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# E-Government Insights to Smart Cities Research: European Union (EU) Study and the Role of Regulations

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**ABSTRACT** The recent evolution of smart cities research has initiated a holistic dialogue for the integration of past initiatives promoting e-government at European Union Level. At the same moment Future Smart Cities research, is justified as a multi-disciplinary and inter-disciplinary research domain. Within this context this research work provides insights for the integration of Economics, E-government, Information Systems, and Social Sciences. The study addresses the e-government process as one of the most important application of smart cities in our current societies. More specifically, we have examined the existence of  $\beta$ -convergence between EU member states in terms of e-government services, confirming the hypothesis that low performance countries record higher growth rate than developed countries. In order to move closer to the factors with high impact on e-government development, we have analyzed other variables for testing the differences between countries, in terms of education, digital skills and access to internet for controlling the hypothesis that countries initially have different development conditions and they will not probably converge to the same steady state. We found that the opportunity of using e-services, particularly e-government services, is less accessible to citizens with low overall digital skills and, as is technically normal, to those with low access to internet access. In this context, at EU level it is needed to rethink and design the e-government services in order to be adapted not only to needs of the citizens, but also to their digital skills. The main contribution of this research is two-fold: From one side provides an integrated study with emphasis on the impact of social sciences and economics research to Future Smart Cities Research and from the other side it brings forward several soft factors for the adoption of Smart Cities services in the context of government transformation and provision of ubiquitous e-services to citizens.

**INDEX TERMS** Smart cities, e-government, digital skills, internet, convergence, digital transformation, future smart cities, social sciences, urban computing.

## I. INTRODUCTION

The urban area systems become more complex and as result, cities are concerned about strategies that ensure efficient use of resources while addressing development goal, being also concerned about requirements for transforming them into smart cities. In a smart city the traditional networks and services are more efficient as result of using digital and telecommunication technologies, for the benefit of its inhabitants and businesses [1].

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Smart cities will contribute to the improving of the quality of life, while ensuring the needs of present and future generations, with respect to environmental challenges. Urban areas have grown rapidly, being characterised by high concentrations of economic activity and wealth.

As the world's population becomes increasingly urbanized, the problems of building sustainable cities also grow. A challenge for the development of sustainable and smart cities are the social inequalities faced by many urban areas. This highlights the need to create living cities through the application of systems thinking and cybernetics [2]. Even if a smart city tackle urban prosperity and sustainability issues mostly

through the technology solutions, there are some conceptual frameworks to assist cities and their public administrations in understanding this urban development paradigm [3]. The sense of community is very important for the development of smart cities, because the design of cities should prioritize social interactions [4]. The access to e-government is important for all categories of citizens in order to increase the social inclusion by providing free and fast access to public services, good practice models being very important for efficient policies in smart cities.

E-government is a necessary process in the European Union (EU) in general, but especially in the urban areas, as it is becoming increasingly evident the trends of aging population, of overcrowding of the outskirts areas of the cities, of maintaining high unemployment rates of youth or elderly population. Increasing the efficiency of public services through e-government is important for the release of resources useful to serve new needs of the expanding and developing urban areas.

The main objective of our study is to examine the state and progresses made by EU countries in e-government process and also to examine how the access to information and communication technologies (particularly Internet of Things) and education (especially digital skills) influence this process and societies as a whole. Into this respect, the article explores the e-government development in EU urban areas. First, the paper aims to test if EU recorded a convergence process in terms of e-governance. Second, the article aims to identify, for urban areas, factors explaining differences between countries and to show the extent to which these factors influence the e-government development in EU countries.

The structure of the paper is logically elaborated, considering the research objectives. The paper is organized as follow. The next section includes the literature review. By the end of the second part we have investigated the public regulations in EU. The third section presents the research methodology and data used. Then we performed the analysis of convergence of e-government process within the EU and the correlation analyzes in order to highlight the influence factors explaining the differences in using e-government services in EU. We aim to address through our paper the e-government issue from a double perspective: from EU level to national performances and to urban areas in EU. The last part presents the conclusions and further research directions.

## II. INTEGRATED LITERATURE REVIEW

The scientific contribution in the context of Future Smart Cities research needs to be grounded on an integrated understanding of reference disciplines. The debate on smart cities in the last years has integrated various aspects including, emerging and streamline technologies, policy making issues, sustainability and social inclusivity as well as sophistication of information systems and social impact. In this section we provide a compact, not exhaustive discussion of complementary aspects of our research problem. First, we present the latest developments in Smart cities research. This overview

leads to the second pillar of our analysis which is directly connected to enabling technologies and infrastructures for smart cities research. The last part of our literature review is related to governmental policy making implications and regulations. This three-fold analysis of our research context defines also the key contribution of our work: The intersection of E-government, ICTs and Social Impact with an emphasis on Future generation smart cities services.

### A. SMART CITIES UNDERSTANDING

The urban areas must successfully integrate the technological innovation in order to respond to increasing population and changing the geography of production in the globalized world. There is an urgent need to change the model of the city development worldwide as to become more sustainable, more competitive and more liveable. Considering these new challenges and opportunities, it is important to identify strategies for future development based not only on size, industrial profile or administrative attractiveness [5]. It is of major importance to identify competitive advantages and to exploit them focusing on reducing vulnerabilities associated to the new current society's changes.

As result of globalization smart cities become the new reality. They gain the attribute of being smart not only for automation of routine processes, but also for advances in monitoring, analyzing, understanding and improving processes that increase the quality, efficiency and equity of activities and human life. Gaining smart attribute can be made in the long term, but with continuous action in the short term. Smart cities should deal with new concerns like: developing new technologies both for communication and dissemination of results; connecting and coordinating these technologies in efficient and feasible ways; developing new methods for using data irrespective of time and space; new understanding, proactive defining and solving of critical problems related to smart cities; early identifying of risk, uncertainty, hazard associated with smart cities development [6].

