



THE GREAT IMPACT OF INTERNET OF THINGS ON BUSINESS

N. Angelova*, G. Kiryakova, L. Yordanova

Faculty of Economics, Trakia University, Stara Zagora, Bulgaria

ABSTRACT

Internet of things (IoT) - the new paradigm has a great impact on different areas like industry, health, education, agriculture, farming and many others and its main functions are to make our life easier and more comfortable. Implementing this new technology in any business model has advantages but also all the players (companies, governments and consumers) in this field should be aware of some challenges and threats like privacy, security and standardization. The article aims to explore how IoT changes the way we live and work and to present some of its best business practices, statistics and trends.

Key words: Internet of Things (IoT), business, smart home, wearables, statistics, security, privacy

INTRODUCTION

The dynamic development of modern ICT has a huge impact on our daily routine, work, way of living and thinking. Household appliances could be controlled through our smartphones and could exchange data using build-in sensors, cars could choose the best route to avoid traffic and automatically order a new part to replace the broken one in the nearest workshop.

Just a few years ago, all these "smart" and "talking" devices were part of the science fiction movies, but today they are part of our everyday life. The technologies make life easier, create a variety of conveniences, speed up the access to different services and management automation. On the other hand there is a threat of creating dependency on these new technologies and "smart" devices, so users need to be taught how to use them properly.

The concept of the **Internet of Things** is a part of our time and the current work aims to present its main applications in different spheres of our life, the main advantages, development trends, problems and challenges that need to be addressed.

1. INTERNET OF THINGS (IoT)

1.1. DEFINITIONS

Over the years many authors have been trying

to define the *Internet of Things* phenomenon by expanding the concepts of "Internet" and "things", describing their features, ways of connecting and interacting. Discussions take place and even arguments are given against the use of the words "Internet" and "things" because of the interference of the human factor, so the term "Internet of people" is suggested.

Rob van Kranenburg (1) explores and systematizes different definitions of the concept. One of them, given by the EU project Casagras, explains in details that IoT is "A global network infrastructure, linking physical and virtual objects through the exploitation of data capture and communication capabilities. This infrastructure includes existing and evolving Internet and network developments. It will offer specific object-identification, sensor and connection capability as the basis for the development of independent cooperative services and applications. These will be characterized by a high degree of autonomous data capture, event transfer, network connectivity and interoperability".

Adrian McEwen (2) gives very simple definition presented by the following equation: **Physical object + Controller, Sensor and Actuators + Internet = Internet of things** where actuators are the outputs into the world produced by the "things".

All these definitions shows that the prerequisites that make the *Internet of Things* come into all spheres of our life are Internet

*Correspondence to: Nadezhda Angelova, Faculty of Economics, Trakia University – Stara Zagora, Bulgaria, nadja@uni-sz.bg

accessibility, including building a good Internet infrastructure, cheap Internet connection, and increasing IP address space, thanks to IPv6. This makes possible to connect and address all the "things" on the planet. (3).

Like any other immersing technology *Internet of Things* has a lot of advantages that gives new opportunities and creates variety of applications for businesses and customers. Along with this there are some threads and problems that need to be solved in order to make all the players feel safe and comfortable when participating in the IoT ecosystem.

1.2. ADVANTAGES

According to (4, 5) the major advantages of *Internet of Things* that have impact on business are:

- **Communication** - *Internet of Things* provides a permanent connection and data exchange between connected devices and users. Thanks to the built-in sensors and the different technologies that ensure communication among objects, it is possible to track the health indicators of patients, to locate items and goods during transportation, to monitor the status of buildings, etc.

- **Control and automation** – All *Internet of Things* consumers (users and businesses) through applications installed on their mobile devices such as phones, tablets, etc. can remotely control smart devices, adjust different metrics, and choose specific options. In many cases, systems send automatic messages and warnings or take actions. For example, the fridge can order food from the supermarket if some of the products are down, the car can send a request for the spoiled part that needs to be replaced, and the user can adjust the temperature at their homes while they are away.

