New forms of entrepreneurship and innovation for developing smart cities

Didier Grimaldi

New forms of entrepreneurship and innovation for developing Smart Cities

Ph.D. Thesis

By

DIDIER GRIMALDI

Ph.D. Advisor
PROF. VICENC FERNANDEZ

Department of Management
UNIVERSITAT POLITÈCNICA DE CATALUNYA - BARCELONATECH

Ph.D. Thesis submitted to the Universitat Politècnica de Catalunya - BarcelonaTech in accordance with the requirements of the Ph.D. program in BUSINESS ADMINISTRATION AND MANAGEMENT in the Department of Management.

ACADEMIC YEAR: 2015-2016

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola de Doctorat

Acta de calificación de tesis doctoral

Curso Académico: 2015/16

Nombre y apellidos

Didier Grimaldi

Programa de doctorado

Administración y Dirección de Empresas

Unidad estructural responsable del programa

Departamento de Organización de Empresas

Resolución del Tribunal

Reunido el Tribunal designado a tal efecto, el doctorando/la doctoranda expone el tema de la su tesis doctoral titulada: *New forms of entrepreneurship and innovation for developing Smart Cities*.

Acabada la lectura y después de dar respuesta a las cuestiones formuladas por los miembros titulares del tribunal, éste otorga la calificación:

☐ NO APTO ☐ APROBADO ☐ NOTABLE ☐ SOBRESALIENTE

Nombre, apellidos, y firma	Nombre, apellidos, y firma	Nombre, apellidos, y firma
Presidente/a	Secretario/a	Vocal

Barcelona, ______ de __________ de ______.

El resultado del escrutinio de los votos emitidos por los miembros titulares del tribunal, efectuado por la Escuela de Doctorado, a instancia de la Comisión de Doctorado de la UPC, otorga la MENCIÓN CUM LAUDE:

☐ SÍ ☐ NO

Nombre, apellidos, y firma	Nombre, apellidos, y firma
Presidente de la Comisión Permanente de la Escuela de Doctorado	Secretario de la Comisión Permanente de la Escuela de Doctorado

Barcelona, ______ de __________ de ______.

Abstract

Cities are receiving more and more residents while the natural resources are getting scarce and scarce. As a possible answer, diverse streams of thoughts have emerged declaring that cities need to become intelligent, wired or human. We decided to consider the last stage of this reflection that defines the paradigm of Smart Cities to highlight the use of the information and telecommunication technologies for a better efficiency of the urban services and in response to the residents' needs. In a Smart City, public officials monitor the services of the city and enable a better quality of life.

Social insurance schemes and tax-financed municipal services are monetarily constrained and are unable to respond effectively to growing societal needs. As a consequence, the urban development has moved from a public managerial to an entrepreneurial focus where the emerging technologies e.g. Big Data, Social Media and Internet of Things (IoT) are the drivers of this transformation. My research consists on exploring, describing and analysing different forms of innovation and entrepreneurship in the city. Accordingly, we decided to orientate our epistemological works on studying the cases of two Smart Cities internationally recognized (i.e. Barcelona and Nice).

To achieve this objective, we have split this research in four studies according to four chapters. The first chapter studies and shortlists amongst all the emerging technologies those which play a principal role in the building of the Smart City. It analyses also the gap that the universities have to cross to prepare the students to develop new models of urban services. The second chapter presents a case of business development in the domain of public parking. It focuses on the conditions of establishment of a digital business ecosystem based on an IoT platform and analyses the value created and captured by this model.

The third chapter presents the case of a citizen initiative in the domain of the education called 'the school road'. It has the objective to list, classify and analyse the barriers that limit this project. It finalizes proposing different solutions to mitigate the impediments and stress the possible social contribution of the small and local shops for this initiative. In the final chapter, following these recommendations, we investigate how the stores spread in the urban grid could play this social role. Focusing on the first phase of the entrepreneurship process, i.e., the opportunity identification, we suggest a heuristic able to recommend and numerically prioritize the vacant locations as per their opportunity of business value creation. The originality of this heuristic resides on the capacity to cover social and business perspectives together.

The first and third study are inductive and qualitative researches whereas the second and fourth are deductive and quantitative ones. The qualitative researches are based on interviews to Smart City experts and a survey sent to parents. The quantitative ones are supported by scientific theories about business model generation. The value calculation of the digital business ecosystem is verified by paired T-Test and polynomial linear regression analysis. Data from parking sensors are collected and analysed with a Big Data analytics solution. The heuristic leverages the theory of complex networks applied to the urban grid.

We recommend the entrepreneurs to consider our results before starting any new services based on an IoT supply chain platform or deciding on the location of their future shop. We advise also public managers to leverage our findings to revise their urban policy if their goal is to revitalize the local industrial and services urban base.

