

Economic and Social Implications of the Internet of Things in Europe in Relation to Business

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Abstract The increasing availability of high-quality data collected and transmitted in real-time through cheap, ubiquitous hardware and connections will undoubtedly lead to scientific, technical, and commercial innovation. Opportunities for business are massive in terms of improvements in productivity, and control of supply chains and distributed real-time processing. The paper's objective is to analyze chosen economic and social impacts of the Internet of Things (IoT) in relation to its business potential. The Internet of Things is a scenario in which objects, animals or people are provided with sensors and gain the ability to communicate. The resulting information networks are capable of creating new business models, improving business processes, and reducing costs and risks. Economic impacts treated in this paper include aspects like ICT sector's expenditures, innovation, and investment in the EU, and trends and business potential of the IoT. Social impacts, which might be both positive and negative, will be discussed as well. Among the positive ones belong improved access to information and education, new tools and equipment. On the other hand, the IoT may cause job losses or reduced physical activity and personal interaction.

Keywords Business • Internet of things • Economic and social impact

1 Introduction

The increasing availability of high-quality data lead to scientific, technical, and commercial innovation. Falling technology costs, developments in complementary fields like mobile and cloud, together with support from governments have all contributed to the growing of an Internet of Things (IoT) (BCS 2013).

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It is therefore vital not only to reveal opportunities linked to the IoT and its applications and implications to social sphere, but also to foresee how this technology may transform social life (Shin 2014). Greater public understanding and discussion of the potential benefits as well as threats is vital. Rethinking of practices and policies will be necessary as local, national, regional and global will become close to each other (Erguler 2015). Nevertheless, research on the social impact of the IoT has not fully taken off, yet (Crump and Brown 2013). Of course, most people agree that the IoT provides great opportunities but at the same time there is a pressing need for sound social research into this field on the basis of real evidence and thorough analysis as very little is known about the likely social impacts of the IoT on lives of citizens (González 2011).

The aim of this contribution is to focus on the IoT from both economic and social points of view. Particularly, the objectives are to specify: the economic situation of European countries and of European ICT industry as prerequisites to the development of the IoT, possible utilization of these technologies, expected economic and social benefits and risks to business and to the wider society, strengths and weaknesses, opportunities and threats (SWOT analysis) that the IoT poses to business as well as wider society.

2 Economic Impact of IoT in Europe

2.1 *Situation of ICT Industry in Europe*

In order to be able to describe the potential impacts of the IoT on business in Europe, it is crucial to know the economic situation of European countries, the level of innovation and technological equipment as well as the state of European ICT sector. The ICT sector's share of GDP in the EU countries has recently fluctuated between 3 and 5 %. In this short period it is impossible to witness either growing or falling trends. Germany, France and England remain long-term leaders in this respect. Research and development expenditures differ a lot in European countries. Figure 1 shows several (in this respect the best and the worst) European countries compared to the USA and China. Expenditures in China are similar to the EU average.

The patenting activity is another indicator of the country's development. In Fig. 2, the patenting activity is evaluated based on the Global Innovation Index (on the scale from 0 to 100). It shows that even the most advanced European countries are ranked below China and the USA. On the other hand, technological infrastructure is very good in Europe. The incidence of internet access and PC ownership in households was in 2012 between 55 and 95 % in individual countries.

In the private sector, the share of European companies with internet access has recently been growing. In 2012 it reached 92 % (Fig. 3).

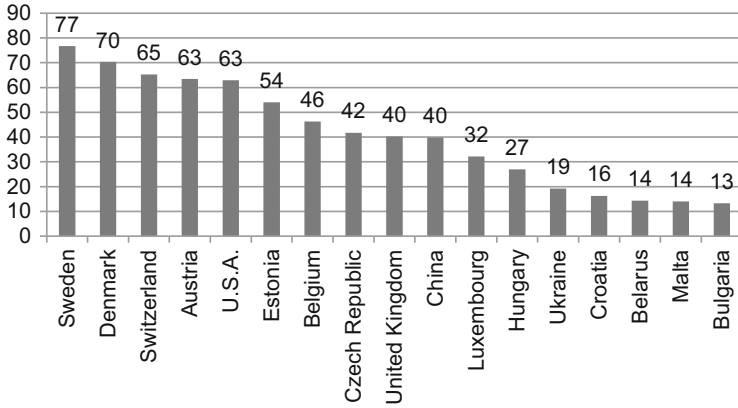


Fig. 1 Gross expenditure on R&D (in %). *Source:* Global Innovation Index (2014)

