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The alignment of University curricula with the building of a Smart City: A case study from Barcelona

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ABSTRACT

This paper argues the role of the University in the Smart City transformation strategy. The theoretical structure takes as reference the recent Complexity theory for city development and their application to the networks of the Connected city. The approach is based on a justified selection of Barcelona and its four universities. We carry out a deductive and interpretivist method interviewing 19 senior experts whole profiles represent the different forces of the Triple Helix model. Our results show the Barcelona city hall has the objective to implement five main innovative services which are fuelled by six main emerging technologies. Nevertheless, we demonstrate that the universities curriculum is not aligned with the city hall's objectives and a gap exists to prepare the undergraduates to the professions required for the Smart City. We recommend six propositions to reshape the University program curricula and leverage the application of Complexity theory to network. The originality of this study is to propose a 3-phases method along with a framework with pre-filled templates and protocols of interviews to analyze universities that pursue the objective to support Smart Cities implementation in a new context of science of cities.

1. Introduction

We observe cities are receiving the biggest part of the worldwide population growth progressing more quickly than the national average (Assadian and Nejati, 2011). They are consequently the locus of major challenges to economize limited natural resources, to absorb the demand of jobs from the immigrants and to mitigate the negative effects due to the congestion of citizens in a space more and more reduced (Rodriguez & Bonilla, 2007). A rich literature echoes the reflection regarding the contribution of the cities to the global challenges through different concepts like Intelligent City, Wired City, Digital City or Smart City (Hollands, 2008; Komninos, 2006; Martin, 1978; Vespignani, 2009). More recently, many scholars suggest cities need to be understood not only as a sum of physical places but also of network systems and flows. They develop new ideas and applications for long-range future cities based on the Complexity science that they consider as the foundations of a new science of cities (Portugali et al., 2012; Samet, 2013; Townsend, 2013).

Emerging technologies like Big Data, Mobile, Social Media and Internet of Things enable groups to work together creating learning systems that behave as dynamic networks and whose number of nodes may vary up or down depending on the flow between them. The Complexity science introduces tools and framework that can be applied to analyze these networks and other structural aspects of the city (population density, dwelling surface and housing costs). This science provides theories to address urban issues and to establish predictive methods of interactions and flows to design next-generation cities. Emerging technologies are also an opportunity to innovate the services offered to the citizens. The cities that base their economy on the research, technology and the science are called Knowledge cities. In these latter, both private and public sectors create and capture knowledge, invest in supporting knowledge dissemination and discovery to create innovative products and services through the action of clusters (Engel, 2015). However, Campbell (2012) highlights the academic circles have remained in the urban surface networks in spite of the national innovation governance (called Triple-helix model) that many cities have deployed to foster the interplay (Etzkowitz and Leydesdorff, 2000).

Therefore, our paper proposes to evaluate if the University academic programs are preparing the students to learn the technologies that the innovative services of the Knowledge-based economy requires. Our study determines the level of alignment between University and Smart City policies and identify possible gaps. We concentrate our analysis on the country of Spain which gathers excellent and internationally recognized universities along with state-of-the-art smart cities like Madrid, Malaga, Seville and Barcelona which hosts every year since 2011 the outstanding Smart City world congress. In our methodology, we list and classify the main innovative services of the Smart Cities

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and the emerging technologies which play an important role in the innovation of the urban services. Then we analyze the programs of different universities taking into consideration the large spectrum of science and technologies fields covered in Spain: Industrial Engineering, Civil Engineering, IT and Telecom Engineering, Physics and Mathematics, Technical Architecture, and Business administration for ICT companies. Finally, we conclude the level of alignment and draw different recommendations.

2. Defining the concept of smart cities

2.1. The science of cities

We live in a world where its future challenges like global warming, scarcity of the resources, or access to potable water have to be resolved in the cities. The growth of citizens whereas the resources available are more and more scarce (DESA, 2009) increases drastically the complexity of these issues and generates a lot of controversy debates (Madlener and Sunak, 2011; Assadian and Nejati, 2011). Cities as a sum of systems managed in silos have been studied hitherto through quantitative theories of built environment. Portugali et al. (2012) assert that Complexity science proposes to improve this analysis including also qualitative theories coming from social field. Complexity science gives birth to a new science of cities and describes the behaviour of units system in interaction with its environment in order to maintain its future. This emerging science is an evolution of the civil system and its characteristics and demonstrates how entity interacts differently from what might be summing up the individual behaviour of each one. Samet (2013) shows that urban development is a process of guided self-transformation and the Complexity science can provide its internal rules integrating different parameters such as the urban classification (from township to megalopolis), the population range, the Gross National Income (GNI) per capita, the dwelling area per person or the cost of new housing per m2. This science makes consider an urban zone different than a 'self-organisation' like an ecosystem. The key parameter of the system growth is the investment capital that increases the complexity and the maturity of the city evolutionary structures. This new science of cities constitutes an important framework for developing planning standards and forecasts. It defines the macro laws for the evolution of the civil system, and prognostics for the long-term future in a horizon of 150 years from now. They are inputs for sustainable development studies and models of climate change to forecast the overall population density for human settlements, the world's land surface covered by urban zones, the remaining uninhabited land for wildlife or the level of forests and cultivated land (Samet, 2013).

