

The Accelerated Development Of Information And Communication Technologies And Their Role Within Smart Cities

Marta Christina SUCIU

The Bucharest University of Economic Studies, Bucharest, Romania

mcsuciu50@gmail.com

Adrian PETRE

The Bucharest University of Economic Studies, Bucharest, Romania

adi.petre13@gmail.com

Abstract

Information and communication technologies - ICT - play an essential role for the smart cities sustainable development. They may support advanced strategies and policies, based on the principles of smart competitiveness that will facilitate the medium and long-run regional economies, smart, sustainable, inclusive development and correspondingly a higher quality of life and environment.

Based on the evolution of ICT, many states have designed and implemented their own standardized strategies and policies in order to develop smart cities and creative local communities.

The main goal of the paper is to highlight how the evolution of Information and Communication Technologies (ICT) has influenced the smart cities development across Europe with a special reference to some local communities.

In order to better achieve this goal, from a methodological point of view we applied an empirical analysis of the strategies adopted by some of the European smart cities (Warsaw and Munchen), with an attempt to identify if there is a relevant correlation between ICT evolution, on one hand, and the development of smart cities and local communities, on the other hand.

We designed our research methodology such as to get a broader imagine concerning the entire development process that can support or, in some cases, invalidate some of the theoretical approach dedicated to our topic. At the same time, we consider that our research results may be used as the basis for developing further studies through which we intend to illustrate how Romania can design in a sustainable manner, according to the

specificity of our national economy and local communities, its own strategies and policies based on the best practices identified on the European level.

Keywords: *smart communities, smart competitiveness, long-run smart, European cities, sustainable and inclusive development strategies.*

1. Introduction

Nowadays, there is an increasing tendency of urbanization, characterized by the migration of the rural population to the urban environment. According to data presented by the United Nations in its report entitled *"2018 Revision of World Urbanization Prospects"*, in 2018 55% of the global population lives in urban areas and it is predicted that this proportion will increase to 68% by 2050.

According to (Ji et al., 2011) population mobility in urban areas creates certain problems, such as insufficient public resources.

In this context, it is necessary to develop and implement new innovative solutions so that modern cities develop smart and be able to respond to new challenges.

One of the most important solutions in favor of a sustainable development for smart cities is represented by Information and Communication Technologies (ICT), on the basis of which there might be designed proper strategies to increase the regional economy and improve the standard of living of citizens.

According to (Manville et al., 2014), smart cities create an interdependent connection between society, government and technology, through which the smart economy, the smart community and the smart governance develop in a sustainable way.

Thus, we can assume that access to advanced information and technologies creates the premises for the development of knowledge-based society and economy, which is nowadays the main engine of economic development.

Considering these facts, the main purpose of this article is to highlight the role of information and communication technologies in the development of some smart cities in Europe and those local communities.

For a more detailed analysis of the subject, we will continue to discuss the state of knowledge in this field, where we will present some of the most important approaches in the scientific literature regarding the characteristics of smart cities, as well as the role of information and communication technologies in their development.

2. Brief literature review

By investigating the scientific literature, we had identified many studies and publications that highlight the key role of ICT for the sustainable development of smart cities. There is currently no unanimously accepted definition for defining a smart city.

For example, (Washburn et al., 2010) asserts that smart cities are entities characterized by high-tech public infrastructures and services where IT systems contribute greatly to optimizing socio-economic processes.

In another study (Angelidou, 2016) describes two of the essential features of smart cities. The first feature is the role of technologies in the accumulation and organization of a large amount of information, which is used to improve urban life and save public resources. The continuous accumulation of information, processed through advanced analytical systems, helps to predict trends or events and in this way, depending on the circumstances, they can be properly managed or prevented. At the same time, the accumulation of information through advanced technologies helps public authorities to adopt the best decisions and strategies for optimal problem solving. The second key feature of smart cities is *the development of human and social capital* by creating and disseminating knowledge and digital inclusion, thus implementing new forms of innovation more indicated in the context of a knowledge and innovation based economy and society.

