Cities 60 (2017) 272–280

Contents lists available at ScienceDirect

Cities

journal homepage: www.elsevier.com/locate/cities

The effect of ICT use and capability on knowledge-based cities

José Luis Alfaro Navarro [a,*], Víctor Raúl López Ruiz [a], Domingo Nevado Peña [b]

[a] Faculty of Economics and Business Administration, University of Castilla-La Mancha, Avenida de España s/n, 02.071 Albacete, Spain
[b] Faculty of Law and Social Sciences, University of Castilla-La Mancha, Ronda de Toledo s/n, 13.071 Ciudad Real, Spain

ARTICLE INFO

Article history:
Received 10 March 2016
Received in revised form 14 September 2016
Accepted 17 September 2016
Available online 30 September 2016

Keywords:
Information society
ICT indices
Indicators
Intellectual capital
European cities

ABSTRACT

In the information society, ICT (Information and Communications Technology) use and capability are regarded as keys to economic growth. Use of these ICTs depends on the access and ability of citizens, while capability primarily depends on government investment in Research and Development (R&D) and the degree of development of technology-related sectors.

Using information society and science and technology statistics for NUTS 2 statistical regions from the Eurostat database, we construct two synthetic indices for cities based on ICT use and capability, and these are used to group the cities into clusters. We then study the relationship between the ICT indices and economic development, taking wealth and intellectual capital as a measurement of knowledge-based European cities. The results show that both factors, use and capability, are significant but particularly so regarding investment in R&D and the development of ICT sectors.

1. Introduction

Since the end of the 20th century, knowledge, defined as information that generates a useful and quantifiable value for society, has played a key role in adding value to society and helping to create the so-called knowledge society. Within this framework, information acquired by way of information and communications technology (ICT) has taken on a central role and has given rise to a new industrial blueprint, which in turn has led to the development of a telecommunication-based sector and of software used to apply these new technologies to a variety of different industries. Furthermore, ICTs play a key role in addressing some of the issues arising from territory growth, such as pollution, the rise in social inequality, traffic congestion and so on.

Similarly, there has been a change in the economic policies of countries, given that knowledge acquires a major significance and it is therefore important to know how to manage and cultivate it. Investment in research and technological development, education, healthcare, and environmental factors is such that governments establish enabling mechanisms where innovation is a fundamental component of development. Furthermore, cities or metropolitan areas are essential as producers of wealth generation processes, bolstered through technological and business innovation, while at the same time correcting the negative effects for societal values such as nature conservation and cultural identity (Castells, 2001). Therefore, not only does the citizens' use of ICTs play a key role, but also the capacity of countries, regions or cities in terms of ICTs should be taken into account, in other words, investment and development in R&D. Nevertheless, specialized literature considers accessibility to new technologies in cities as a key factor (Janelle & Hodge, 2000; Dijst, 2004; Reggiani, Bucci, & Russo, 2011; Tranos, Reggiani, & Nijkamp, 2013), while ignoring factors related to cities' ICT use and capability.

The major relevance of such intangible elements has led to the appearance of a new dimension with which cities need to realign themselves: Smart City. This is a city that knows how to manage its intangible assets properly. The concept of the Smart City goes far beyond new technologies, as Angelidou (2015) points out, taking two dimensions into consideration: urban futures and the knowledge and innovation economy. The first one is closely associated with the influence of new technologies on the future development of the city, while the second includes the so-called Knowledge Management (KM) in the context of cities, in other words, it focuses on knowledge-based cities. Therefore, although technology plays an essential role in Smart Cities, other aspects linked to human, social, relational and environmental capital should also be regarded as key aspects of urban growth (Caragliu, Del Bo, & Nijkamp, 2011).

In cities, therefore, the interaction between citizens and the different institutional, urban and technological elements should be facilitated, making their daily lives easier, and providing them access to education and culture together with environmentally sustainable growth. This, together with the use and application of ICTs, helps provide citizens with an infrastructure that allows for an improvement in their quality of life and their active participation in the life of the city, sustainable growth and an efficient use of resources. The ultimate aim, therefore, is to create

* Corresponding author.
E-mail addresses: joseluis.alfaro@uclm.es (J.L. Alfaro Navarro), victor.lopez@uclm.es (V.R. López Ruiz), domingo.nevado@uclm.es (D. Nevado Peña).

http://dx.doi.org/10.1016/j.cities.2016.09.010
0264-2751/

economically, socially and environmentally sustainable cities that are able to manage their intangible elements in such a way that they achieve a perfect harmony between all of these aspects. The characteristics of a Smart City are linked to the growth drivers of the intellectual capital models as applied to cities, factors such as innovation, technology and human capital.

Therefore, a review of the specialized literature reveals a gap. To the best of our knowledge, no papers to date have analysed the influence of new technologies on the different aspects of smart cities, as earlier literature primarily focuses on an analysis of the influence of certain specific aspects, without taking into consideration the ICT use and capability of the cities.

This paper thus aims to analyse two key factors that are related to ICTs, namely their use (citizens' use of and access to new technologies) and capability (investment in R&D, staff, training, patents) in order to determine their influence on the different dimensions that help make a Smart City.

