

Current Global Trends in ICT Development: Disruptive Technologies, Smart City and Economic Impact

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Abstract

ICT development has been exponential in the last decade both at European level and globally. Analyzing some relevant statistics, we focused on demonstrating that ICT is being used more and more at the individual level, by citizens, we cannot ignore the fact that local government institutions are the ones that need to be responsible for educating society and getting involved in the development of smart cities. Finally, we discussed about disruptive technologies and their connection to the smart city concept. As we have seen, these disruptive technologies such as IoT, Big data or Open data are in the attention of private companies in order to improve their profitability, but public bodies still struggle to understand and implement these concepts. Few examples are given with regards of disruptive technologies and recommendations are formulated for organizations to keep up the pace with technology development.

Key words: ICT development, smart city, disruptive technology

J.E.L. classification: M15, O33

1. Introduction

For centuries, knowledge has been perceived as the driving force that stood behind technological and scientific progress. It has also always been considered as a facilitator for production systems that have become increasingly sophisticated over time. The first industrial revolution gave a significant boost to the growing position of knowledge in the production value chain. Its role changed again with the development of information technology and telecommunications (ICT) which created the information age. In the following decades, the importance of knowledge in trade, business and production grew and evolved into one of the primary factors of production in many industries. The rapid development of science and technology since the early 1990s has further strengthened the status of knowledge, being the main resource in all economic sectors related to technology, but also as the most valuable facilitator of economic growth and social transformation (Figure 1).

As (Kabir, 2019) stated, ICT might be viewed only as a step in the evolution of humanity, a tool, and technological advances and innovation are what have initiated the rise in living standards. Thus, the fourth industrial revolution is considered, worldwide, as an evolution designed to ensure sustainable development in the context of the new economy, that is the knowledge economy. It is characterized by the intensification of knowledge in the provision of new products and services, the increasing importance of learning and innovation, globalization and sustainable development.

ICT is a term used to refer to information and communication technology, emphasizing the integration of telecommunications, computers and the relevant system needed to access, share, transmit and also to store information. The term information and communication technology has been used in academic research, while the abbreviation ICT has spread worldwide after being used by Dennis Stevenson in a UK government report (Kelly *et al.*, 2000). Studies have shown that ICT is one of the strongest driving forces of social development and will play a vital role in sustainable growth in the 21st century.

When it comes to urban development, ICT has taken over the role of changing the evolution of cities, introducing the innovative concept of "smart city" (Escher Group, 2014). As Bakici, Almirall and Wareham (Bakici, Almirall and Wareham, 2013) define smart cities as cities that use information and communication technologies in order to increase the quality of life of their inhabitants, while ensuring sustainable development, we can conclude that ICT plays a crucial role in the sustainable development of urbanization to ensure the best quality of the living environment and its citizens.

2. Theoretical background

It is nowadays more than obvious that there is an interdependency between ICT and smart city, both key concepts in urban development. The use of ICT in cities is becoming increasingly important, even vital in urban development, a fact that is easily observable once we analyze the concept of smart city. According to Mone, cities are systems of systems (Mone, 2015) and therefore technologies are applied to create a more efficient system that improves communication and exchange of information between different bodies in the city system. Many scientists agree that the application of ICT is what makes a city smart. Thus, in smart cities, information and communication technology (ICT) is seen as the core technology and among the important criteria for smart cities (Ahmad and Mehmood, 2015). The integration of technologies into the daily lives of citizens allows them the opportunity to share feedback and gain new experiences, and even to create new products and services.

The essence of smart cities is to find smart solutions that enable the smart and efficient use of modern ICTs in the daily lives of citizens, taking into account other aspects, such as environmental protection and social issues. Analyzing environmental solutions, these are the responsibility of public administration, but also of large corporations, and they cannot afford to ignore it. Thus, the structure and governance of smart cities (or smart communities, if they are related to larger areas) are based on the institutions of the so-called green economy, which is a key aspect nowadays (Ferrara, 2015). In addition to environmental issues, the application of ICT in the smart city is a strong reason to take into account social factors related to citizens.