From another point of view, (Nam and Pardo, 2011) demonstrate that it is essential to have a human capital characterized by affinity for lifelong learning, flexibility and creativity so that it can contribute to the sustainable and inclusive development of smart cities.

On the other hand, (Kramer et al., 2007), (Adeyanju et al., 2013) and (Rangan, 2009) believe that information and communication technologies contribute to the improvement of the productivity by reducing transaction costs, rapid access to information and knowledge, expanding the geographic sphere of potential markets, decreasing communication costs and accessing a wide range of goods and services.

According to (Smas et al., 2016), cities can now be considered as urban living labs where new ideas, experiments and concepts are tested and implemented.

Modern research studies examine how smart cities and local communities are developing, places an important emphasis on the Triple Helix Model (Etzkowitz and Leydesdorff, 1995) which tests the interaction between universities, governments and economic industries to provide the latest information, strategies and innovative solutions that lead to a sustainable, inclusive and smart development of the economy and society as a whole.

In the next section we will conduct an empirical analysis of the main strategies adopted by some of the smart cities in Europe and we will determine the correlation between the evolution of ICT and the development of those cities.

3. Case studies and best practices examples. The case of Warsaw and Munich as smart cities

Warsaw and Munich are two of the most important smart cities in Europe, and we consider it opportune to identify the strategies adopted by these cities in smart development projects and the role played by ICT in achieving this goal.

We chose to focus the case study on these two cities because they have different level of development, budgets and cultures. Moreover, because Poland is an emergent country that intends to join the Eurozone, we believe that the strategies

adopted by the capital of this country can be an example of best practice for some of Romania's cities as well.

3.1. Warsaw case study as a smart city

The capital of Poland, Warsaw, is one of the smart and innovative cities in Europe, which has developed in this direction based on well-developed and implemented strategies, designed to improve the citizens' living standards. These strategies are mainly represented by investments in infrastructure and digitalisation of public services (Warsaw towards a smart city, 2018).

Also, one of the most important measures adopted by the Warsaw administration was to involve citizens in the city governance, because human capital is one of the essential parts of the sustainable development approach of an area. To reduce pollution and urban traffic, the city administration has developed one of the Europe's largest bicycle transport network.

In addition to building bicycle tracks, the local government has also developed a network of parking facilities in all major areas of the city to encourage this kind of transport more and more.

As a result of this measure, in 2017 over 600,000 citizens used the leased-on electric bicycle transport, this type of transport becoming more and more an alternative to public transport.

In terms of urban transport, local government has also deployed several mobile applications to help users acquire their tickets, plan their routes, or estimate the time when public vehicles arrive at different points. Based on ICT, an intelligent digital platform has been developed that collects data from the urban transport network and through which users can plan their most efficient routes.

Regarding the requirements for a smart economy, Warsaw has taken several initiatives to become a hub for the start-ups development and for innovative entrepreneurial environment. In this sense, several creative-innovative centers have been developed to support new entrepreneurial ideas.

Based on *the Triple Helix Model*, Warsaw will develop the largest urban living lab in Europe in order to test new creative and innovative technologies and to create a physical infrastructure and intelligent public services for improving living standards of citizens.

Regarding the environment, the authorities have concluded a partnership with a local company having the initiative to develop a smart ecological system based on ICT.

To achieve this goal, a number of smart equipment and applications have been developed and implemented, through which there might be obtain important results concerning:

- the diminishing rate of carbon dioxide emissions;
- improvements of the air quality, mostly among areas with a higher degree of pollution;
- the reduction of the electricity consumption.

Another initiative of *the City of Warsaw* on environment protection is represented by the replacement of cars, both public and individual, with some

electric ones. In this regard, several hundred electric buses have already been purchased and dozens of electric loading stations have been installed for individual drivers. The transformation of *Warsaw into a smart city* is not limited to measures for improvement the physical infrastructure and public services through ICT.