- **Cost savings (time, resources, money)** – The connectivity and fast communication among devices reduces response time and human labor, thus **increase productivity and efficiency**. Many of the appliances that make our homes "smart" save electricity, resources and money. Nowadays a lot of investments are made for **predictive maintenance** that will help to predict and avoid failures in IoT ecosystems.

- **Citizen experiences** – The idea of *Internet of Things* and the connectivity of objects tend to improve the quality of life and facilitate citizens. The use of smart devices and systems that have elements of interactivity and gamification make users more active and make them feel part of this ecosystem, creating a better experience for them.

- **Greater revenue opportunities** – The

widespread penetration of the *Internet of Things* phenomenon in all spheres of life enables manufacturers to offer smarter devices, expanding to new markets and developing new products that will generate great revenues.

1.3. THREADS AND CHALLENGES

The main issues and challenges facing the *Internet of Things* are identical to those of Internet-based technologies - data security and data protection, data quality, the use of common standards and protocols, interoperability, legal issues, etc.

Another major challenges facing *the Internet of Things* outlined by (6) are: making a common addressing mechanism for effective addressing of the devices, creating embedded devices available at a low cost that can be more energy efficient and more reliable, creating governing bodies that can govern the usage of the devices, making quick and reliable communication, minimizing the load on servers as well as on the embedded devices. The increased production and deployment of these devices goes beyond the solution of these issues and all actors, especially companies and government, must be united to solve them in time and implement policies for the proper and lawful use of the *Internet of Things*.

- **Privacy** defines the rules on which individual data can be accessed and is therefore one of the biggest challenges. The identification and tracking of devices, all the actions they perform, the collection of personal data from various applications make users feel spy as if they are part of the Big Brother and can be localized at any time (7). On one hand, it is convenient to discover people who have been lost, abducted or have suffered an accident. On the other hand, it is an inconvenience for all who want to preserve their privacy.

- **Security** is one of the most critical challenges that *Internet of Things* has to tackle. Affordable and at low cost broadband connection and Wi-Fi capabilities in many devices are a prerequisite for easy localization in public places, making them unprotected and victim of cyber-attacks. *Internet of Things* allows permanent data sharing between related objects and identifies three main components ensuring security - authentication, confidentiality, and access control, with a special focus on IoT systems.(8)

- **Compatibility**. Different manufacturers of sensors embedded in smart devices and different platform providers use different data transfer protocols that would cause communication problems. (9). There are many initiatives and projects that aim to create

standards of communication.

- **Complexity.** Errors may occur in complex systems that connect and manage multiple objects. Users should not rely excessively on technology because faulty data or no data can be exchanged because of faulty scanners and sensors. This can also be due to electromagnetic disturbances, vibrations, the age of humans. For example, when scanning the iris of an eye or fingerprint for biometric data, it can be affected by eye and fingers injuries. (1)

2. INTERNET OF THINGS APPLICATIONS

The concept of *Internet of Things* and all connected objects exchanging data is widely used in all areas of life, including wearables, and other devices and sensors that make smart every object.

IoT Analytics presents *Internet of Things* by segments for the third quarter for 2016. (10), analyzing 640 actual enterprise IoT projects, not including smart home and wearables projects (Figure 1).