Looking to the future, it is very likely that ICT will play not only a significant role as a technological tool, simplifying daily services and activities, but also as a tool for citizens to be active participants in creating and further developing of smart city. Even if ICTs should increase productivity, profitability, equity, information transfer, lead to less bureaucracy, etc., the costs of ICT infrastructure in the perspective of sustainable development must ultimately be taken into account. However, ICT addiction is constantly growing and will reach one of its peaks when people live and work exclusively in smart cities (Ahmad and Mehmood, 2015). Trust in technology also plays an important role in the process of involving citizens in decision-making for the smart city through ICT. Different societies and cultures, even religion are the factors that influence such a willingness of citizens to share their experience, to get actively involved and to bring development suggestions. We believe that it is important to study all these aspects, in particular to analyze how to successfully manage ICTs that can reduce risks and increase the potential of smart cities.

In Table no. 1 we have presented the main goals of creating smart cities and also reveal how information and communication technology is applied in order to implement such objectives. Basically, ICT is almost the only and truly most applicable tool to implement the key element of smart cities, to create a sustainable urban environment. It is very likely that without ICT, the idea of smart cities will disappear, because new tools for implementing goals, such as establishing closer relationships, maintaining a sustainable environment, managing urban flows, city administration should be rediscovered, and these issues need to be considered. Also, if we take a look at it from another perspective, the concept of smart city was invented after information and communication technology was known as such, which means that ICT is the foundation that led from the beginning to the emergence of the concept of smart city.

Table no. 1 Applying ICT in creating the smart city

The purpose of smart city	ICT application
Establish a closer relationship between different sectors, such as: private, governmental, non-governmental organizations, associations, other communities and citizens	<ul style="list-style-type: none"> • Implementing the common framework or systems that allow different sectors to communicate more easily and efficiently; • Broadband infrastructure that combines cables, fiber optics and wireless networks
Maintaining a sustainable environment	Reducing greenhouse gas emissions and improving the energy efficiency of urban infrastructure (Schaffers <i>et al.</i> , 2011)
Urban flow management / urban development control	Tracking these flows using ICT, creating applications for data collection and analyzing them to make forecasts.
Efficient administration and management of the city, health care, education, real estate, transportation, security, etc.	Creating applications that will run and improve each business sector, city cluster and infrastructure (Schaffers <i>et al.</i> , 2011)

Source: author's own elaboration

Apart from those mentioned, the vision on the technologies implemented in the smart city cannot be limited only to the technical means. Smart cities need smart management to function successfully, and one of the main challenges for the successful creation of smart cities is to establish a close relationship between the three parties: government, the private sector and citizens. The government sector in this case could include state bodies, associations or other communities, private sector actors can also range from large enterprises to a very small non-profit organization. The third and main element in the smart city are the citizens. Close communication and two-way understanding, as well as cooperation between these three types of stakeholders, is a key to success not only at macro level but also within a single city or community.

3. Research methodology

In the current paper we discuss a wide-spread concept with connections to all fields, not only economy: information and communication technology, as a foundation for the development of smart city projects and solutions. We debate the role of ICT in the smart city, but also the effects of the development of this sector in the economy analyzing and comparing some statistical data issued by Eurostat for the year 2019. Indicators of economic and social development in the ICT sector provide a statistical view of the use of ICT at both European and global level. By comparing them, we conclude that ICT is used more and more every year and we could even observe some saturation. This high development of the sector had usually led to disruptive technology in the past and current state of the sector is no exception either. We focused also on bringing into attention some concepts defined as disruptive technologies nowadays since we believe that there is a direct connection between increased usage of ICT and disruptive technologies.