Since there is an interdependent link between the evolution of ICT and human capital, Warsaw places a special emphasis on knowledge and innovation based society and economy and on a learning process throughout its life. Thus, there are universities dedicated to the elderly, where they can learn new things in their areas of interest.

Also, in order to increase labor productivity in the case of the active population, projects for the construction of smart buildings and smart bureaus have been launched.

They are characterized by elements such as ecological construction materials, green power supply, optimal energy consumption, green areas both indoors and outdoors, sports and recreation halls, broadband connections and so on.

At the same time, in the process of forming an smart society, digital projects have been launched to actively involve citizens in volunteer activities or to combat violence.

In the complex process of transforming the city of Warsaw into a smart one, a special emphasis was placed on the way government had been involved. In this case, ICT has played an extremely important role. There have been created complex IT platforms and applications through which citizens can express their views on decisions that are adopted at the administrative level or may propose different solutions to solve the problems they have encountered.

In the future, Warsaw aims to become one of the most important smart European cities, and in order to achieve this goal in the coming years, complex projects of information and communication technologies innovation will be launched, which will support a high standard of living for the inhabitants. The whole process will be based on the active involvement of all residents, as they are the main force that can develop creative solutions for all current and future challenges.

3.2. Munich case study as a smart city

Munich, the third largest city in Germany, with a population of 1,526,056 inhabitants, is placed in the category of smart cities in Europe that are constantly developing based on the information and communication technologies.

In order to meet the objective of continuous smart development, the Munich administration has implemented several projects and strategies that we will discuss in the following.

One of the most important projects implemented is "*Smart Together*" (www.smarter-together.eu), a project developed by the local government in partnership with the academic environment and the business environment.

The main objectives of this project are:

- reducing the carbon dioxide emissions;
- reducing the dependence on fossil fuels;
- increasing the share of renewable energies by more than 20%;

- modernizing homes to reduce energy consumption;
- installation of intelligent lighting systems for public lighting;
- implementing a mobile application and an intelligent IT platform that establishes a link between all public services;
- increasing and strengthening the multimodal mobility.

In order to increase the efficiency of *the Smart Together project*, another important project has been implemented, called symbolically *Communication Munich*, which aims to mobilize and integrate citizens in civic activities and to inform them about the state of the *Smart Together* project and the smart plans.

Like Warsaw, an urban living lab has been developed in Munich, which fulfills several functions: civic center, exhibition hall and presentation of innovative ideas and technologies, location for cultural and educational events.

On the other hand, workshops are organized in Munich, where business people, politicians, specialists in various fields and other interested people meet, discuss various topics related to the intelligent development of the city and manage to find the best end-user-centric solutions.

Another area in which ICT-based innovation measures have been launched is urban mobility. Smart mobile stations have been set up as an alternative to public transport. Through these stations city residents can find detailed information about urban mobility options, electric loading stations, bicycle or electric cars rental centers.

Another innovative initiative is the district boxes. Through them, companies can safely deliver a wide range of products and buyers can pick them up at any time. The result consists mainly in reducing road traffic and in to customers loyalty. Since data is the pillar of developing strategies for creating a smart city, it is extremely important that the available data sets be as large as possible and to have a complex system of partners to provide this data.

One of Munich's strategy for data collection is the installation of smart devices in apartments, where temperature and humidity data are collected. All of this data is available on a smart digital platform and can be accessed from anywhere via a mobile application.

Thus, citizens can see in real time the differences between their consumption behavior and the average of the city and may take measures to reduce these differences.

The Smart Digital Platform is a complex technological innovation based on artificial intelligence, which collects, processes, analyzes, interprets and distributes data about all the way the city operates. Specifically, the smart digital platform transforms the large amount of data into smart data on which the best strategies to improve the standard of living of citizens can be developed. An example of this is the collection and processing of traffic data and environmental quality through smart devices mounted on street lighting pillars that act as receptor sensors.