Dedication and acknowledgements

I would like to express my sincere gratitude to my supervisor Dr. Vicenc Fernandez not only for his huge engagement, weekly availability and immense knowledge but also for his useful teaching classes, proven methodology and constructive comments through my learning process. His rigour and large expertise in quantitative and qualitative studies helped me in all the time of my research providing the necessary advice to write this thesis. I could not have imagined actually having a better advisor and mentor for my Ph.D. Thesis.

Furthermore I would like to thank the technical and management teams of the companies and startups working in the domain of Smart City that provided me the needed information to execute my field. In alphabetical orden: Capgemini, DesideDatum Data, DroneFutura, Eixos, Everis, IBM, Infonomia, Innopro, Urbiotica. Thanks to you: Miquel Barceló, Marc Boher, Carlos Carrasco, Irene Compte, Alfons Cornellá, David Nogué, Olav Oma and Marc Viader.

I could have not written either this thesis without the large support of the preceding Barcelona and Nice mayoral teams in function between 2011-2016 and the public-private organizations in charge of the Smart City projects. Many thanks to Jaume Battle, Pilar Conesa, Dr. Angelo Corsaro, Tomas Díez, Josep Ramón Ferrer, Vicente Guallart, Dr. Josep Miquel Piqué, Dr. Artur Serra and Frédérique Vidale. I would like to thank also all the participants of the different surveys, who have willingly shared their precious time during the process of interviewing. I have counted it and it is more than 80 interviews.

I thank also my colleagues of Toulouse Business School, Catalonia Polytechnic University, La Salle Ramon Llull University, IESE and ESADE respectively Dr. Christophe Favoreu, Dr. Christophe Benaroya, Prof. Josep Lluis Torres, Prof. Ramón Martin de Pozuelo, Dr. Paul Fox, Dr. Pascual Berrone and Dr. Esteve Almirall for the stimulating discussions, their encouragement, insightful comments, and hard questions. They helped me to orientate myself and find my way in front of the big task I had to face.

Finally, I would like to thank my little boys: Arnau and Pol for keeping me harmonious and happy along with my dearest Laura who have supported me throughout the entire process, listening carefully to me and providing me with a lot of useful encouragement. A lot of sleepless nights would have been impossible without thinking about all of you. I will be grateful forever for your love.

I hope not to leave anyone out along the way. If I do, it is clearly an error by omission.

Author's declaration

I declare that the work in this Ph.D. thesis was carried out in accordance with the regulations of the Universitat Politècnica de Catalunya - BarcelonaTech and the requirements of the Ph.D. program in Business Administration and Management in the Department of Management. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED: .... DATE: ....

Table of Contents

List of Tables

List of Figures

Figure **Page**

Chapter 1

Introduction

I've only lived in cities: Marseille, Paris, and Madrid and Barcelona. However, I hardly remember the name of all the mayors that have administrated them. Actually, their election were not so popular and covered by TV/newspapers/radio if we compare them to Prime Minister or President ones during the same period. I have always thought it was not fair since managers of cities and district are those that have solved my daily problems. They decide to open new libraries, new schools, additional lines of subway, free WiFi access or to engage large infrastructure works to install fibre in my neighbourhood. Recently, I read Barber (2013) and I start wondering if he was right stating that the future of the world may lie with the mayors who implement practical changes every day. I had found my subject of thesis. I decided to study cities, Smart Cities i.e. how the emerging technologies (Big Data, Internet of Things, Social Media, Cloud, etc.) are opportunities to simulate new urban models and build innovative services to the citizens (Caragliu et al., 2011). I decided also that the field of my research would be Barcelona where I've been living for the last five years and Nice since both cities are outstanding case studies usually ranked amongst the top Smart Cities in the world (IESE, 2015). Actually, in the last five years, Barcelona and Nice have implemented large programs which have positively transform the life of their residents. The results of their strategy are as an illustration interactive display screens which provide touristic information, an ubiquitous bicycle renting system, connected dumpsters that inform if they are full or empty and modify the route of the bin lorries, or also connected parking spots that inform the drivers on their availability. In other words, I decided to analyse if the new paradigm of Smart Cities may imply new form of entrepreneurship and create novel conditions of sustainable business opportunities in the urban area.