4. Indicators of economic and social development in the ICT sector

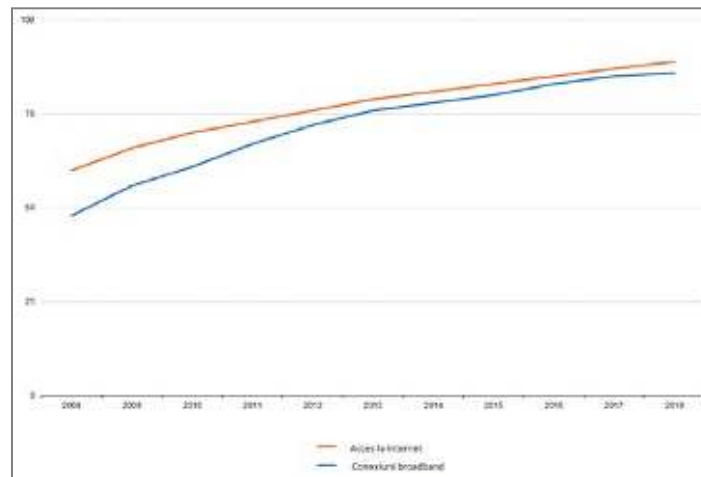
Modern developments in EU states generated by initiatives and measures aimed at shaping the digital single market are the key expression of the fundamental principles and elements of the European conglomerate, mainly those of the free movement of people, services and capital. The purpose of implementing the digital single market is to create a single market without borders. This market is estimated to contribute EUR 415 billion annually to the European Union economy (EC, 2015). The digital single market strategy, adopted in 2015, was designed on three pillars, as follows:

- better access for consumers and businesses to digital products and services in Europe;
- creation of digital networks and innovative services;
- expansion of growth potential that the digital economy has.

Still, the implementation of this strategy is blocked by the different levels of development of the digital economy infrastructure. Among the reasons for that we observed that this is caused by the different levels of the information and communication technology sector in the economies of the member states. Moreover, the implementation of this strategy is also influenced by the resources dedicated to research and development, in order to streamline the processes and technologies involved. We will analyze in the following section some of the indicators in order to observe how ICT has been developing the last decade.

Accessibility and cost of ICT has led to this being more accessible to citizens across the globe, especially in EU beginning with 2007. At that time more than half (55%) of EU-28 households had internet access. This percentage has grown over years and in 2018, the share of EU-28 households with access to the internet was 89%. Development of information society may be observed by analyzing broadband access and wide access statistics. Broadband is the most used internet access in EU, and we can observe in Figure no. 1 a percentage of 86% of EU-28 households in 2018, an increase of 38 points comparing with year 2008.

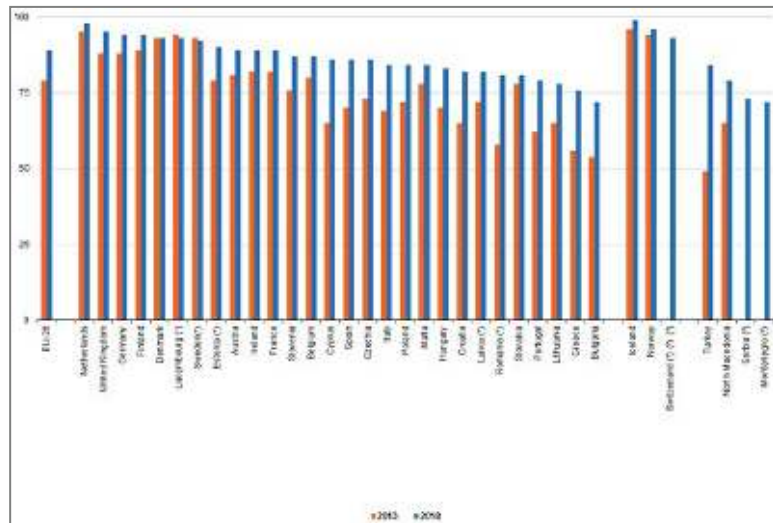
Figure no. 1. Internet access and broadband internet connections of households, EU-28, 2008-2018 (% of all households).