Smart cities are considered instrumented, interconnected and intelligent cities that exploit operational data. Instrumentation enables cities to collect data through the use of different devices (web, sensors, video surveillance cameras, mobile phone, public wireless area network etc.). Urban areas are increasingly rich in such instrumentation, widely explored with Internet of Things. These large data can be used and integrated both physically and logically into interconnected processes that bring together unstructured or en masse information. By intelligence, they analyze the interconnected data, identifying trends, patterns, results and making forecast in order to identify efficient and timely solution to improve production value, system organization or processes outcomes [7].

A smart city has goals related to economic growth, quality of life and sustainability of natural resources and it pursues them through investment in human and social capital, infrastructure and technologies. Technologies incorporated in cities has the potential to solve major problems, transforming

urban areas into smart cities, based on usage of data as lifeblood of smart urban solutions and changing behaviour of the cornerstone of smart cities: smart people. The use of data should create smart solutions for real needs of the people [8]. Smart cities concept refers to exploiting opportunities to improve people's lives by using technology for modernizing infrastructure (energy, transportation etc.) and improving city services and operations [9].

A city cannot be smart without one of the 3 pillars: data and information, technology to collect and analyze it and human capital endowed with skills and competencies that can exploit advantages provided by the first two pillars.

An important problem associated with smart cities development is the risk of investment as they do not have a large history of good practices, even if the return on investments in smart cities initiatives could be rewarding. Under these circumstances, public authorities could be reluctant to invest in development of new technologies supporting smart cities even if the future positive externalities are high, because the initial cost is also high [10]. A second problem associated with deployment of smart cities technologies is the need to focus on more physical infrastructure projects, aspect that leaves limited resources for smart projects [11]. The third major problem associated with smart cities development, particularly with smart services delivery, is the risk of increasing inequalities between citizens [12].

A great benefit of smart cities could be the possibility of interconnection and to learn from others by using their experience to solve similar problems [13]. Also, the economic and social benefits induced by the transformation of smart cities will be more evident as technologies become mature and there will be fewer errors as processes are more automated, without direct human interaction.

Smart cities have a crucial role in societal change because they are increasingly incorporating innovation and technologies, they have high concentration of people, ideas and resources that push forward their own boundaries [14].

### **B. ICTs AS ENABLER OF E-GOVERNMENT DEVELOPMENT IN THE SMART CITIES CONTEXT**

E-government requires complex interactions between citizens, governments and stakeholder and has an important role in smart cities development becoming an emerging domain of study that attracts both scientific and political attention [15].

E-government and smart cities are supporting each other. E-government is delivering better services by using the information and communication technologies (ICTs) by public authorities and smart cities are focusing on using innovation for collecting, delivering, processing or analyzing information/data. Their synergy is contributing to better decision making process, better informed citizens, highly quality public services. The challenge for e-government in the process of making cities smart was to surpass the stage of being a disruptive change driven by a group of few to the next stage: being intrinsic to the way government work [16].

National governments play an important and increasing role in coordinating the smart cities development, while local authorities are the most able to understand and exploit the opportunities and address challenges of their cities. The first requirement is to be well-equipped, cities using a large variety of technologies. Many of the applications used in smart cities are using Internet of Things and wireless technology. Smart cities technologies have many potential applications that will arise as technologies will gain widespread application. Municipal government service delivery is one of these applications having an increasing impact on satisfaction and wellbeing. Local government can understand and act in line with challenges and opportunities specific to their region as to become more effective, efficient and responsive [17].

E-Government refers to the use by national or local governmental authorities of ICTs that can reshape the relations with citizens and businesses. It contributes to the evolution of smart cities when ICTs are integrated in strategies for citizen participation to public services and policy [18].

The literature has widely debated the development and the public sector reforms associated to improvements in the e-government process, considering ICTs as enabler. The success of e-government depends on exploiting all aspects related to ICT systems and infrastructure [19]. There were developed many stages models theories of e-government in order to explain its evolution and dissemination [20]–[23]. The models refer to three to five stages, including accessing information in a static way, interaction with governments using email or downloading forms, conducting transactions online and total integration of e-services across different administrative levels.

Important factors that determine the stages maturity are:

- the level of development of the economy, measured by GDP, as the e-government requires important financial resources for investments in technologies;
- demographic and socio-economic conditions, including population size and population density, education and access to technologies. Population size is an important factor that encourages the development of e-government and the high population density could also provide a more innovative attitude towards this process [24]. The level of education is directly correlated with the demand for e-government services and with e-participation [25], [26].
- the political factors: their implication and willingness to act, to the detriment of other more tangible investments in the short run [20].

Information systems from e-government differs from commercial ones as result of their strategic different goals which include not only efficiency and effectiveness, but also social and political objectives (trust, social inclusion, community wellbeing, sustainability etc.) [27]. But, like business environment, e-government is facing technical and economical challenges. These put pressure on public authorities to align to the innovation and to be innovative.

This means that e-government needs to use and benefits from the newest ICTs in order to increase both its efficiency and effectiveness. As result of budget constraints, e-government needs to deliver services as economically as possible and to use appropriate technologies to obtain desired outcomes [28]. Under these circumstances, ICTs and digitalization have the role of inputs or enablers of modernization of government. Electronic government focus on the provision of user-centric, agile and innovative public services [29].

