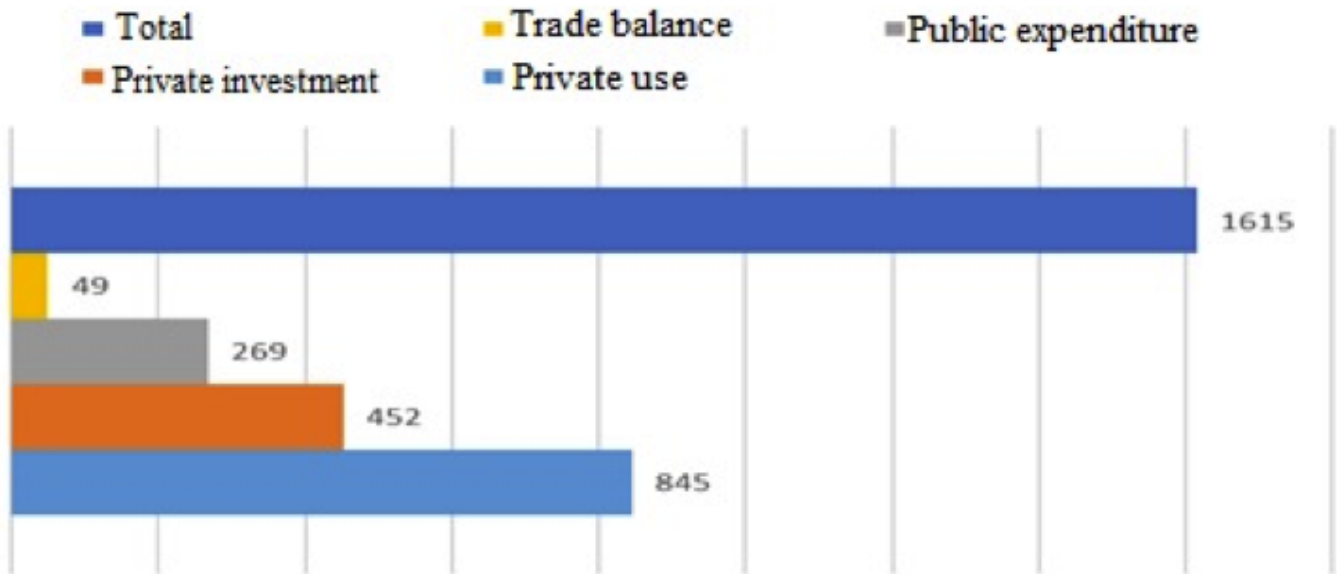
3. Results

The McKinsey Global Institute was chosen as a source of quantitative data collected on the same methodology (which allows comparing such information), as well as processed by common methods (which makes it possible to assess trends and form comparisons by the time criterion) and obtained as a result of practical activities on different continents (which guarantees the reliability of such data and reflects the real state of the market). The organization operates in the countries with different economic development and applies single consolidated standards. This fact makes it to be a source of reliable and representative information.

Our study shows that the Internet on average accounts for 4.2 percent of GDP in large economies, which makes up 70 percent of global GDP (Fig. 2). If Internet usage and expenditure were a sector, its weight in GDP would be greater than that of the energy or agricultural sector (Fig. 3). The overall contribution of the Internet to global GDP is greater than that of Spain or Canada, and it is growing faster than the GDP of Brazil.