Source: Eurostat

Figure no. 2 shows that Netherlands with 98% of households with internet access in 2018 is the leading country among EU Member States, followed by United Kingdom, Germany, Finland, Denmark, Luxembourg and Sweden. Bulgaria with 72% has the lowest percentage in internet access rate across EU. Still, one might argue that Bulgaria, Romania, Cyprus, Greece, Portugal and Croatia are the countries that reached a fast expansion of the proportion of households with access to the internet, between 2013 and 2018. Some countries such as Netherlands, Denmark, Iceland and Norway are relatively stable in this area since in 2013 home internet access was already almost saturated here.

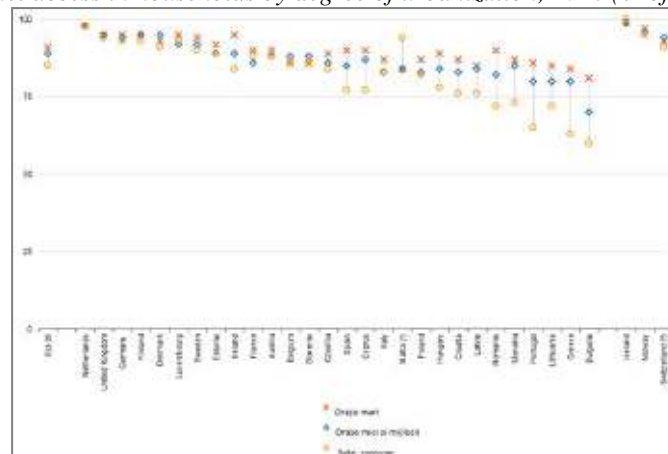
Figure no. 2. Internet access of households, 2013 and 2018 (% of all households).



Source: Eurostat

There is no doubt that there is an urban-rural gap within the EU-28 countries in what concerns the access to internet, as we can observe in Figure no. 3. Thus, large, medium-sized and even small cities have households with high access rates (between 89% and 91%), while internet access in rural areas is approximately 85%. This gap could better be observed in countries such as Greece, Portugal, Bulgaria and Romania, each with a lower overall level of internet access than the EU-28 average. In the Netherlands, on the other side, the share of households with access to internet is the same for rural and urban areas, no matter the size of the cities taken into consideration. A similar case is attributed to United Kingdom, with only a smaller percentage in rural areas.

Figure no. 3. Internet access in households by degree of urbanization, 2018 (% of all households).

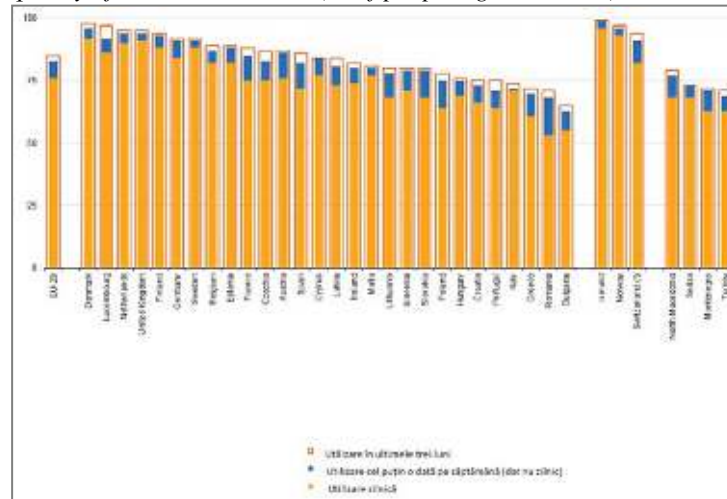


Source: Eurostat

There is a percentage of approximately 85% of all EU-28 people with ages between 16 and 74 that have used the internet in 2018. In states like Denmark, Luxembourg, the Netherlands, United Kingdom, Finland, Germany and Sweden, at least 9 out of 10 people have used the Internet in the three months prior to the survey conducted. On the other side, the lowest shares could be observed in Italy (74%), Greece (72%), Romania (71%) and Bulgaria (65%). In 2018 only 11% of the entire EU population has never used the internet is 11%, this percentage falling every year when compared to year 2008 when its value was 33%. More than three quarters of people in the EU-28 have accessed the internet daily, and 7% were using it at least once a week.