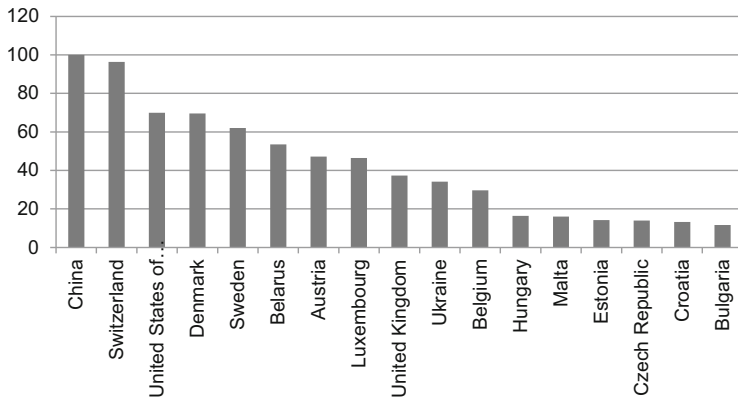


Fig. 2 National office resident patent applications. *Source:* Global Innovation Index (2014)

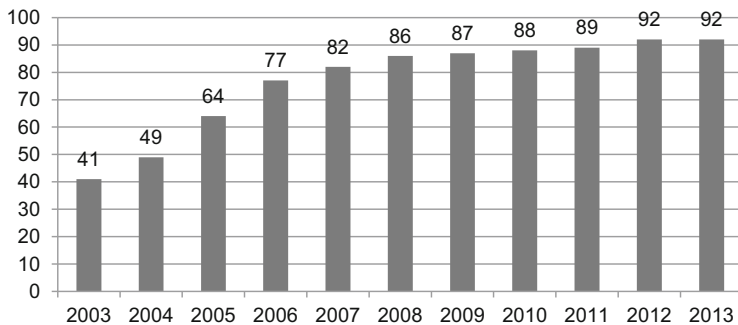


Fig. 3 Companies with high speed internet connection (% of companies with 10-plus employees). *Source:* Eurostat

To sum up, the level of internet access as well as used technologies is high in both European households and companies. Much worse is the situation in the field of innovation support. European countries spend less on research and development and the number of patents is low.

3 Economic Benefits and Risks of IoT in Relation to Business

3.1 Potential IoT Applications

The potential of the IoT has been specified particularly in the field of health (González 2011; Chui et al. 2010; Crump and Brown 2013; Mehta 2014), where it will be instrumental particularly in remote monitoring the patient's medical conditions, e.g. diabetes, Alzheimer's, high blood pressure, heart rate and rhythm, sugar level, as well as the patient's behavior, sleeping pattern, and so forth. If necessary, it will be possible to monitor the patient's heart, intestines or other organs. Consequently, doctors will be get early warning of the patient's condition, and they will be allowed to better diagnose disease and prescribe customized treatment (Chui et al. 2010; Efremov et al. 2015).

Traffic is another promising field of IoT application. The IoT will increase safety on roads (Chui et al. 2010; Mehta 2014). Driving will be much safer as smart cars will reduce the probability of failures, detect imminent collisions and take evasive actions by means of automatic braking systems. Traffic management will become much better as e.g. traffic lights will adjust to real time traffic conditions, road sensors will advise car dashboards about real-time traffic information. Real time information like path optimization, traffic monitoring, etc. will be available. Accident monitoring will help coordinate incident management and emergency response (Mehta 2014).

In the automotive industry (Haller et al. 2009), sensors and embedded systems already play a large role. When detecting hazards or blockings on the road as visualized, these vehicles can generate appropriate messages containing a description, their geographical position and many more application-dependent pieces of information. Messages may be immediately broadcasted to all other cars within communication range, which in turn can store, evaluate and forward them.