Figure 2

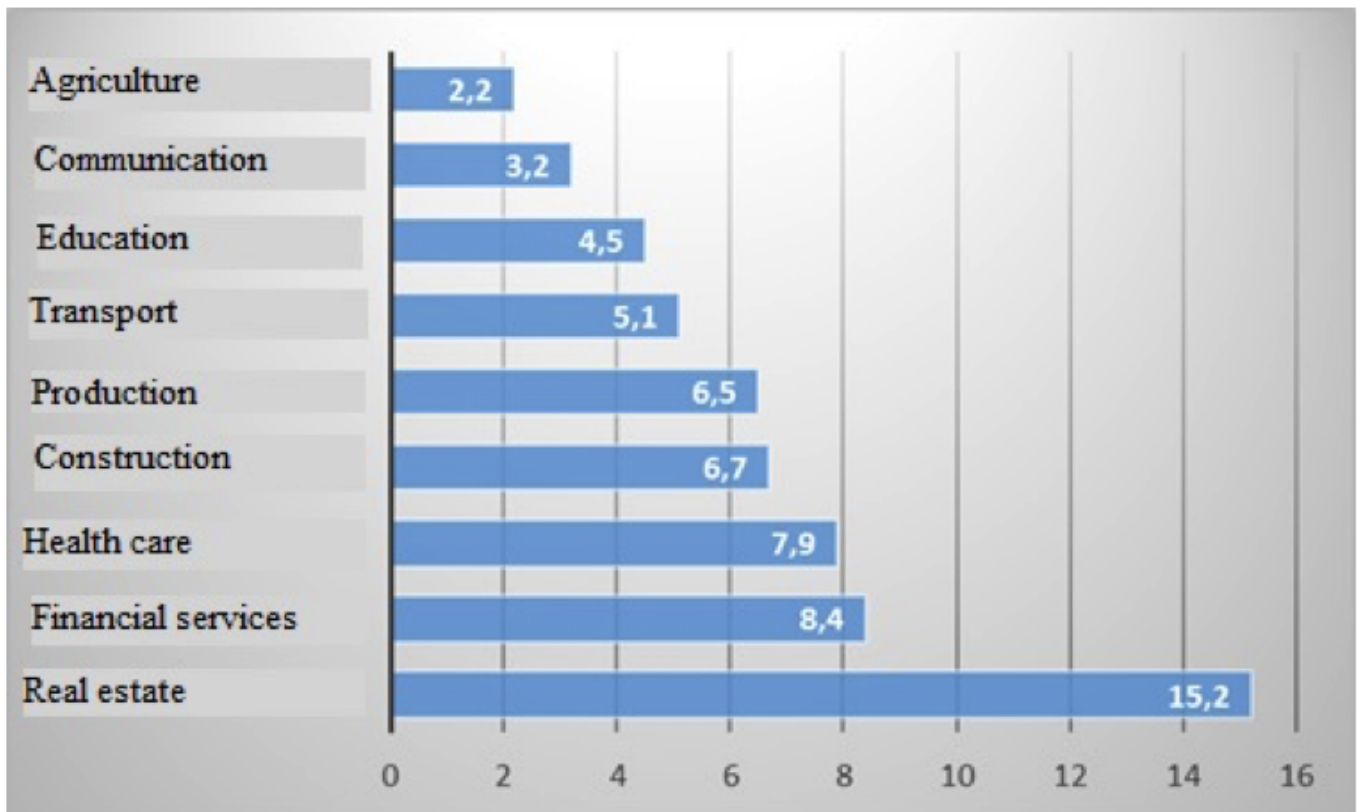
The contribution of the Internet to the GDP of individual countries and the economy development, 2018



Source: own development on the basis of the McKinsey Global Institute database.

We have considered the contribution of the Internet in 13 countries making up 70% of global GDP. The countries that were surveyed are the G7 countries; as well as China, India and Brazil (developing countries); additionally Sweden and South Korea (since they are the most developed countries in terms of broadband Internet connection). For other countries, we used estimated percentage shares based on the Internet penetration in each country.

Figure 3
The share of economy sectors in GDP compared to the "Internet sector"



Source: own development based on the McKinsey Global Institute database

The Internet of Things is most often used in supply management, diagnostics, inventory management, monitoring and automation. Thus, production moves into a new development phase as digital systems increase efficiency and promote management flexibility. In addition, the Internet of things contributes to the integration of participants through the creation of a single information field. For example, smart meters in German smart factories.

From the perspective of the global capital flow, the IoT reached its peak when the number of devices connected to the Internet exceeded the number of users of such devices. In this connection, it is possible to talk about a shift from the extensive spread of technology to the intensive penetration into people's lives. Therefore, a similar flow of the IoT capital can be predicted.

Despite its scale and reach, the Internet of Things is still in its infancy. As for studying the implementation of the IoT concept in a post-industrial economy, it is necessary to look forward to the future, we can identify the following trends:

The Internet of Things promotes competition: businesses using the Internet of Things achieve greater productivity. Such competition ensures that the most innovative and productive companies create more attractive products and services for consumers and gain a larger market share.

The Internet of Things promotes innovation and the development of the eco-system: an environment that encourages innovation and entrepreneurship is vital to capturing the Internet-related growth. Smart home technologies, unmanned vehicle technologies, smart kitchen, smart transport system provide an innovative approach to using the Internet of things in the consumer segment.