The proportion of daily internet users per total in 2018 was approximately 89% on average in the entire EU with variations from 76% in Romania to 96% in Italy and also United Kingdom. Iceland is the country with the highest share of daily internet users among all internet users, that is 97%.

Figure no. 4. Frequency of internet use, 2018 (% of people aged 16 to 74).

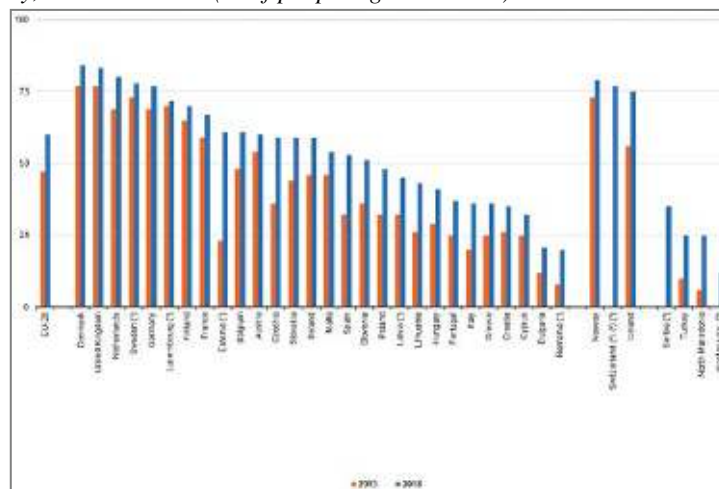


Source: Eurostat

The proportion of EU citizens with ages between 16 and 74 who ordered or bought online goods or services for private use has continued to grow since 2013, as we can observe in Figure no. 5. Thus, it was 60% in 2018, while in 2013 was only 47%. High percentages have been recorded in countries such as Germany and Sweden (more than 75%), 80% in Netherlands, 83% in United Kingdom and 84% in Denmark. On the other side, Cyprus (32%), Bulgaria (21%) and Romania (20%) have the lowest percentages in EU of with individual aged between 16 and 74 who ordered or bought online goods or services for private use.

The largest increase in the percentages of individuals who ordered or bought online goods or services between years 2013 and 2018 could be seen in the Czech Republic (23% more), Spain (approximately 21% more). Denmark, United Kingdom and Norway have the lowest percentages of individuals who order or buy online products or services and that is because these countries already had already good percentages in this field in 2013. By comparison, moderate increase in this indicator have been observed in Malta (8%) and Cyprus (7%).

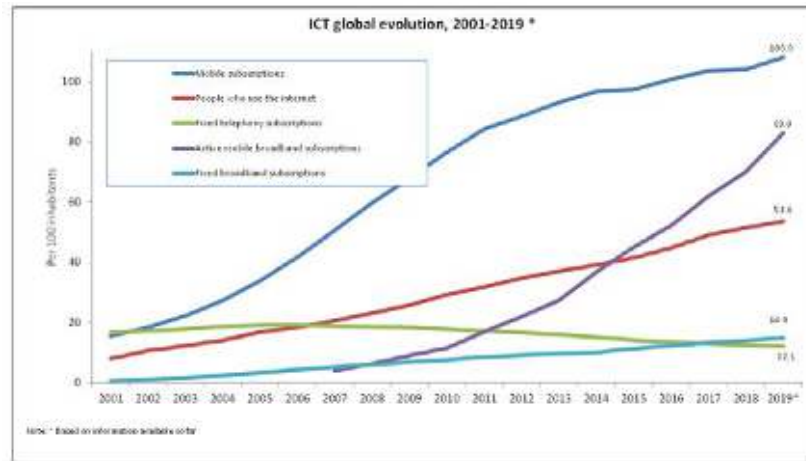
Figure no. 5. Persons who ordered goods or services on the Internet for private use in the 12 months prior to the survey, 2013 and 2018 (% of people aged 16 to 74).