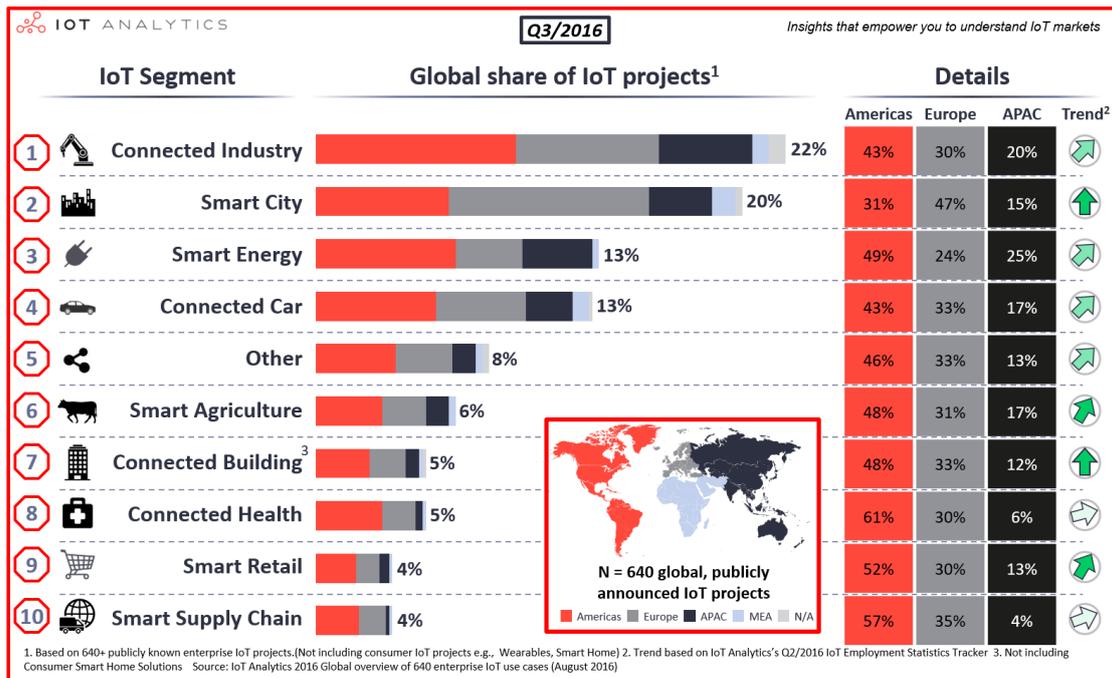


Figure 1. Internet of Things by segments for the third quarter for 2016

2.1. CONNECTED INDUSTRY

Connected industry is also known as Industry 4.0 and its main approach is to digitize production and implementation of new ICT. The domain includes the process innovation and product innovation and a combination of these two. Smart industry has a social context because it changes the way people live, their working environment, where they interact with machines and robots. (11). Connected industry includes the largest number of business management projects, including Oil & Gas and Automotive Industry, which are presented separately here.

2.2. SMART HOME

This is perhaps one of the most popular *Internet of Things* applications, including various home appliances that have built-in sensors and via an Internet connection can be controlled through a smartphone. This includes:

- Smart thermostats that regulate home

temperature and significantly reduce electricity costs;

- Smart refrigerators that monitor the availability of products every time when the door is open and order new ones, offer recipes, plays music and thus make it easier for consumers to shop and cook;
- Smart locking systems;
- Smart devices that switch on and off the electricity of the appliance, thus reduces the risk of fire, the risk of damage of the appliance by electric accidents;
- Smart devices with sensors to monitor our homes for accidents and intruders and notify users through messages.

According to a US study of smart home devices use in 2015, the most common smart home item is the wireless speaker system (17%), followed by smart thermostats (11%), smart / wireless home security systems (9%) and domestic robots (8%) (12). Another statistics reported that connected home

technologies sales in the United States from 2012 to 2017 (in million US dollars) have increased from 98 in 2012 to 1,485 in 2017.(13)

2.3. SMART CITY.

The concept of "smart city" includes technological solutions and initiatives that alleviate and improve the life of citizens. This is an ecosystem that allows the rational management of the resources of different city services and ensures maximum safety. Some applications are (14):