After the introduction, where we set out the aim of the paper, the second section provides a brief overview of the concept and main characteristics that are required for a city to be a Smart City, as well as the dimensions and procedures to be followed to measure its intangible capital, which are based on those used by López, Alfaro, and Nevado (2014). Afterwards, two technological factors of ICT use and capability are established, based on NUTS 2 statistical regions (Eurostat, 2015a and b). The fourth section looks at the relationships between these technological factors and the level of development of cities to determine the positive or negative influence of these factors, as well as the degree of influence that each one has. The last section contains the key conclusions of the study, as well as a review of its main limitations.

2. Smart City: an intellectual capital approach

As the aim of this paper is to analyse the influence and effects of ICTs on economic growth, especially that of Smart Cities, the first requirement is an analysis of the concept of a Smart City. Its characteristics should then be classified into a set of dimensions that allow us to determine the influence that ICTs have on the different dimensions under consideration, in keeping with the measuring and management systems that are being used for intelligent cities.

2.1. Concept of the Smart City

Population growth in cities, with local governments moving their focus towards town planning and sustainable growth, has resulted in the popularization of the term Smart City. Nevertheless, there is no clear definition of the concept of the Smart City, and definitions vary depending on the particular focus of the author and the research approach they employ. Moreno and Gutiérrez (2012) provide a summary of the main definitions, while Albino, Berardi, and Dangelico (2015) provide an extensive review of the concept of the Smart City. We, however, only feature the following definitions:

- Amara (2010) suggests that a city becomes a Smart City primarily by means of digitization, using the whole range of technologies that are available to citizens. Likewise, a Smart City must be able to create jobs, in addition to having a high quality transport system available to local residents, to ensure efficient and convenient mobility. The definition also includes healthy and functional homes, a good healthcare and education system, as well as recreational and leisure facilities.
- According to LHYRA (2010), a Smart City is one where all amenities are accessible via an efficient telecommunications network, and the provision of information services whereby residents and local authorities can interact with each other.
- IBM (2013) contends that a Smart City is also a city that, through technological innovation, spends less but more effectively without reducing the quality and quantity of the services provided to local citizens and businesses.
- Frost and Sullivan (2013) reason that a Smart City can be defined by eight intelligent characteristics: government, energy, buildings, infrastructure, mobility, technology, healthcare and smart citizens.
- Monzon (2015) proposed a definition developed as part of the ASCIMER (Assessing Smart Cities in the Mediterranean Region) project carried out by the Universidad Politecnica of Madrid (UPM). It considers a Smart City as an integrated system where human and social capital interact in order to achieve a sustainable and resilient development and a high quality of life.

The general conclusion that can be drawn is that there are a number of different key characteristics that are present in the majority of the definitions: environmental matters (energy production, waste management, etc), communication between the different users (businesses, collectives, institutions and individuals), the use of ICTs in their different facets to enhance the operational workings of the network, social aspects (healthcare, educational and cultural services available) of the infrastructure and efficiency in how they are controlled. Furthermore, Albino et al. (2015) argue that one of the reasons why no clear definition of the term Smart City exists, has to do with its application to different areas of expertise: on the one hand, areas where ICTs play a decisive role, such as buildings, energy grids, natural resources, water management, waste management, mobility and logistics (Neirotti, De Marco, Cagliano, Mangano, & Scorrano, 2014); and on the other, areas where ICTs do not usually play such a decisive role, such as education, culture, policy innovations, social inclusion, and government. This is one of the reasons why this paper analyses the influence of ICTs on the different aspects of the Smart City.

By way of a summary, and taking into account the fact that ICTs are present in one form or another in a Smart City, Table 1 contains the classifications of the concept of a Smart City based on the importance of the use of ICTs, or cities where ICTs are of less importance but where their capacity is boosted through investment in R&D, human resources, training, and patents developed. We also highlight the differentiating factor that each author focuses on in their definition, based on which we allocate a specific name to each type of city.

Certain conclusions can be drawn from the above classification. On the one hand, generally speaking, the concept of the Smart City has evolved based on the particular circumstances and on the position of the researcher. We have therefore created a set of different labels for the city (information, smart, knowledge, digital, etc.) given that there are both common elements and certain differences. In other words, certain concepts clearly focus on specific characteristics while others have a much more global perspective. For example, information is linked to a digital city, but in turn, said information generates databases that create smart communities connected by networks, and when technology policies fuse together with cultures, the city becomes a source of knowledge that in turn facilitates economic and social development, along with environmental aspects and different styles of governance.

Furthermore, we have also carried out a classification based on where the focus of the ICT lies in a Smart City. ICTs are a key element, but the ways of understanding them, implementing them and using them, enable us to differentiate between their use and capacity. Furthermore, technology could potentially be used to train citizens, as long as it is adapted to their needs instead of citizens having to adapt their lives to technology requirements (Cugurullo, 2013; Kitchin, 2014 and Vanolo, 2014).

Finally, in our opinion, the concept of a “Smart City” should include a certain harmony between the quality of human life, economic activity and the exploitation of non-renewable resources, in other words economic, social and environmental sustainability. It is true that certain definitions do not take into consideration some or other of these dimensions, given that many times we end up with what could best be termed a “digital city” or a “planned city”.