Munich's future objectives for smart and innovative development have to be better understood based on its new challenges towards an attempt dedicated to the identification of a multi-directional smart link between all systems (eg energy, transport, mobility, environment and so on).

By fulfilling these objectives, extremely important information can be gathered on the new problems that have arisen, and based on ICT, intelligent solutions can be developed.

At the same time, the Munich administration intends to develop, the smart application of the city to provide citizens with as many facilities as: a smart digital city map with access to all points of interest, secure online payments, access to digital services, real-time information about the environment or traffic conditions, and so on. As we see in the empirical analysis conducted so far, both European cities have adopted and continue to adopt similar strategies to meet the overall goal of smart development, based on the evolution of information and communication technologies.

But, in order to meet the overall objective, a number of secondary objectives have been identified: smart economy, smart society, smart environment, smart mobility, smart governance, smart lifestyle.

Taking into account the initiatives and strategies adopted by these cities in order to become some of the most smart and competitive in Europe and to improve the quality of life for the inhabitants, we will continue to try to determine the extent to which the evolution of ICT has influenced their development and communities local.

3.3. Main research methodology

One of our most important goals for this initial stage of our research had been dedicated to identify and analyze the correlation between the evolution of the share of ICT in GDP in Poland and Germany and each of the following sectors in Warsaw and Munich: education, the labor market in the high-tech industry, life expectancy, economy and Internet access.

For each sector we have selected the following statistical indicators, indicated in the following table (Table 1):

Table 1. The indicators used to analyze the sectors of a smart city

Sector	Statistical Indicator
Education	The percentage of the population between 25 and 64 with tertiary education
Labor market in high-tech industry	Employment in highly technological sectors (% of total employment)
Life expectancy	Life expectancy level (years)
Economy	Real growth rate of gross regional added value (variation from previous period)
Internes access	The percentage of individuals using the Internet daily

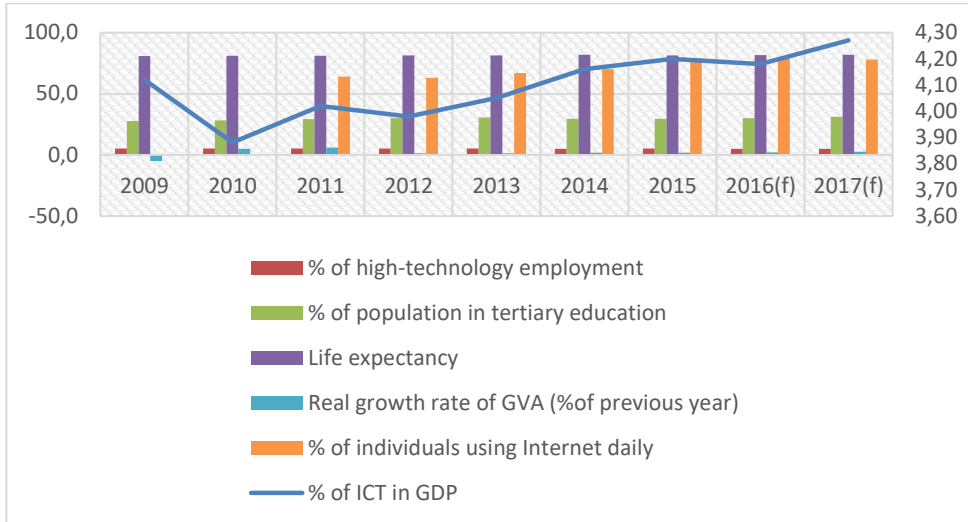
Source: Table made by the authors

3.4. Main data based series

The data series are retrieved from *Eurostat* and refers to Poland and Germany (in case of % of ICT in GDP indicator) and to *the Mazovia* (Central region) - the capital Warsaw and *Bayern* - the capital Munich (in case of the indicators shown in Table 1). These regions have been selected due to incomplete data for the two cities (capitals of the regions). Some of the indicator values have been predicted, as there are no official data so far.