- **Waste management** - Waste bins equipped with build-in sensors to monitor their fill level. This prevents overfilling by alerting companies and optimizes the trash collection routes directing garbage trucks to places where waste disposal is needed in order to save time and money.
- **Smart parking** - Many parking places have installed sensors to inform the public in real time, where are free parking spaces depending on driver's location or destination.
- **Smart street lighting** - The equipment of street lights with sensors to adjust the brightness of street lights, depending on the illumination, the presence of pedestrians and cars, saves electricity.
- **Traffic congestion** - Directing drivers and pedestrians to places with less traffic, switching green traffic lights depending on where the cars are and at what time of day is. This reduces traffic and air pollution from the exhaust of cars, which burn more than 17% of their fuel, waiting for red light;
- **Smart roads** - Highways that show signs of traffic situation and warn drivers of icy roads and accidents.
- **Structural health** - Tracking the condition of buildings, bridges and cultural monuments to prevent their destruction and incidents related to their use.

Since 2007, the Technical University of Vienna has been working on a project to develop a model that categorizes cities as "smart". The established model includes 6 key fields - smart economy, smart mobility, smart environment, smart people, smart living and smart governance (15).

In 2013 Barcelona is the first "Smart" Spanish city and one of the smart cities in Europe ahead of Paris, Stockholm, and London. Some of the initiatives that the government of Barcelona implements are: stellar bus transit system, bicycle sharing system, smart parking places, pneumatic waste management system, smart lighting and effective energy systems (16).

2.4. E-HEALTH/ HEALTHCARE.

The use of the *Internet of Things* in healthcare can be applied in different directions - medical equipment, medical treatment, diagnosis and prevention, social care. This includes:

- Control of freezers used for storing medicines and vaccines;
- Monitoring of patients in hospitals and in their homes;
- Monitoring of elderly people living alone;
- Measuring biometric data and sending it to the doctor without need to go to his office;
- Sensors that send signals and remind patients of taking their medication at the right time and according to the prescribed prescription;
- Appliances that take care for our health like a smart toothbrush, a smart fork that vibrates when we eat too fast.

Early diagnosis of diseases and their prophylaxis reduces the expenses of hospitalization and treatment. The main requirements for Internet-based healthcare systems are related to *interoperability, reliability, flexibility* and *extensibility*. (17)

Some of the benefits of implementation *Internet of Things* in healthcare are: decreased costs, improved outcomes of treatments, improved disease management, reduced errors, enhanced patient experience, enhanced management of drug (18).

A research shows that the global smart healthcare products market is expected to rise at a CAGR of 8.84% between 2015 and 2023. This will result in the market's valuation to increase from US\$31.71 bn in 2016 to US\$57.85 bn by 2023 (19).

The main problems are connected with generating big amount of data and the privacy and security of data. The quality of data of all the measurements that are made by the sensors is very important in order to take the right treatment for the patients.

2.5. TRANSPORTATION AND CONNECTED CARS.

The equipment of cars with sensors and a permanent Internet connection ensures the comfort and safety of the passengers, reduces the pollution of the environment.

Some of the most significant features of connected cars are:

- to program in-car navigation system remotely via smartphone;
- to fire up car engine remotely up to 15 minutes before start to drive in order to heat the car in frosty morning or to cool it when it is

hot outside;

- to monitor information about fuel consumption, average speed, traffic conditions and distance;
- to alert the emergency services in case of a serious collision, using GPS to locate the vehicle and send help;
- to remind where driver have parked;
- to monitor car's maintenance schedule, fuel and oil levels, and tracks it in the event of a theft (20).

Smart cities include the improvement of road infrastructure and the implementation of connected cars in public transport in order to reduce traffic, reduce transport-related carbon dioxide emissions and increase passengers' comfort and safety.

According some statistics the projected size of the global connected car market in 2016 and 2021, by segment (in billion euros) in 2016 and 2021 are *safety, home integration, mobility management, vehicle management, entertainment, well-being* and *autonomous driving*.