Over the last years, many new disruptive technologies have emerged in many domains of societies, including e-government [30]:

- Artificial intelligence is an area of computer sciences that add intelligence to applications, it is the next technological development that gives computers human-like abilities, having as engine the Internet of Things [31]. The artificial intelligence has the potential to redefine how government serves citizens, being able to raise citizens' expectations and change their behaviour [30], [32]. Artificial intelligence refers to interaction and relationship between many other domains, e.g. Machine Learning and its subfield Deep Learning (the ability of an algorithm to learn from previous experience in order to make correct decision in new situations), Data Security and Privacy (which require strong policies, measures and standards), Natural Language Processing (interaction between computers and human languages) etc. [33]. Using artificial intelligence has the capacity to automate and facilitate e-government services and make process integration dynamic [34].
- Distributed ledger technology (DLT) is a new technology that allows users from different locations to validate and update transactions in a synchronized way across the network. It stores transactions in a decentralized way using algorithms that eliminate the need for centralized database. The most used DTL is blockchain, expected to disrupt the domains/industries which represent a potential conflict of interest between the parties, like communication infrastructure [29]. The exploration of blockchain technology by governments will reduce the bureaucracy, corruption and discretionary power and will increase both the efficiency of the process (reduce economic costs, time and complexity of information exchanges; boost productivity) and the trust in governmental public recordkeeping (reduce errors, increase speed, transparency, accountability and security) [35]. In blockchain models data are public resources that anyone can change but only with the consent of everyone. Its innovation is that the transactions will automatically verified and recorded through cryptographic algorithms, making unnecessary the human intervention, the central authority or the points of control of third parties. The governments will act as supervisor with regards to the transactions [36], [37].

- Cloud Computing can be used as a model for improving efficiency and user satisfaction in e-government using Internet platform. It combines a set of technologies for enabling convenient to access the network and application, information and computing services being provided as services [38], [39], [40].

The impact of these technologies in e-government needs to be evaluated in terms of cost, risk and benefits.

OECD considers that E-Government refers to the of ICTs, and particularly the Internet of Things, as a tool to achieve better government. The online public services have increased rapidly due to the citizens' consciousness on internet [41].

The use of internet, wide area networks and mobile computing can help to make the interaction with authorities faster, more efficient and transparent, being a key element of the success of the Single Market [42].

Internet of Things has an exponential growth in the last thirty-five years, from a thousand to billion of users. It refers to connections that creates a new dynamic network that connect the world's objects in both a sensory and an intelligent manner and endows it with protection and privacy [43]. From its beginning, it incrementally adapts to the needs of users and it has changed the human communication habits, being a driver of globalisation [44]. The development of Internet of Things in a growing information and communication technology environment is mainly characterized by the following aspects: scale (increasing the number of devices and reducing their size), mobility (ensured by wireless connectivity and object portability), heterogeneity and complexity (many applications that generate challenges in terms of interoperability) [45], that make development more inclusive, efficient and innovative. From the perspective of accessing e-government services, these three characteristics of the new development model: refer to a better coverage of accessing public services (inclusive); strengthen the public sector capability meanwhile the internet's and technology's costs are decreasing (efficient); use new technologies that reduce the human input and create platforms for a better connectivity between citizens and authorities [46].

The increasing adoption of new technologies change expectations about how governments are delivering public services and are creating public value in the society. The citizens engagement increase as digital technologies facilitate access to information, improve decision making through better, complete and faster information, express opinion through online platforms, petitions or voting [47]. The new digital environment helps governments to be more open, transparent, coherent and relations more participative and requires policies for digital technologies at all level of public sector. Failure to make the transition to this services could have important consequences on government trust, which is one of the most precious assets for a nation [48], [49]. The citizens trust in e-government services depends on information quality characteristics (accuracy and completeness) and channel characteristics (convenience and personalization) [50]. Also,

the citizens' continuance usage of e-government is influenced by the system quality, user satisfaction and habit, the user satisfaction having the stronger impact [51]. This links the e-government services success with the quality of the infrastructure, technologies and applications used, because some authors also suggest that even the most educated and skills endowed users of smart services, express concerns regarding the utility, safety, accessibility and efficiency of these services [52].

These new technologies will serve to different objectives: better delivery of government services to citizens and more efficient public management, improved interactions between public sector and business, citizen empowerment through access to information [53].

### **C. E-GOVERNMENT BENEFITS THE IMPORTANCE OF EU REGULATIONS IN E-GOVERNMENT CONVERGENCE AND ECONOMIC GROWTH**

The general benefits of e-government are less corruption, increased transparency, greater convenience, revenue growth and/or cost reductions. They can be analyzed both in terms of users (citizens, businesses) and government. For users, there are benefits in terms of time and cost reductions, better services, less corruption and increased satisfaction and transparency. Moreover, for businesses, it creates a safer environment for investments, by reducing corruption (as result of easiness to access the history of data on transactions and trace the corrupt acts) and improve the market functioning by reducing the asymmetric information that can cause market failure [54]. For the government, the benefits refer to cost savings (for front office human resources for example) and, consequently, increased administrative efficiency and trust [55], [56].

Considering these intangible benefits, the overall e-government productivity is difficult to be measured and it have to assessed through indirect aspects like changes in the perceptions of tax compliance costs, the competitiveness of government procurement and corruption in taxation and government contracting after the introduction of e-government systems in a country [46].

In the current societies the relationship between e-government and growth becomes increasingly important because institutional communication, and particularly that exploiting digital channels, plays an important role in the GDP growth and in building the trust of citizens and markets [57].

Nowadays, growth is not driven only by economic structural factors, like relocation of production factors from agriculture to industry and services. Institutional quality becomes one the most important conditions for real convergence. Under these circumstances, e-government as part of institutional framework can enhance the flexibility of markets (including labour market), improve business environment, control corruption etc. that can contribute to the enlargement of convergence dimensions [58]. Moreover, considering the objective of EU convergence, appropriate institutions should

exist not only at national level, but also at EU level. However, the approaches on institutional quality need to be complemented by country specific decisions in accordance with specific conditions./.

Growth (and more widely, development) is a moving concept that should always be reinterpreted and updated in line with the new evolutions from societies and generates demands for new approaches. Not only the concept, but also the perception on development had changed, becoming an exercise done with people, for the people in order to improve their livelihoods [59].