The Internet of Things promotes human capital development: the USA used its vast personnel pool in higher education to promote the Internet-related human capital, serving as an incubator for new industries and a magnet to attract talent from around the world.

The Internet of Things helps build infrastructure: infrastructure is a prerequisite for the entire Internet ecosystem growth. It creates the platforms on which users and organizations become familiar with the Internet and on which entrepreneurs introduce innovations. The UK and Sweden used very strong infrastructure to gain greater importance in the global Internet ecosystem.

We believe that the benefits of the Internet of Things can be developed in any economy. Although the Internet of Things accounts for about 6 percent of the GDP of Sweden and the United Kingdom, in others, its contribution is below 4 percent. But this gives them tremendous opportunities for further expansion. In less developed countries, the expansion opportunities are even greater. Developing economies have an excellent opportunity to "leap" towards the Internet of Things paradigm to build a 21st century innovative digital economy, just as some developing countries introduced mobile communication, rather than followed the example of developed countries in building stationary infrastructure.

Our research shows that a strong Internet ecosystem, which promotes competition, encourages innovation, develops human capital and creates a comprehensive Internet infrastructure, democratizes access to information. This explains the interest of states to develop various areas of knowledge making it possible to scale support systems for their new innovative industries.

According to the research (Gao & Bai, 2014; Evans, 2015; Gartner, 2016), the Internet of Things in industry contributes to cost savings of 3-5%, increasing efficiency by 10-22% and reducing labor costs by 27%.

The use of the Internet of things in building "smart cities" is a development priority of many countries. For example, a sensor system throughout Singapore ensures the digitization of the entire transport system.

Having carried out our own research, we can say that now it is difficult to assess the share of the Internet of things in the economy, since the main consumer of the IoT is still the industry, which is a serious and complex economic driver. It is also quite difficult to determine the IoT contribution to the economic growth. Perhaps it is not great, and the GDP growth is promoted by the industry itself. This is an open question, but the fact that industrial companies are interested in the IoT speaks in its favor.

4. Discussion

The Internet accounts for 10 percent of the GDP growth in developed economies. Over the past five years, the IoT contribution to the GDP growth in these countries has doubled to 21 percent. If we look at the economies of China, India and Brazil, we will see that the Internet has provided a 7 percent growth over the past 15 years and 11 percent over the past five years. In Turkey, Malaysia and Mexico Internet usage and GDP per capita are within the average (Gómez et al., 2013). The Internet of Things has made a significant contribution to their economic growth, although its contribution has been greater in developed economies. Current research suggests that the Internet has provoked roughly half the increase in GDP in these countries. However, there are