2.2. The Connected city

The different technological (r)evolutions have connected the different systems of the cities through different networks (road, telecommunication, railway, network, energy, water supply) while the urbanization of the population was increasing and becoming one of the most important topics for social research. Neal (2013) justifies that the analysis of networks is an important tool for making sense of cities giving the opportunity to fill a gap in the social sciences known as the micro–macro issue and so, reevaluate question like how behaviours of individual people give birth to big urban phenomena. Whereas in the past, both graph theory and social network analysis treated networks as static structures, Newman (2010) applies the Complexity science for the networks theory and shows how networks are the product of dynamical learning processes that add or remove edges that form it, modifying the pattern of nodes and the traffic between them. This complexity of interactions increases while civil or societal phase transitions arise at upper development stages like informational stage (Samet, 2013). However, novel ICT capacities allow through the use of sensors the collect of real-time information concerning these networks like public participation of events in the city, traffic congestion, telecommunications and energy consumption. The simulation of urban models through the use of the technology gives birth to the concept of Smart Cities.

A lot of definitions of Smart Cities exist and for this study, we suggest to use a combination of the most applied definitions in the recent literature (Caragliu et al., 2011; Gershenson, 2013; Hollands, 2008; Komninos, 2006, Vespignani, 2009). They highlight four main objectives: improving quality of life of the citizens, increasing competitiveness and innovation for a new economy while keeping in mind the scarcity of natural resources. This new economy also called knowledge-based economy (Miles, 2005; Komninos et al., 2012) or in its more specialized grades, knowledge-based intensive economy (Gallouj et al., 2014) resides on the application of emerging technologies for the innovation of traditional historical services of the city. Neal (2013) argues that an abstraction of services into networks is a viable and holistic research strategy. He justifies it saying that a network-based analysis encompasses not only the pattern of relationships between people but also contextual factors of the city like culture or ethnic groups characteristics. He adds that the communities and the sense of solidarity instead of disappearing in cities, keep alive by virtue of their network structure i.e. the varied and numerous relationships that inhabitants maintain. But, such a statement puts maybe too much causal determination in the structure of the network. Greenfield (2013) responds "The city is here for use" and opposes himself to the top-down vision of a Smart City with centralized and network-based surveillance and control services. He shows furthermore the possible derives bringing forward different examples such as a large Siemens sensor system roll out that for the unique collect of quantitative data in the network (misregarding qualitative ones) has driven to wrong decisions concerning security and safety aspects of the city. In his turn, Campbell (2012) adds it's not enough to be wired or high tech or high speed to take smart decisions illustrating it through different case studies in the world like Barcelona, Bilbao or Curitiba.

2.3. Knowledge cities

The development of strategies that facilitates investment in the producers of human capital i.e. University is an important factor to reach the Knowledge cities phase of the Smart City transformation (Bakici et al., 2012). Yigiscanlar et al. (2008) identifies different fundamental key elements of these strategies like the technological aspect, the creativity and the development of urban clusters that give access to major infrastructure such as airports or research institutions (Engel, 2015). Leibovitz (2004) adds that the benefits of clustering for businesses include a larger talent pool, cost reductions, greater efficiency gains, and bigger opportunities to share. Campbell (2012) has conducted for over four years repeated visits and web-based surveys in 53 cities that unveil the reasons why the implementation of Knowledge cities may fail. He identifies amongst others that a small urban size impedes the creation of a critical mass of social capital and a lack of private interest the share of information. But he especially adds that a "cloud of trust" is mandatory for a city to learn, innovate and operate into Knowledge cities in the context of the knowledge-based economy (Ergazakis, 2006).

Universities have been long recognized as key components in the city for their role in training and education. The late 19th century witnessed an academic revolution in which research was added to teaching into the University mission. Actually, they have been effective vehicles for government-sponsored research initiatives that lead to major commercialization successes, such as the transistor, RFID, or internet. Fini et al. (2009) foresees the next-generation change in University and other educational institutions asserting they will be also effective catalysts and places of innovation community development. Etzkowitz and Leydesdorff (2000) represent the national innovation system as the interaction of two historical forces: private companies and public administration but adding the role of the University as a third force and positioning it in a central role in the innovation (the