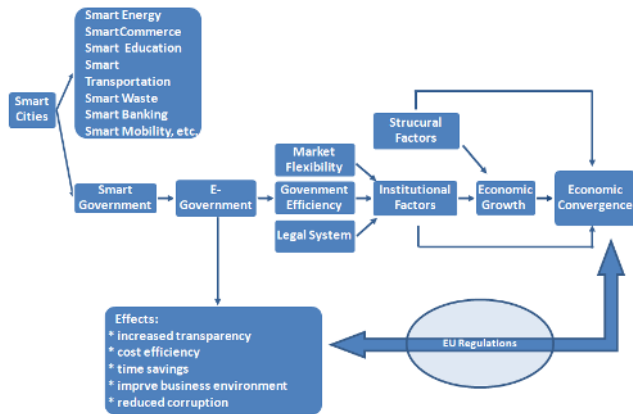
E-government supports growth, both directly and indirectly. It decrease the cost of interacting with government both for citizens and business. E-government promote the Information Economy, reinforced by ICTs, as its adoption and use require increasing level of experience and skills in using the electronic services. It also creates positive externalities by generating awareness of the capabilities of ICTs and increasing overall confidence in electronic service delivery. Also, the public sector demand for ICT goods and services is stimulating economic growth and also is less cyclical than private sector demand [54].

Public administration consider ICTs as a tool to reshape the sector, taking into account the efficiency gains reflected both in cost savings to governments (reduce public expenditure) and increasing benefits to citizens and business (administrative simplification, time savings). These effects generate overall positive impact on the economy, improving the performance of economic activities. The authorities also use ICTs for increase the quality of its services by a better transparency and accessibility for the citizens, improving trust in government [60].

Countries that face convergence problems need to improve the institutional quality and governance in order to enhance the resilience of their economic structures. This could provide also a highly power to face the shocks [58]. A successful convergence process of e-government is considered to be an important factor that contributes to the social an economic wellbeing of citizens [61].

The development concerns regarding the smart cities in EU are multidirectional addressed. At EU level it was understood that the challenge of convergence should be addressed in all the fields, including public policies and government. It was recognized the importance of the digital services (that provide information, transparency and strengthen the trust in public authorities) for improvement of the overall economic performance. As many other actors, the government needs to adapt to the technological progress in order to ensure a secure and efficient e-government services [62]. Increasing performance in this area will enhance the overall convergence at national and, in return, will improve the advance to smart cities in EU (Figure 1).

The challenges associated with an aging workforce, relatively low economic growth and high levels of youth unemployment have stimulated the EU authorities to seek innovative e-government solutions to improve



**FIGURE 1.** The link between e-government convergence and smart cities research.

competitiveness [63]. It is stressed the need to ensure quality public services, both for businesses and for citizens, a process that will increase the efficiency of public spending and the focus for supporting economic growth. The development of ICT and e-government are considered necessary tools to ensure efficiency gains and cost reductions [64].

The Europe 2020 Strategy consider the digitalization of Europe as one of their major flagship initiatives to speed up the use of the internet, in order to increase the benefits of a digital single market for citizens and business. The European Structural and Investments Funds supports investment towards the objectives of Europe 2020 Strategy. This strategy defines three goals for the development of EU between 2010-2020: a sustainable, inclusive and smart growth [65].

The Common Provisions Regulation for the European Structural and Investment Funds transpose these objectives into relevant thematic objectives. They represents major steps forward in supporting the three objectives of the strategy [66]. Of major importance for our focus are 2 objective: the first related to the smart growth and the second related to inclusive growth. The first objective, Enhancing access to and use and quality of ICTs, creates the background for the development of e-government and supports by European Regional Development Fund (ERDF) the development of ICT products and services and the strengthening ICT applications for e-government. The second, Enhancing institutional capacity of public authorities and stakeholders and efficient public administration, supports by European Social Fund (ESF) and ERDF the investments for increasing the institutional capacities and the efficiency of public services at all administrative level [67].

In 2015, EU sets up a Digital Single Market Strategy that, starting from the hypothesis that ICT is the foundation of innovative and modern economies, build three pillars in order to improve the access to online services. They refers firstly to breaking down the barriers to online activities, secondly to improving the infrastructure and the speed of digital services by right regulations for innovation, investment, competition and, thirdly, to increasing the growth potential of digital

economy by research and innovation that ensure higher competitiveness and better public services and skills [68].

Also, starting from 2016, at EU level is running a new program ISA2 - Interoperability solutions for public administrations, businesses and citizens - which supports the development of digital solutions that enable public authorities and citizens to benefit from public services [69].

EU e-Government Action Plan for 2016-2020 highlight the following principles [42]:

- Digital by Default - the preferred option for deliver services will by the digital one;
- Once only principle - the information should be requested only once with no additional burden on citizens or businesses;
- Inclusiveness and accessibility - digital inclusive public services, including persons with disabilities or elderly;
- Openness and transparency - enable control and sharing data and information between authorities and private actors;
- Cross-border by default - for facilitating the mobility within the EU Single Market;
- Interoperability by default - based on free movement of data and digitals services;
- Trustworthiness & Security - aspects related to personal data protection and privacy as preconditions for take-up to digital services.

EU recognize the necessity to address the digital skills gap not only for youth and new generations, as people around the middle of their working age should also use e-services (e.g. e-government, e-banking), which implies the need to strength the training and lifelong learning into this direction [70]. For achieving these objective, EU provide guidance through Country Specific Recommendations (CSRs) and it details, for each country, the specific actions and concrete plans in line with CSRs through National Reform Programmes (NRPs).

The full benefit of e-government would be achieved when it will available seamlessly available across EU and they will be able to ensure digital public services faster, cheaper and more citizen-oriented, approach that highlights the importance of convergence of this process within EU [42].