3.5. Main results

In *Chart 1* we illustrate the parallel evolution of the share of ICT in GDP in Germany, on the one hand, and the other 5 indicators selected for the Bayern region, on the other hand.



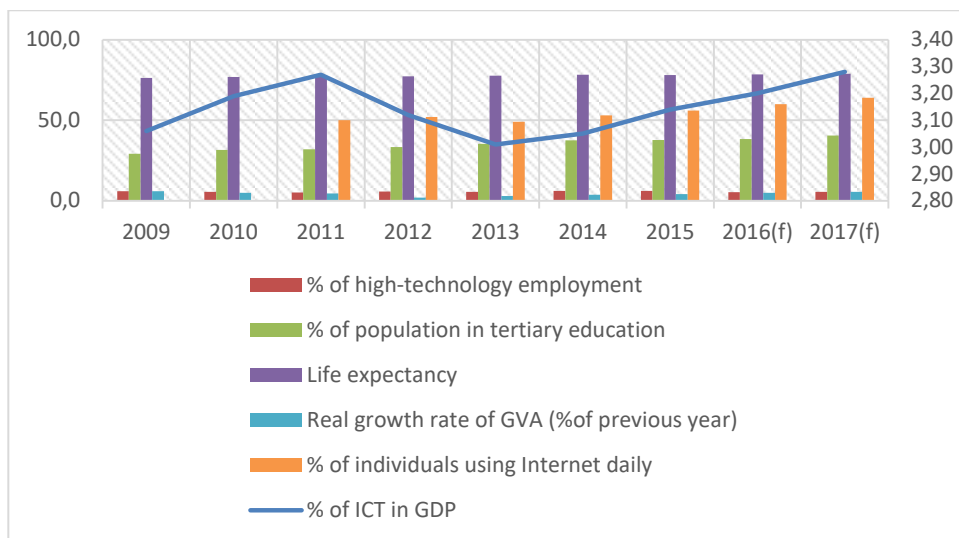
(f) – forecasted data in 2016 for the following indicators: % of ICT in GDP, Real growth rate of GVA, and in 2017 for the following indicators: % of ICT in GDP, Real growth rate of GVA, Life expectancy.

Chart 1. The evolution of the main smart development indicators for Munich city. 2009-2017
Source: Authors' chart based on Eurostat data

Between 2012 and 2017, we can observe there was a slight upward trend in the share of ICT in GDP in Germany, which shows that this area has gained increasing importance each year and has attracted rising investment. This evolution is well correlated with the fact that, as we have seen above, the city of Munich is in a continuous smart development, which is based on innovation and ICT.

On the other hand, we can state that between 2009 and 2017, the smart development strategies of the city of Munich based on the evolution of ICT have had positive effects: increasing the share of daily use of the Internet, increasing life expectancy, increasing the share of the population with tertiary education, and, in the last years, the increasing of the real growth rate of GVA.

In *Chart 2* we can observe the parallel evolution of the share of ICT in GDP in the case of Poland, on the one hand, and of the other 5 indicators selected for the Mazovia region, on the other hand.



(f) – forecasted data in 2016 for the following indicators: % of ICT in GDP, Real growth rate of GVA, and in 2017 for the following indicators: % of ICT in GDP, Real growth rate of GVA, Life expectancy.

Chart 2. The evolution of the smart development indicators for Warsaw city, 2009-2017
Source: Authors' chart based on Eurostat data

Similarly to the case of Germany, in *Chart 2* we can see that the share of the ICT sector in GDP is increasing during the period 2013-2017, which also shows in Poland that information and communication technologies are gaining increasing importance from year to year, given that they are involved in all intelligent and sustainable development processes and projects of the cities (for example, the case of the Warsaw smart city presented previously).