Another important asset of the IoT is its potential to greatly increase efficiency and reduce waste, loss and cost. Automated systems may change the use of scarce resources, including water or energy and increase energy efficiency (Chui et al. 2010; Crump and Brown 2013; Glova et al. 2014). Energy supply and consumption will be monitored and adjusted according to the real time needs. It will apply to whole cities (smart cities) as well as individual households (smart homes). Household appliances like thermostats, lights, dishwashers, air

conditioning etc. will adjust themselves to consume less energy by switching off during peak times (Chui et al. 2010).

There is a huge potential of IoT in business in general. According to the Aberdeen Group, 70 % of manufacturing executives are focusing on plant-floor data initiatives to drive operational and business excellence, faster time to market, and immediate access to data from machines on the factory floor. Characteristics of the new intelligent manufacturing environment include (Davenport 2013; Gubbi et al. 2013):

- **Smart Assembly.** Seeking to reduce disconnects between the manufacturing and enterprise networks, manufacturers are adopting converged intelligent networks are reducing downtime by allowing remote access to systems and partners and delivering precision, resiliency, and reliability from the plant floor to the enterprise.
- **The Visual Factory.** Manufacturers need better visibility into equipment performance, resource needs, and security threats. Emerging networking and connectivity solutions enable a dashboard view of multi-plant environments, enhancing efficiency, safety and return on assets.
- **Wide Visibility.** Industrial facilities with globally dispersed production sites need better integrated production systems to shorten lead times. Internet Protocol (IP) network technology connects enterprise applications with device-level production data in real time, allowing faster information flows, faster decisions, and greater market responsiveness.

3.2 Benefits of IoT

The IoT may provide ubiquitous services for connected customers and lead to a truly sustainable development as it can help reduce the environmental impact of human activities. At the same time, individuals will be able to play a more active role thanks to their permanent and ubiquitous connectivity. As a consequence of this access to information and communication, large corporations may lose some of their influence to individual entrepreneurs capable of identifying efficient alternatives. Individuals will probably be much more involved in innovation as it should become much more user-led in the future than it is today (Crump and Brown 2013).

Last but not least, current experience with social networks prove that individual effort may become a platform open to millions of people. One of the most promising fields influenced by the popular use of social networks is the optimization of consumption (González 2011).

Today's IoT technologies and services are also employing increasingly sophisticated business intelligence (BI) and analytics to determine when the data generated from remote devices and objects suggests that a potential problem or opportunity is likely. This predictive capability can enable a service provider to replace parts before they fail based on their usage patterns. It can help companies

better anticipate consumer demand based on their current behavior. This capability can also improve operating efficiency and produce greater customer satisfaction.

3.3 *Risks of IoT*

The IoT is not deemed to be solely positive. There are a lot of risks and concerns attached to it. It is quite difficult to estimate the potential risk of new relationships between people and computers. The most frequently mentioned risks are privacy and data protection. In this respect, public attitudes, opinions and behavior will be critical as far as privacy and data protection are concerned. It will depend on the people how much they will care about giving away information about themselves. People may nonetheless embrace privacy-friendly approaches to data collection and data minimization can become an important data protection concept (Crump and Brown 2013).

ISACA (Angeles 2013), a professional information security, assurance, risk management and governance association, has released 2013 IT Risk/Reward Barometer, a study highlighting consumers' struggle between privacy and convenience in an increasingly interconnected world.

The IoT may cause several problems linked to its social aspects. People may find the IoT intrusive on their private life, it may further reduce personal interaction as more people will work from home. Teleworking may cause psychological problems, such as the feeling of loneliness and unhappiness, to individuals who need social interaction in their daily lives. Another negative aspect of new technologies is reduced physical activity caused by using smart gadgets. It may lead to health problems like obesity, heart disease, diabetes, etc. (Ashton 2009). Nonetheless, the most frequently mentioned problems are privacy, security, and data protection. Data protection will probably not be globally coordinated as there is little chance that European data protection regulations will be adopted in the USA or elsewhere (Crump and Brown 2013). The unprecedented amount of data sharing may have much more dramatic effects than those in the case of ICT. The implications will be both intended and unintended, the latter not only difficult to forecast but also potentially dangerous. The resulting change to society may be huge. The whole society will be much more vulnerable to hacking or major system crashes. Potential inequality in access to valuable data may cause another digital divide between individuals as well as societies. Social consequences may also include job losses as robots and automated systems will replace manual operations, resulting in social problems caused by the fact that the unemployed loss both status and self-esteem. To sum up, the field of social impacts of the IoT needs further research. Experts, politicians as well as public should be involved in the discussion to determine potential advantages and risks linked to the introduction of the IoT.