### III. RESEARCH METHODOLOGY FOR GOVERNMENT PROCESS IN URBAN AREAS-FACTS AND POLICY IMPLICATIONS

#### A. DATA AND METHODS

In order to reach the objective of our research we have used data provided by international organizations (United Nations and European Union) focusing on important indicators for e-government, such as E-Government Development Index (EGDI) (provided by United Nations starting from 2004), internet use for interaction with public authorities, digital skills endowment of population, access to internet and frequency of internet use (provided by Eurostat, the official statistics of European Union). The EDGI is used for assess the e-government development at the national level, being

defined by UN as the weighted average of three normalized indices: Telecommunications Infrastructure Index, Human Capital Index and Online Service Index [63].

At EU level data are available at different administrative level. Our study aims to perform an analysis at urban level in EU, including both town and cities. We consider this aggregation important for carrying out further analysis and improve decision making at national and EU level. For this purpose we have aggregated the indicators at urban level, using for this computation the total population at the end of reporting year by degree of urbanization, available in official statistics.

We have highlighted the gaps between countries using appropriate graphical representations. We presented the structure of population in urban areas in total population, but also divided by cities, towns and suburbs. Also, for urban areas were presented: the shares of population by educational attainment, the interactions with public authorities using internet and their decomposition on the reason of interacting in the last 12 month and the frequency of internet use, highlighting the share of persons that use daily or never use internet.

In our study we have used correlations analysis, showing that data vary simultaneously, according to the positive or negative correlation coefficient. Positive correlation were found both between the level of GDP per capita and EDGI and between the share of population having basic or above digital skills and interaction with authorities by internet.

We extended the convergence theory to the e-government development in EU. The topic of convergence is widely debated in the literature, even if studies differ in terms of theoretical background of their empirical data. In neoclassical growth theory, the real convergence theory highlights the hypothesis that low development countries will have a growth rate higher than developed countries [71]–[73]. The convergence process refers to the situation when poor countries record a catching up process to the richer countries. This process is known in literature as  $\beta$ -convergence and is usually investigated using growth regression [74], [75] (the general model is the following):

$$\ln(\Delta Y_{i,t}) = \alpha + \beta \ln(Y_{i,t-1}) + u_{i,t} \quad (1)$$

where:

-  $\Delta Y_{i,t}$  and  $Y_{i,t-1}$  are the growth rate and the initial level of EDGI in EU member states, in 2004-2018

-  $u_{i,t}$  is the standard error

This equation characterizes the situation in which countries tend towards the same level of long-term equilibrium, a situation known as absolute  $\beta$ -convergence. However, the characteristics of the countries are different, which implies that each country will converge to its own long-term equilibrium and different steady-states, situation described as conditional  $\beta$ -convergence [74], [76], [77]:

$$\ln(\Delta Y_{i,t}) = \alpha + \beta \ln(Y_{i,t-1}) + \gamma Z_{i,t} + u_{i,t} \quad (2)$$

$Z_{i,t}$  - represents other factors that affect the e-government development

The success of the convergence process depends on the intensity of the negative correlation between the initial level of development and the annual rate of growth.

The study examines the e-government performance of EU countries using the EDGI convergence within the period 2004-2018. Testing  $\beta$ -convergence for e-government is performed based on average rate of growth for the analyzed period and on the EDGI level from 2004. This issue is important because e-government needs rapid development in all EU countries under the circumstances of challenges of current societies.

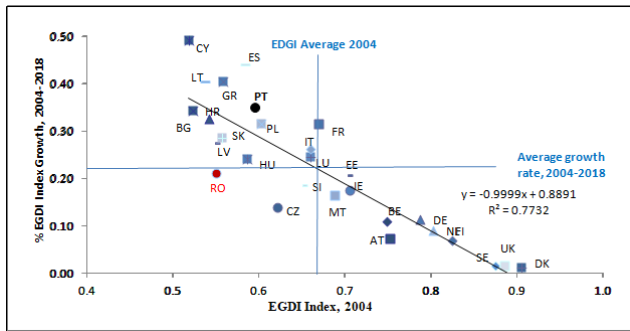
The literature on convergence, refers also to  $\sigma$ -convergence that considers the variation of cross-sectional distribution of the variables, measured by standard deviation of coefficient of variation. Some authors [78] consider that this type of convergence is more important as it shows differences between countries without relying on a particular model [79]. However, many authors consider that  $\beta$ -convergence still remains in the center of empirical studies because it is necessary for  $\sigma$ -convergence but is not sufficient [80]. This is the result of the fact that even the economies converge towards one another, some shocks push them apart of because they converge towards different steady-states [75].

For evaluating the  $\sigma$ -convergence we have calculated the coefficient of variation (as the ratio between the standard deviation and the average level of the variable) using EDGI for period 2004-2018 for all 28 countries of EU, including Croatia, Romania and Bulgaria which joined the EU in 2013 and 2007.

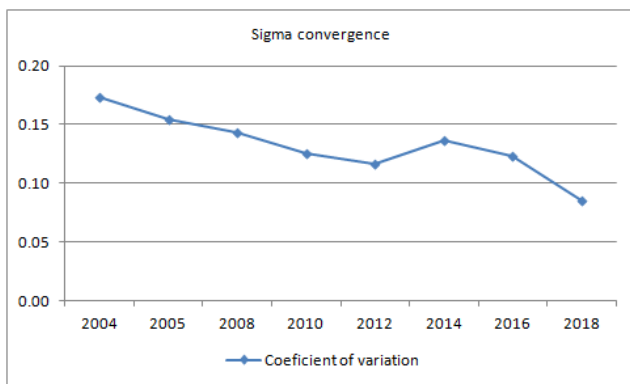
## B. THE CONVERGENCE PROCESS WITHIN EU RESULTS AND DISCUSSION

The progress made by the EU states in terms of economic, social and technological aspects can be analyzed using the neoclassical growth theory. The real convergence model sustains the hypothesis that countries with low (poor) performance in terms of economic development will have higher growth rate than developed countries, achieving this way a process of catching up, based on the assimilation of knowledge (learning) and technologies.