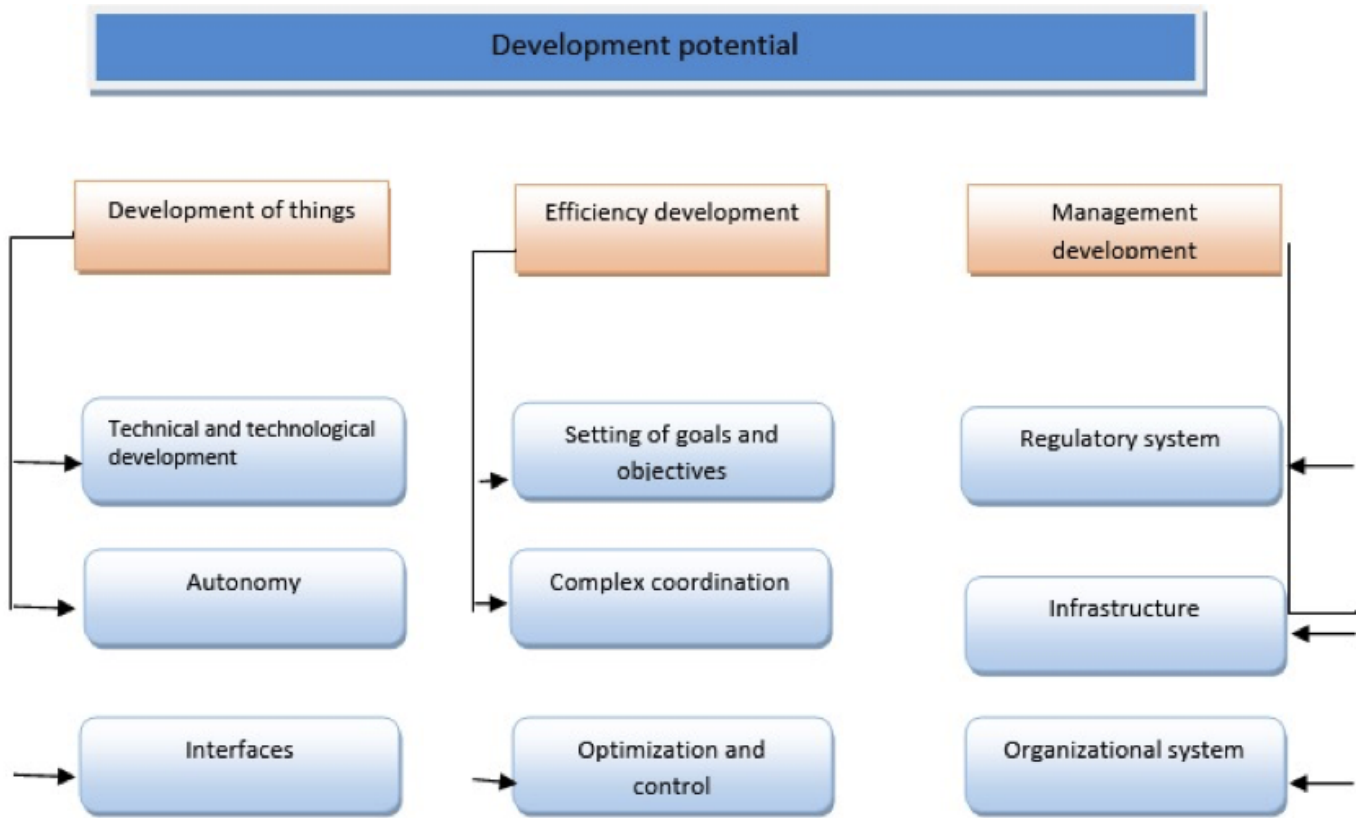
significant differences between the countries, including those countries which are at the relatively similar development stage, that provide enormous opportunities for further Internet-related growth.

There is also a clear connection between the maturity of the Internet ecosystem and improved living standards. It can be concluded that the increase in Internet maturity in developed countries correlates with the increase in real GDP per capita by an average of \$ 500. For example, it took 50 years to achieve the same results for the industrial revolution. This shows the magnitude of the positive impact the Internet has on the society and its speed. The correlation with improved living standards is particularly important for developing countries, where there is a potential for a quick leap forward and stimulating Internet-related growth (Gu & Liu, 2013).

The United States had a leadership role in terms of the Internet infrastructure strength, access and innovation. Today, India, China and Brazil have fast-growing Internet systems and technologies, while other developed and developing countries are catching up with the use of improved infrastructure and access.

We agree with Tyurin V.A. (2016) that the Internet of Things has a great development potential (Fig. 4). We believe that the main direction of development of the Internet of Things in Russia is the technical and technological development and improvement of management.

Figure 4
Systematization of the IoT development directions



Source: (Tyurin, 2016)

The main impact of the Internet of Things on the economy is the modernization of traditional activities. Fundamental business transformations covering the entire value chain in all sectors and company types become possible. Today, even a tiny business can work with dynamic supply chains that span geography and operate with the global workforce (Gubbi et al., 2013).

Despite the fact that the Internet has made some professions obsolete, it is a powerful catalyst for job creation. Jobs are created in the Internet ecosystem itself, because Internet companies hire employees to process applications, communicate with customers, etc.

There is the e3 Index (Guinard et al., 2011). It measures e-ngagement, e-nvironment and e-xpenditure. The e3 Index represents the importance of a country in the access to and usage of the Internet infrastructure by individuals and enterprises.

The Nordic countries (the Netherlands, Switzerland and the United Kingdom) and South Korea have taken the first ten positions in the e3 ranking of online sales and services.

The authors of (Khasawneh et al., 2011; Han et al., 2014) argue that over the past 15 years 500,000 jobs have been destroyed, but the Internet has created 1.2 million new jobs, that is, 2.4 jobs per every one destroyed. This statement is confirmed by the McKinsey Global Survey of Small and Medium-Sized Businesses which said that 2.6 jobs were created per every one destroyed.