Source: Eurostat

Given that we have discussed the importance of the use of ICT in the EU, as well as the link between ICT and development of *smart city* concept, we consider it relevant to conclude that the use of ICT is growing both in the EU and globally. To illustrate this conclusion, we present in Figure no. 6 the global developments of ICT in the period 2001-2019.

Figure no. 6. Global ICT developments for the period 2001-2019.



Source: <https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx>.

We can observe in Figure no. 6 that Internet usage increased all over the globe, with more than a half (approximately 53%) individuals using the Internet. Still, there are estimation that state that approximately 3.6 billion people do not use Internet, especially in the least developed countries, where only two out of ten people are online.

In developed countries situation is at the opposite end and is approaching saturation, with approximately 87% of people being online. The highest internet usage percentage is in Europe with 82% and Africa is the lowest with 28%. ITU estimated that by the end of 2019 a percentage of 57% of households on the entire globe will have access to the Internet. Still, households owing a computer was expected to grow to approximately 49%. This slow increase is due in our opinion to the fact that computers alone are no longer needed to connect to the Internet at home, individuals being accustomed nowadays to use other electronic devices as well (smartphones or other devices).

Key barriers to the adoption and efficient use of the Internet are represented by accessibility infrastructure and lack of digital skills, especially when it comes to the least developed countries. In 40 of the 84 countries which have declared relevant data in the field, less than half of the population has skills such as basic computer usage (e.g. copying a file or sending an e-mail with an attachment). There is no doubt that more data are required, but the current findings indicate a strong and pressing need for governments to focus on measures to develop digital skills, especially in least developed countries. This is all the more necessary as, as we have already mentioned, ICT and their use is closely linked to the development, urbanization, emergence and implementation of *smart city* solutions designed to increase the quality of life in urban areas and beyond.

5. Disruptive technologies and their economic implications

It is generally accepted that development of ICT, together with technological innovation is the basis for increasing the productivity of firms and the economic growth of states. This general statement, as described by (Solow, 1956) and improved by (Romer, 1990), (Aghion and Howitt, 1992), contains an essential truth that more productive firms will ultimately replace the less productive in a Schumpeterian manner. The exponential growth of economic development since the Second Industrial Revolution and the considerable improvement in living standards are an undeniable consequence of the importance of technological innovation.

A catalyst for economic growth, technological progress offers a lot of potential, but it can also be a disruptive force for the labor market and already established business models. Disruptive innovation, as defined by Clayton Christensen (Christensen, 1997), refers to innovation that creates a new market by applying a different set of values and that ultimately (and unexpectedly) goes beyond an existing market. This is partly achieved by capitalizing on new technologies, but also by developing new business models and exploiting old technologies in new ways. Products or services based on disruptive technologies are usually cheaper to produce, simpler, more efficient and more convenient to use.

Disruptive technologies can have an impact on growth, employment and inequality by creating new markets and business practices, needs for new product infrastructure and different work skills. This, in addition to affecting existing firms in well-established markets, may also affect the labor market, workers' incomes and, ultimately, income distribution. Examples of disruptive technologies include concepts such as the email, personal computer or laptop, and smartphones that have revolutionized communication and the way we work or spend our free time and have taken many products out of use, such as typewriters, pocket cameras, and GPS devices, among others. New business models are also disrupting entire industries, such as Uber in the taxi industry, Netflix with satellite and cable TV, and Skype with telecommunications.