The public administration efficiency and modernity is in continuous change. We have analyzed the real convergence process in terms of evolution of EGDI (E-Government Development Index) for the EU countries, starting from 2008 and analyzing the growth rates for 2008-2018. The real convergence process is reflected in the intensity of the negative correlation between the initial level of the indicator and its growth rate. Over the last 15 years,  $\beta$ -convergence was strong between EU member states. Negative and statistically significant correlation was found between the initial level of EDGI and its growth rate between 2004 and 2018 (Figure 2). We can note that the countries with the lowest EDGI levels in 2008 (South-Eastern European countries) recorded the highest growth rates, as also the theory states. The countries



**FIGURE 2.** Convergence process in terms of EGDI in EU, 2004-2018. Source: own computation based on Eurostat statistics.

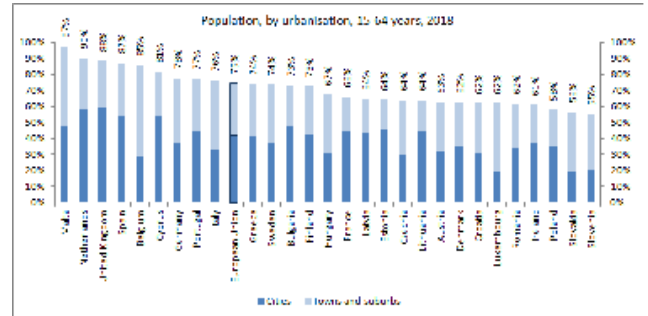


**FIGURE 3.** Sigma convergence in EU, 2004-2018.

with the highest index in 2008 recorded the lowest growth rates, Northern European countries: Netherlands, Denmark, Sweden. Also, the EU countries have increased their overall performance in terms of EGDI from an average of 0.6490 in 2008 to an average of 0.8015 in 2018, an increase of 23.5%.

We have distinguish between  $\beta$ -convergence which refer to the process of catching-up, in which poor countries or regions are growing faster than rich ones and  $\sigma$ -convergence that refer to a decrease of disparities among regions over time, measured by the coefficient of variation. The coefficient of variation in 2004 is 2.5 times greater than in 2018 (Figure 3). Only between 2012 and 2014 there was an increase. It could be explained by some temporary factors such as sovereign debt crisis that redirected attention and funds to other objectives. After this period, the disparities continue to decrease, till 2018. Thus for the EU as a whole,  $\sigma$ -convergence occurred from 2004 to 2018.

An important issue revealed by the results of the analysis of the convergence is that there is a need for gap recoveries and continuous development in all EU countries, which implies the necessity for reforms, regulations and strategies at EU level. This should address the influence factors of e-government. Even decreasing, the disparities between EU countries continue to exist. Considering this aspect, we aimed to analyze factors that affect e-government and condition the convergence process: internet access, digital skills, frequency



**FIGURE 4.** Distribution of population in urban area, EU, 2018 (% of total population).

of internet use. Opening through these aspects, generates effects not only on e-government. Developments of internet access and digital skills generate favorable implications on labour market as well and on the economy as a whole. We aim to confirm the hypothesis that countries with the major gaps in terms of these characteristics are those who also record the major gaps in terms of real GDP convergence.

**C. ASSESSING THE E-GOVERNMENT DISPARITIES FACTORS IN URBAN AREAS AT EU LEVEL**

Considering the development of smart cities concerns in the EU, we aim to analyze the e-government process in urban areas, assuming that these areas will generate positive effects over all regions, regardless of population density or link to the political level.

At EU level, the administrative classification of the regions in the urban or rural areas is made according to the definition of the Organization for Economic Cooperation and Development (OECD) based on the presence of an urban center, that is a new concept based on high-density population grid cells. In urban are included areas cities and town, which represent intermediate density areas (towns and suburbs/small urban area) and densely populated areas (cities or large urban area) [81].

The major part of EU population lives in urban area, including cities and towns, 74.8%, of which 42% in cities and 32.7% in towns and suburbs (Figure 4).

E-government represents a new way of public management that can solve problems faster and cheaper both for the authorities and for citizens. It implies a modern efficient use of information and communication technologies having as background and prerequisite the access to the internet. This is the tool that can support different applications in order to obtain a closer and rapid linkage between the parts involved in the process. The aim is to ensure access to the appropriate information and services provided by public authorities.

At EU level there are major differences between countries in terms of interaction with public authorities by internet (Figure 5). The most used utility from e-government was for almost all countries in EU, in 2018, obtaining information from public authorities web sites. This is more a passive



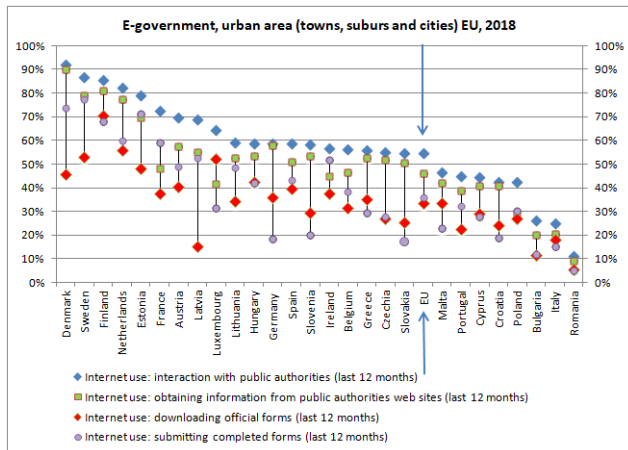


FIGURE 5. Interactions with public authorities using internet, EU, 2018.

interaction and it does not show an increased efficiency of e-government services. It is directly related mainly to the access to internet in a specific country. The more active interactions, downloading or submitting official forms, are generally two times lower than the overall public interaction with authorities. These types of interactions are mostly related to the digital skills endowment of population. Good performance in terms of active interactions with public authorities recorded Northern Countries and the poorest could be found in South-Eastern European Countries.