- 2016: safety(15,5), home integration (0), mobility management (4,4), vehicle management (3,6), entertainment (6), well-being (2) and autonomous driving (9,5),
- 2021: safety(49,3), home integration (0,1), mobility management (5,6), vehicle management (7,1), entertainment (13,4), well-being (7,6) and autonomous driving (39,6).

As can be seen, the largest share occupies the security segment, followed by autonomous driving and entertainment, which will increase more than twice.

Overall, the connected car market is predicted to grow from 40.3 billion euros to 122.6 billion euros (21).

2.6. SMART AGRICULTURE AND FARMING.

The use of the *Internet of Things* in agriculture and livestock farming aims to improve the quality and quantity of crops, to monitor livestock indicators. Real-time data is collecting, processing, and analyzing. This allows farmers to take measures to properly process and avoid mistakes, plan the actions and costs involved in sowing and harvesting, make weather forecasts for drought, hail, take measures to reduce the loss of production.

Built-in sensors in devices, machines and systems could provide and ensure modern breeding, crop growth, quality and safety of agricultural products monitoring with using IoT to focus on RFID technology, weather

forecasting, wildlife management, forestry, livestock farming, market identification and rural financing (22-24).

2.7. WEARABLES.

Generally, we can say that wearables are all devices that can be worn as accessories - watches, bracelets, clothes, glasses that are connected to the Internet. They are able to collect, process, analyze and transfer data. These devices are usually used in the field of health, fitness and entertainment. They are highly energy-efficient, ultra-low power, and small-sized (25).

Some of the most popular wearables are **fitness bands**. They measure people's activity, stairs climbed, running distance, calories burned and sleep quality. With an application installed on the smartphone, these metrics can be synced, presented in a graphical form and help users to track their fitness progress.

Smart glasses are not only a fashionable accessory but another example how IoT could help users to improve their everyday experience through multiple build-in sensors like gyroscope, accelerometer and magnetometer and can also measure fitness activity and location. Embedded cameras and processors give them the capabilities of small computers. The collected and processed data is presented directly in front of user's eyes.

The ability of **wearables** to integrate with third-party applications is one of the benefits that makes them so popular and increases their sales.

A research shows that health and fitness wearables can change the consumer's attitude towards his health conditions and how these fitness devices make users more active and more responsible for their health. Factors that might influence the adoption and use of wearables are defined:

- **Context of use** - Technical infrastructure, Observational learning, Social expectations
- **Technology user** - Personal characteristics (age, gender, psychological traits), Previous experience with technology, Habit
- **Technology features and utility** - Utilitarian and hedonic benefits sought, Perceived costs and challenges of using the technology, Features deemed most useful (26). The development of wearables and the presentation of their capabilities can be used in various initiatives by governments to improve the health of the population and to fight obesity and diabetes (27).

The statistics reports that manufacturers of wearable fitness devices Fitbit, Garmin, Samsung show a slight increase in global wearable device shipments for 2016 compared to 2015, while Apple, the third on this list, has a slight decline of 11.6 to 10.7 million units. Overall, the Wearables market is rising, in 2014 worldwide units shipments amounted to 28.8, 2015 - 81.9, 2016 - 102.4 million units (28).

DISCUSSION AND RECOMMENDATIONS

According to Gartner's reports and forecasts, there will be 20 billion connected devices on Earth by 2020. BI Intelligence is projected to reach more than 24 billion and nearly \$6 trillion will be spent on IoT solutions over the next five years (29).

This will change the way companies, connected with IoT, act. They should invest in *Internet of things* hardware and optimize the workflow, transform and adopt new business models, modify the traditional organization roles, ensure cyber security and customer's privacy (30).

The Cisco's report (31) shows the investment opportunities of Bulgaria:

- Invest in digitalization in the public and private sectors;
- Recognize the importance of national policy leadership in digitalization;
- Investing into future-proof infrastructure such as broadband and ICT conversion;
- Invest in 3G/4G mobile services;
- Invest in ICT based health technologies;
- Invest in Big Data as a Big Opportunity for Inclusive Growth.