The Internet contributes to increased productivity in large companies and it is even more important for small and medium-sized enterprises and start-ups. There was a survey involving 4,800 SMEs in 12 countries. And it was found that the enterprises using Internet technology, increased revenue twice as fast as businesses with minimal use of the Internet of Things. These results can be applied to all economy sectors. In addition, the export revenue of the Internet-savvy SMEs was twice higher than the revenue of the enterprises that were not so actively using the Internet of things. Companies working with the Internet of Things create twice as many jobs as companies that are not active Internet users. This statement is true for all types of activities from retail to manufacturing (Kim & Shin, 2015).

The McKinsey Web Index is determined by the number of technologies that companies have and the degree of the IoT penetration (that is, the number of employees / customers or suppliers having access to these technologies). In other words, this is the ability to contact customers, find suppliers and attract personnel from anywhere in the world, as well as to use the Internet to provide good marketing (Kowatsch & Maass, 2012). As a result, small-sized enterprises can compete with the large ones. This has led to the emergence of so-called micro-transnational corporations, which can become global due to the Internet and the Internet of Things. In other words, these companies start their activities in one country and through the Internet of things establish business relationships in many other countries (Lee, 2009).

It should be noted that the main driving force of the Internet of Things is a person. The Internet of Things has significantly increased consumer opportunities, allowing customers to save time in routine purchases, automatically compare prices, find instant sales, as well as find specific car makes or real estate without brokers and dealers. This saves consumer's time, increases price transparency and provides customers with an easy access to goods (Li & Wang, 2013).

People have benefited not just as consumers, but also as citizens, individuals and members of the community and the nation. For example, 82% of the IoT users in the United States use the Internet to make transactions with government agencies, as well as to address health and education issues. Public organizations and non-profit organizations are increasingly using the Internet of things to conduct their operations, expanding the range of their services from disaster relief coordination to public safety. The value of such activities related to the use of the Internet of Things is significant.

It is necessary to access and analyze "big data" which is large data sets generated by every user. Most "big data" will not be processed on separate computers, but in the "cloud" with large computing power. Management is provided as a service and users can collaborate more quickly in real time. Cloud computing and other collaboration technologies will provide increased operational efficiency and employee productivity through shared virtual workspaces and social networks (Medaglia & Serbanati, 2010). The Internet of Things will also improve educational services through providing young people and adults with the access to low-cost content, online instructors and student communities. Cloud services can also significantly reduce the cost of new applications for both large- and small-sized enterprises, allowing them to pay for services "on demand" (Su et al., 2014).

The Internet of Things will become a powerful transformation tool when physical assets become elements of an information system with the ability to collect and compute information, as well as communicate and collaborate on it. The more connections there are, the more powerful this network becomes. Objects ranging from letters to document packages shipped with embedded sensors, drives and communication capabilities begin to generate and transmit information on a large scale and, in some cases, adapt themselves and respond automatically to external changes. These "smart" assets can make processes more efficient, as well as provide new opportunities and new business models (Sundmaeker et al., 2010).

However, the attention should be paid to an important fact that the achievement of the joint IoT security objectives and protection, economic growth and participation will require cooperation between the private, public and non-profit economy sectors.

5. Conclusion

People must recognize and accept the tremendous opportunities created by the Internet of Things, especially when the required work is done to eliminate security and privacy risks. Research on the development of the Internet of Things proves the need to promote a healthy Internet ecosystem that will increase access to infrastructure and create a competitive environment that will benefit users and allow innovators and entrepreneurs to thrive and improve human capital. These elements can maximize the impact of the Internet on economic growth and prosperity.

We found out that the TOP 5 rating of the Internet of Things includes: predicative analytics; smart, interacting products; prospective materials; smart plants and digital design, modeling and integration.

We also proved that the IoT development will not be a destructive force that will decisively shape the economy and society. It will rather be the supplier and driver of the growth in the regions that used to be poor in the past; it will create new industries based on electronics and software code and provide an ability to spread knowledge, empower consumers and organize social interactions.

Summarizing the results of our research, we should note that despite the fact today the Internet of Things is still a fashionable trend for futuristic journalism, the industry has already adapted and uses the IoT. The penetration of the IoT into the industry has already created a new promising paradigm in not very developed countries. Thus, an average person reading a fantastic article on the IoT does not even suspect that the future has already come.

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