In the current ICT era, there is a spectacular increasing of the opportunities to use e-services. New technologies associated with the use of internet can also transform the public administration into a more effective sector, which provide an easier access to the service provided.

A necessary condition for using e-government is the access both to the Internet and to associated technologies. Despite the rapid spread of technologies, especially digital technologies, there are still many people that lack internet access in EU. At EU level, for urban areas 10% of total population do not use and do not have internet access and for rural areas the percent is higher: 15% of total population. Moreover, only 78.7% of the urban population use the internet daily (Figure 6).

The e-government facilitate the free movement of citizens as they are able to complete administrative procedures being in other country or region in the same or in other EU member state. This is part of Single Market and allows the development of efficient public organization across EU [82] and depends on the internet infrastructure that allows people to benefit from free movements across EU. Under these circumstances, policy makers focus on ways to ensure that ICTs and services, including internet access, are widely available and accessible to a larger part of population [83]. For interaction with public authorities, this aspect is particularly important, as the correlation between the frequency of internet access and the interaction with public authorities reveals a strong correlation and also shows that countries with

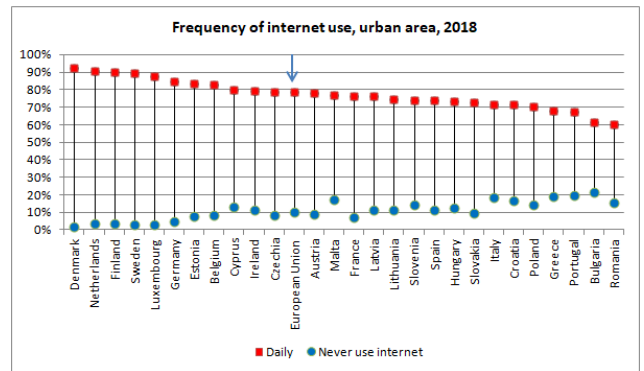


FIGURE 6. Internet use, EU, 2018.

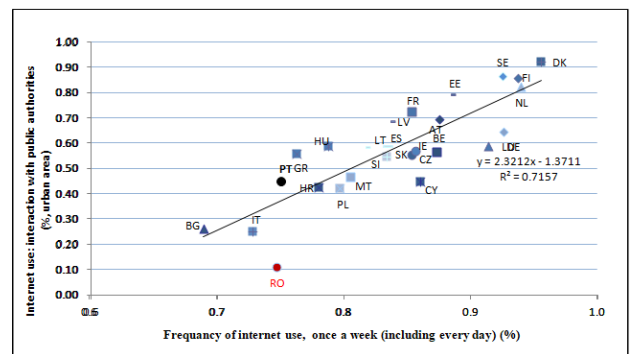


FIGURE 7. Correlation between frequency of internet use, once a week (as percentage of total population) and interaction with public authorities by internet (% of population).

best performance in terms of  $\beta$ -convergence record higher levels for both indicators (Figure 7).

At EU level, e-government is correlated not only with the use of internet but also with citizens' preferences and skills endowment (both general and digital skills) [14]. In order to obtain a high efficiency of e-government, a high literacy rate is needed [63] to benefit as much as possible and to safely exploit a wider area of services: identifying, making payments, sending forms, report problems, participating in public consultation or request information.

The technologies are flexible enough to adapt to the different demands of today's societies, including e-government, but the success in development of these services is related to the human factor, considering the particular relation with the new way of working for public services employees and the need to have adequately skills [84]. A particular attention should be paid to the general education attainment of the population, analyzed compared to EU targets. Tacking into account the objectives set by Europe 2020 Strategy, both at the EU level and in most of the member states, the secondary and especially tertiary education are at an adequate level (Figure 8). In addition, they are on an increasing trend in the last period, which offers optimistic expectations on the overall economic development in the future, with respect to the importance of the human factor in the equation of economic growth.

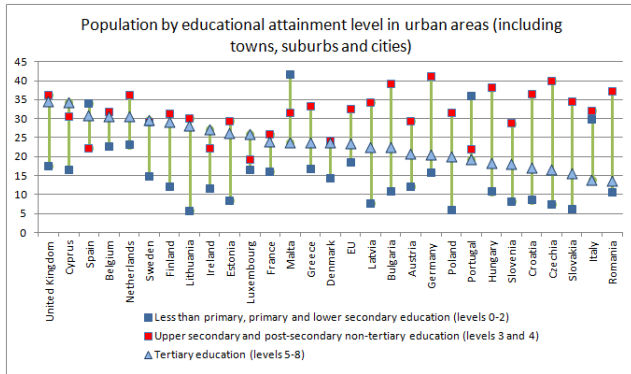


FIGURE 8. Population by educational attainment in urban areas, EU, 2018 (% of total population).

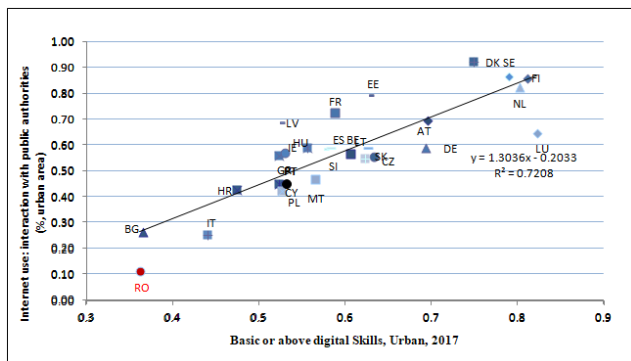


FIGURE 9. Correlation between population with basic or overall digital skills (as percentage of total population) and interaction with public authorities by internet (% of population).

Regarding the e-government improvement, from the perspective of the human factor, we consider that the population is endowed with an appropriate general level of education that will support the openness towards this type of services.