The main directions for the application of the *Internet of Things* in Bulgaria are:

- Energy industry - Build a smart grid to reduce costs and pollution.
- Tourism - Increase revenue and offer more opportunities for users by using mobile technologies and related advertising and marketing.
- Agriculture - Improve the quality and quantity of production by the use of sensors.

Nowadays initiatives and examples of implementation of *Internet of Things* solutions by Bulgarian business already exist. One of the most popular examples of Smart Home application is Tesy Cloud that helps consumers to control remotely electric water heaters and heating appliances. This innovative solution is intuitive and easy to use, saves time and electricity consumption.

Sofia, the capital city of Bulgaria, adopt the idea of smart waste management of one the public markets - Zhenski pazar. The system

that is integrated in the underground garbage bins sends information about the fill level three times a day. The company responsible for the garbage transportation reports that this initiative reduces costs with 20%, saves time and gives opportunities to citizens to send signals about overflowing waste bins. This system will be implemented in other places in Sofia and in other cities (32).

In the next years the first smart city in Bulgaria will be built. The project is named "St. Sofia" and is first one for Bulgaria in the framework of the strategic initiative "One Belt - One Time" between the companies Bulgaria Development Holdings Limited (BDHL) and ZTEICT. IoT, Cloud computing and 5G will be provided in the field of innovative technology solutions for business, education, tourism and services (33).

CONCLUSION

Undoubtedly, the rapid development of new technologies impact all areas of everyday life and the presented analytics and reports show that these trends will continue and grow in the years to come. Whether we want it or not, we are part of this technological revolution and the most important thing is to learn how to use it properly and wisely. Therefore the efforts of all players in the world of *Internet of Things* - device providers, operators, platform providers, systems integrators, application providers, governments and consumers should be united to ensure a secure and safety environment for communication and exchange of personal data. Internet of Things' integration should follow a certain vision and idea, identify opportunities for using technology, attract business institutions and government, and build a culture of using the Internet of Things.

REFERENCES

1. Kranenburg, R., The Internet of Things, draft paper prepared for the 1st Berlin Symposium on Internet and Society, 2011
2. McEwen, A., Cassimally H., Designing the Internet of Things, Wiley, ISBN 978-1-118-43063-7, 2014
3. Internet of Things (IoT), <http://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT> .
4. Lopez Research LLC, An Introduction to the Internet of Things (IoT), 2013
5. Meola, A., IoT for small business: Effects, opportunities & platforms, Business Insider, <http://www.businessinsider.com/internet-of-things-small-business-opportunities-platforms-2016-8> .
6. Rashid, H., Securing the Internet of Things, A Technical Seminar Report submitted for fulfilment of the requirements for the Degree