Intelligence-based ICT development strategies had start to manifest their expected effect since 2013 when there was observed an upward trend in the share of individuals using the Internet daily, the real growth rate of GVA, life expectancy and share of the population with tertiary education.

All of these developments presented in *Chart 1* and *Chart 2* demonstrate that strategies developed based on advanced ICT and implemented by the cities of Munich and Warsaw have so far led to their smart development, with positive effects being identified in almost all areas. The role of ICT in the development of smart cities is an extremely important one, given the increasing share of this sector in GDP, and in the future ICT is expected to move forward so that it can always respond to the challenges that arise at local level and ensure a high standard of living for citizens.

4. Conclusions

The main results obtained within this initial stage of our research validate much of the theoretical aspects identified in the literature related to the development of smart cities based on ICT.

As we have seen in this case study, both cities analyzed and implemented similar strategies, based largely on information and communication technologies, to develop smart and sustainably in the long run.

Thus, both Munich and Warsaw have used advanced information and communication technologies to smart develop the infrastructure as a whole and to improve the quality of life for the inhabitants. The strategies of these cities have successfully pursued the technology and digitization of all the components of a smart city, namely smart economy, smart society, smart environment, smart mobility, smart governance, smart lifestyle.

Even if both cities coming from different economically and culturally countries, they have adopted similar complex strategies for smart and sustainable development, and the results are also similar.

This demonstrates that a developing country like Poland can develop innovative initiatives and take concrete and well-designed measures for smart, sustainable and inclusive development in the long run, both economically and socially.

We consider that the case of Warsaw can be an example of best practice for Romania, and we will analyze this in one of the following scientific papers we intend to prepare.

References

- [1] Adeyanju, I., Oloruntoyin, S. (2013), *Improving sectors of the society with ICT: E-Health, E-Education, E-Journalist, and E-government*, African Journal of Engineering Research and Development, vol. In press.
- [2] Angelidou, M., (2016), *Four European Smart City Strategies*, International Journal of Social Science Studies, Vol. 4, No. 4.
- [3] Etzkowitz, H., Leydesdorff, L. (1995), *The Triple Helix: University - Industry - Government Relations: A Laboratory for Knowledge-Based Economic Development*, EASST Review 14.
- [4] Ji, L., Tang, L., (2011), *Researches on the Meaning and Application Service System of Smart City*, TELECOMMUNICATIONS NETWORK TECHNOLOGY
- [5] Kramer, WJ, et al. (2007), *The role of the information and communication technology sector in expanding opportunity*, Economics opportunity series.
- [6] Manville, C., et al. (2014), *Mapping Smart Cities in the EU*, Bruxelles: European Parliament, Policy Department A: Economic and Scientific Policy.
- [7] Nam, T., Pardo, T., (2011), *Smart city as urban innovation. Focusing on management, policy and context*, Proceedings of th 5 th International Conference on Theory and Practice of Electronic Governance. ACM: 185-194.
- [8] Rangan, S., (2009), *Information technology and transnational interaction: Theory and evidence on the evolution of the modern multinational enterprise*, Journal of International Business Studies, 1496-1514.
- [9] Smas, L., Schmitt, P., Perjo, L., and Tunström, M. (2016), *Positioning urban labs – a new form of smart governance?*, In M. Schrenk, V. V. Popovich, P. Zeile, P. Elisel, & C. Beyer (Eds.), Proceedings of 21st International Conference on Urban Planning, Regional Development and Information Society.
- [10] United Nations, (2018), *2018 Revision of World Urbanization Prospects*.
- [11] Warsaw towards a Smart City Report, (2018).
- [12] Washburn, D., et al. (2010), *Helping CIOs understand smart city initiatives*, Cambridge: Forrester Research.

Web sources

www.smarter-together.eu

<https://ec.europa.eu/Eurostat>