Beyond the general level of education, considered as a basic step of the change of mindset and openness to new forms of evidence of smart cities, digital skills are important in terms of increasing the use of e-government services. They are a sine qua non prerequisite not only for e-government, but for e-services in general. In the EU, in 2017, 60% of individuals in urban areas have basic or above basic overall digital skills, a skill level that allows interaction with public authorities over the internet. The analysis of the correlation between the interaction with the authorities through the internet and the digital skills level showed a strong positive correlation, which means that the use of e-government is higher, the higher the level of digital skills is (Figure 9).

Based on the share of population with basic or above digital skills, it is necessary to be highlighted in many EU countries the need to pay a special attention to the digital education both for adults and for children in different types of formal education.

The digital skills differences between countries could explain both the differences in employability and occupational

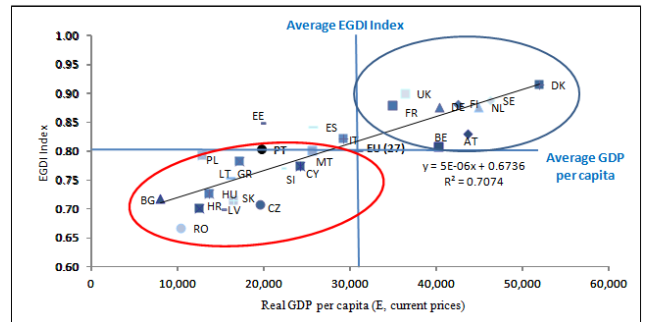


FIGURE 10. Correlation between EGD Index and real GDP per capita, EU, 2018.

structure, but also the participation and the capability of being discerning in the use of e-government services. The digital competences are recognized as part of the lifelong learning strategies and one of the key competences fundamental in the knowledge society [85], [86].

Finally, considering that the aspects that create disparities at EU level: technologies (internet access and the frequency of internet use) and the human factor (digital skills endowment) are important factors in the equation of economic growth [87], we question whether the general level of economic growth can provide general information about the improving performance also in e-government. In this respect, we have analyzed the correlation between the GDP per capita (as an indicator of the general level of development of a country) and the level of EGDI in 2018, in order to identify the existence of a correlation at the broader level of economic growth (Figure 10). The statistical data showed the existence of a strong positive correlation between the two indicators, which indicates that the general level of economic growth is a very important factor for e-government development.

Although it is estimated that delays in achieving high performance in e-government appear as a result of the human factor (UN, 2008), which is not able to accept such changes, we consider that this approach is valid for developed countries with a technological level fit for purpose. For the less developed countries, in addition to the low adjustment of the labour force to the new demands of the labour market (which is observed also in the low levels of digital skills, that indicates a low concern for the increase of the quality of human capital) it must be addressed also to the level of the ICT infrastructure. For both directions, EU regulations and actions are needed.

#### IV. CONCLUSION

The research domain of smart cities and the quest for future generation smart cities research with social impact, promote the vision of digital transformation in modern government and society. The ideas of Policy making for smart cities and the integration of Innovation and social inclusive economic growth for sustainability [88], have tight ties with emerging ICTs like Artificial Intelligence, Cloud and Cognitive Computing [89]. The provision of e-government services were set in the focus of this research study, while at the same

moment sophisticated approaches investigate the impact of Big data and data analytics research for collective wisdom in human decision making and smart machines [90]. The contribution of e-government services, require significant social references and also a bold justification of the social impact [91], [92].

The paper highlights the importance of smart cities in the current societies and their implications on people's lives by improvements in services and operations based on technology and modern infrastructure. The study particularly addresses the e-government process as one of the most important application of smart cities in our current societies.

The e-government process is also promoted as a key enabled of modern future smart cities research including initiatives such as Smart Villages in the EU and Beyond [93]. This work is also a contribution to the recent debate on Rescaling and refocusing smart cities research [94] as a key policy-aware, technology-driven social impact action.

We have examined the existence of  $\beta$ -convergence between EU member states in terms of e-government services, confirming the hypothesis that low performance countries recorded higher growth rate than developed countries. In order to move closer to the factors with high impact on e-government development, we have analyzed other variables for testing the differences between countries, in terms of education, digital skills and access to internet in order to control the hypothesis that countries initially have different development conditions and they will not probably converge to the same steady state.

The assessment of e-government in urban areas is directly dependent on the share of population having internet access, endowment of the population with digital skills, the frequency of internet use. We found that the opportunity of using e-services, particularly e-government services, is less accessible to citizens with low overall digital skills and, as is technically normal, to those with low access to internet. In this context, it is needed to rethink and design the e-government services in order to be adapted not only to the needs of the citizens, but also to their digital skills.

Based on the findings that the improvement of access to internet and the digital skills of the population will increase the use of e-government in urban areas we tested whether the general level of economic growth is related to the performance of e-government. We found that, more generally than specific factors, the overall level of economic growth, expressed by GDP per capita, is a condition for the use and development of e-government, as the variables are strongly positively correlated. This could provide useful information on e-government state in some periods and countries.

Even at EU there is a strong convergence process, there are still many countries that should increase their performances based not only on their efforts but also by relying on the experience of good performing countries, using the transfer of information and knowledge in the field. It is needed a mutual learning process both within EU as a whole and in each country (from urban to rural level), in order to share their

experiences in taking responsibilities, learning and issues in order to increase the potential and opportunities provided by e-governance.

Despite the e-government at EU level provide many possibilities of using the public service and also many solutions for a better connectivity between public administration and citizens, there is still a highly need for increasing the use and confidence in these services in many EU countries. Even in countries with highly penetration rate of e-government, there is a still a need to extend these services to all citizens, irrespective of their area of residence, level of education, wages etc. For this purpose, the EU recommendations, regulations and policies are strongly needed.

Considering that the development of these services is directly related to the human factor, the future research will focus on public administration personnel and its capacity to deploy, to use and the willing to promote the new e-government services.

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