- of Bachelor of Technology, Biju Pattnaik University of Technology, 2012
7. Roman, R., Najera, P., Lopez, J., Securing the internet of things, *Computer*, vol. 44, pp. 51-58, 2011.
 8. Sicari, S., Rizzardi, A., Grieco, L.A., Coen-Porisini, A., Security, privacy and trust in Internet of Things: The road ahead, *Computer Networks*, Elsevier, Volume 76, pp 146-164, 2015
 9. Saxena, P., The advantages and disadvantages of Internet of Things, <https://e27.co/advantages-disadvantages-internet-things-20160615/>, 2016, (last access 30.07.2017)
 10. The top 10 IoT application areas – based on real IoT projects, <https://iot-analytics.com/top-10-iot-project-application-areas-q3-2016/>, (last access 30.07.2017)
 11. Smart industry, <https://www.utwente.nl/en/fraunhofer/smart-industry/>, (last access 30.07.2017)
 12. Consumers Beginning To Embrace Smart Home Technology – Even If They Don't Know It Yet, 2015, <http://www.theharrispoll.com/business/Consumers-Embrace-Smart-Home-Technology.html>,
 13. Connected home technologies sales in the United States from 2012 to 2017 (in million U.S. dollars), <https://www.statista.com/statistics/525878/us-connected-home-technologies-sales/>, 2017
 14. 8 ways the Internet of things will change the way we live and work, <https://www.theglobeandmail.com/report-on-business/rob-magazine/the-future-is-smart/article24586994/>
 15. European smart cities, <http://www.smart-cities.eu/index.php?cid=-1&ver=4>, (last access 30.06.2017)
 16. Ten Reasons Why Barcelona is a Smart City, <http://www.vilaweb.cat/noticia/4175829/20140226/ten-reasons-why-barcelona-is-smart-city.html>, 2014, (last access 30.07.2017)
 17. Kulkarni, A., Sathe, S., Healthcare applications of the Internet of Things: A Review, *International Journal of Computer Science and Information Technologies*, Vol. 5 (5), 6229-6232, 2014
 18. Patel, K., 2017, 6 Benefits of IoT for Hospitals and Healthcare, <https://www.ibm.com/blogs/internet-of-things/6-benefits-of-iot-for-healthcare/>, (last access 30.07.2017)
 19. Smart Healthcare Products Market, <http://www.transparencymarketresearch.com/smart-healthcare-products-market.html>, 2016, (last access 30.07.2017)
 20. Gibson, T., Connected cars: your questions answered, <http://www.telegraph.co.uk/business/sme-library/fleet-management/connected-cars-questions-answered/>, 2017, (last access 30.07.2017)
 21. Projected size of the global connected car market in 2016 and 2021, <https://www.statista.com/statistics/297816/connected-car-market-size-by-segment/>
 22. Mehta, Y., Agricultural Internet of Things technology applications, <https://www.ibm.com/blogs/internet-of-things/iot-agricultural-applications/>, 2017, (last access 30.07.2017)
 23. IoT Smart Farming, <https://www.postscapes.com/smart-agriculture/>, (last access 30.06.2017)
 24. Ray B., Farms of the Future: The Rise of IoT in Agriculture, <https://www.link-labs.com/blog/rise-of-iot-in-agriculture>, 2017, (last access 30.07.2017)
 25. Rahul, IoT applications spanning across industries, <https://www.ibm.com/blogs/internet-of-things/iot-applications-industries/#Wearables>, 2017, (last access 30.07.2017)
 26. Canhoto, A.I., & Arp, S., Exploring the factors that support adoption and sustained use of health and fitness wearables, *Journal of Marketing Management*, 33(1-2), 32-60, 2017.
 27. Nguyen, B., & Simkin, L., The Internet of Things (IoT) and marketing: the state of play, future trends and the implications for marketing, *Journal of Marketing Management*, 33:1-2, 1-6, 2017
 28. Richter, F., Fitbit Leads Global Wearables Market, <https://www.statista.com/chart/8420/wearable-device-shipments/>, (last access 30.07.2017)
 29. Here's how the Internet of Things will explode by 2020, <http://www.businessinsider.com/iot-ecosystem-internet-of-things-forecasts-and-business-opportunities-2016-2?IR=T>, 2016, (last access 30.07.2017)
 30. Kaleel Ahmed A, C.B. Senthil Kumar, Correlating Internet of Things, *International Journal of Management (IJM)*, Volume 8, Issue 2, pp.68–76, 2017
 31. Nedeltchev, P., Manville, J., Reberger, Ch., Morrison, E., Internet of Everything Opportunities for Bulgaria
 32. IndustryInfo.bg, <http://industryinfo.bg/article/19365-vnedriha-sistema-za-sledene-na-obema-na-otpadacite-v-konteynerite-v-sofiia>, 2017, (last access 30.07.2017)
 33. Menager.bg, <http://www.manager.bg/turizm/dogovoreno-s-kitay-prviyat-v-evropa-inteligen-grad-shche-e-v-blgariya>, 2017, (last access 30.07.2017)