Such concepts of "Internet of Things", "Open data" and "Big data" are an integral part of *smart city* and are therefore part of the discussion on how ICT can make the city's processes more efficient and effective. Many urban administrations struggle to understand these concepts and are therefore too little or not applied at all.

First, the Internet of Things represents everyday objects that are part of the Internet and are able to communicate with each other and with their users (Zanella *et al.*, 2014). This should allow public and private organizations to integrate online and offline services and the incorporation of sensors into everyday objects that can make everything connected. This automatically leads to a change in the way products and services are provided to customers or citizens (Li *et al.*, 2016).

Second, through the use of ICT infrastructure and services, local governments, businesses, citizens and other organizations create Big data, i.e. data sets that are too large to be managed using traditional and well-known data management systems. *Smart city* allows the use of this data and the provision of services based on this data. The data can be used by public administrations and companies to provide personalized services but can also be used by citizens to play a more active role in the life of the city and the community they belong to. Therefore, Big data can lead to closer proximity to customers or citizens (Li *et al.*, 2016).

Third, Open data, which is the free availability of information, for example by opening datasets to customers, the public or citizens, is largely related to the concept of *smart city* when it comes to smart governance (Walravens, Breuer and Ballon, 2014). Public institutions produce a wealth of useful data on, for example, mobility, tourism and crime, but which are not only of great value to entrepreneurs, SMEs or large enterprises, but can also be used to empower citizens and increase participation and social involvement. Moreover, it encourages innovation and will stimulate governance to be more efficient and transparent. OECD stated that great potential could be unleashed when government data are made public (Ubaldi, 2013). These Open data can be used freely, reused and distributed to anyone and by anyone. However, the current status quo on Open data, especially those issued by public organizations, is still immature (Vilajosana *et al.*, 2013; Clarke and Margetts, 2014). The necessary departments and expertise are often lacking. For example, in the Netherlands the first improvements were made to an open data culture, so the municipality of Utrecht set up an Open Data Officer position. However, many questions and challenges remain in this area, and governments are still working to address these issues, what business models are appropriate and how to improve existing practices.

In addition, while urban planning history and theories have focused on long-term development (between 20 and 50 years), the focus of Big Data is on short-term thinking about the functioning and management of cities (e.g., daily flows peak). Batty (2013) argues that data without theory is meaningless: it is not enough to just collect data, because when the amount of data increases, the amount of correlations also increases.

As the necessary theories take a longer period of time, this short-term approach may be unsustainable and long-term strategic planning may be desirable. From our point of view, these are the issues and challenges that local governments need to consider when implementing smart solutions for cities.

6. Conclusions

In this paper we have tried to demonstrate that the development of ICT is exponential in the last decade both at European level and globally. In this regard, we have noticed that, together with a more frequent application of ICT and the successful management of technology, the digital economy is gaining more and more ground every day. An increasing number of individuals are willing to use ICT as a tool to simplify their daily lives, and this is undoubtedly a major influence from our point of view in cities. As we have focused on demonstrating that ICT is increasingly used at the individual level by citizens, we cannot ignore the fact that local government organizations are the ones who must be responsible for educating society and engaging in the development of smart cities. Therefore, in our opinion, new ways of effective communication and the adoption of solutions to facilitate this interaction must be established.

Last but not least, we discussed disruptive technologies and their connection to the smart city. As we have seen, these disruptive technologies such as IoT, Big data or Open data are in the attention of private companies in order to improve their profitability, but public institutions are still struggling to understand these concepts, still showing great difficulties in implementation.

There is no doubt that the focal point of a smart city is to create and exploit the relationships and links between human and social capital and ICT in order to generate sustainable economic growth for the city and improve the quality of life of its inhabitants. Furthermore, the success of any initiative in this field would have to take into consideration the current global trends in ICT development, integrating some of the newest disruptive technologies and analyze economic impact and risks, always having in mind all the stakeholders involved and the final beneficiaries, the citizens.

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