Economic as well as social impacts of the IoT are summarized as its strengths, weaknesses, opportunities and threats in the following SWOT analysis.

4 SWOT Analysis of Using IoT in Europe

Strengths and weaknesses of the IoT in Europe, which are based on the above mentioned social and economic aspects of the IoT, are summarized in Table 1.

Table 1 suggests that there is good ICT infrastructure in European countries, which is supported by European governments. Small and medium companies as well as ordinary citizens are interested in ICT, too. There have been identified a lot of opportunities. Among others, there is a huge potential of the ICT related to the fact that European population has been ageing. The IoT generates opportunities for solving senior people’s health problems. It may also help increase safety and efficiency. Moreover, a growing number of European households have had good

Table 1 SWOT analysis of IoT

Strengths	Weaknesses
<ul style="list-style-type: none"> • Support to the ICT sector by governments in many EU countries • Good ICT infrastructure in European countries • High level of development in the field of ICT services • Creating quality legislative measures • Flexible company strategy of ICT sector’s SME (small and medium enterprises) • Fascination with new things and technologies 	<ul style="list-style-type: none"> • Limited financial capital for research and development • Limited possibility of returns to scale • Insufficient focus on commercial utilization of newly developed products • Non-existent legislative environment that would define the IoT • It will be difficult to opt out in case one disapproves with the IoT • Globally uncoordinated data protection policy • Lack of research on the social impacts of the IoT • Public lack of awareness about the potential risks
Opportunities	Threats
<ul style="list-style-type: none"> • European ICT sector has been growing • Excellent results of European ICT sector • Good internet access in many European countries’ households, in other countries it has been improving • Growth in ICT technology facilities in European households • Ongoing discussion on the EU level aimed at defining legislative framework for the IoT • Huge potential of the IoT in relation to the ageing population in Europe • European companies are aware of the potential and opportunities the IoT offers to business • Improved health, safety, efficiency • More active role of individuals in business and society through better access to information and social networks • Responsible public attitudes, opinions and behaviour towards treating risks related to the IoT 	<ul style="list-style-type: none"> • Insufficient legislation in the field of data protection • Worries about the potential loss of privacy, • Financial crisis • Insufficient implementation of ICT, particularly in industrial SME (ECORYS 2009) • The elected representatives’ lack of expertise

internet access, which results in more active role of individuals in solving business and social issues.

On the other hand, there are several weaknesses, too. In particular, there is a lack of financial resources for research and development. Newly developed products are insufficiently utilized in commercial sphere and there is little awareness of potential risk linked to the IoT. Last but not least, some worries about the potential loss of privacy, financial crisis, insufficient implementation of ICT in industrial SME and a lack of expertise of the elected representatives who decide on a lot of important things.

5 Conclusion

IOT presents many opportunities for industry verticals and brings about new innovations to businesses. With real-time data and potentially cross-domain data sharing, new business models can be created. In order to achieve economic benefits from the IoT, companies as well as society should invest in high quality technological infrastructure and be able to integrate new technologies with the existing ones. Moreover, it is necessary to develop effective procedures for treating information.

The level of technological infrastructure in the EU is favourable for the development of the IoT. Problem and risk of its fast development lies in the approach of its potential users afraid of the loss of privacy and in the fact that there is no strictly given legislative framework for the IoT. The implications for human society are difficult to forecast. It is however clear that the imminent changes will be profound. The IoT will transform almost everything: the way of doing things, education or environment. Industry, services and production are presently considered to be the fields having the greatest potential to achieve benefits from the IoT. Their success will depend on mostly the chosen strategy, not on their size or financial strength.

Acknowledgement This paper is published thanks to the support of the internal projects of University of Hradec Kralove: Economic and Managerial Aspects of Processes in Biomedicine and specific university research (MSMT no. 2111/2014).

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