1.1 Smart City concept

Defining Smart cities is a big subject. Many fields of research have shown an interest to study the concept of Smart City. They give birth to theories related to spatial planning (e.g. Freeman, 1977; Morandi et al., 2015), economic geography (e.g. Bunnell and Coe, 2001), knowledge economy (e.g. Zygiaris, 2013), entrepreneurship (e.g. Lombardi et al., 2012), urban technology (e.g. Allwinkle and Cruickshank, 2011; Caragliu et al., 2011) and marketing (e.g. Doel and Hubbard, 2002). Although these multitudinous studies, academic research is at an early stage and lacks a homogeneous and comprehensive definition (Richter et al., 2015). However, the subject retains a constant interest since cities are receiving more and more residents who require living services of quality while financial and physical resources are getting scarce and scarce (UNPD, 2001).

As a possible answer, diverse streams of thoughts have emerged declaring that cities need to become intelligent, wired, human to overcome these challenges. We have decided to consider the last stage of this reflection that defines the paradigm of Smart City to highlight the use of the information and telecommunication technologies for a better efficiency of the urban services (Caragliu et al., 2011). Initiatives of Smart Cities are usually classified into two opposite domains (Neirotti et al., 2014; Bakici et al., 2012). Top-down approach refers to projects governed by the City Hall in opposition to bottom-up one developed by (active) citizens. Technology usually plays a bigger importance in the first case (Nam and Pardo, 2011).

1.2 Emerging technologies

The consulting group McKinsey (2014) analysing the impact of the emerging and disruptive technologies proposes to classify them using two criteria: firstly in terms of business opportunity and secondly according to the technological gap they represent against the current state of art. The list starts with Mobile Internet followed by the Automation of knowledge work, the Internet of Things (IoT), the Cloud Technology, the Advanced robotics, etc[1]. Nevertheless, to the best of our knowledge no study exists defining which are the most relevant ones for the purpose of the Smart City i.e. enabling the new services that improve the quality of life. In the first part of my doctoral thesis, I tend to fill this gap determining how the upcoming technologies sustain the innovation, accelerate the city transformation and convert the society into a Knowledge Society (Bakici et al., 2012).

1.3 Urban innovation system

Etzkowitz and Leydesdorff (2000) describe the national innovation system as the sum of three main actors: universities, private companies and public administration. They define different modes of interactions according to a Triple-Helix model which they comment a full and permanent synchronisation may not always exist. As a starting point, we decided to use this model exploring the role of each actor in the context of the Smart City. The Chapter 3 refers specifically to the university role. The Chapters 4 and 6 are both concerned with the private firms while the government role is covered in all the chapters. However, the originality of this research resides on proposing a new urban innovation system inserting the citizens inside the Triple-Helix model converting it into a Quadruple-Helix one (chapter 5). Accordingly, we investigate new forms of collaboration between public and private sectors where citizens could play a beneficial role as social entrepreneurs (chapter 6).

[1] http://www.mckinsey.com/business-functions/business-technology/our-insights/disruptive-technologies

1.4 Research question

Therefore, my research consists on exploring, describing and analysing novel forms of innovation and entrepreneurship in the city, through the prism of the role played by the four actors of a new designed urban innovation system and considering the lever of the emerging technologies. We decided to orientate our epistemological works on studying the cases of two Smart Cities internationally recognized which are Barcelona and Nice.

To achieve this objective, we have split the doctoral thesis into four chapters. The chapter 3 studies and shortlists amongst the disrupting technologies those which play a principal role in the building of the Smart City. It analyses also the gap that the universities have to fill to prepare the students to develop the new models of urban services. It uses a deductive and interpretivist method based on a large panel of experts' interviews. The chapter 4 presents a case of business development in the city of Nice in the domain of transport. It focuses on the development conditions of a digital business ecosystem based on an IoT platform and analyses the value created and captured by this innovative business model. The chapter 5 presents the case of a citizen's initiative in the domain of the education services. It is based on an exploratory and then a confirmatory survey submitted to ten academic lines of four Barcelona schools. It has the objective to list, classify and prioritize the barriers that impede this project. It finalizes proposing different solutions to reduce the impediments and highlights the possible social role for the small commerce of the city. In the chapter 6, following the recommendations of the previous chapter, we investigate how the shops located in the urban grid can contribute to the social development of the city. Focusing on the first phase of an entrepreneurship process, i.e., the opportunity identification, we develop an heuristic able to recommend and prioritize the vacant locations as the best places to open commercial shops. The originality of this heuristic resides on the capacity to address social and business objectives together. Chapter 2 provides an overall overview of the literature related to Smart City, entrepreneurship and technological innovation while the chapter 7 is the final conclusions of my thesis and suggests future lines of research.

1.5 Academic and professional contributions

I've been working for more than twenty years as a consultant and three years ago, I initiated a career as a researcher. The motivation of my doctoral thesis has been to analyse real situations in order to develop models, methods or heuristics able to be re-used for business or academic purposes. In the domain of Smart Cities research, I believe to have contributed in three different academic fields: the technological innovation (chapter 3), the entrepreneurship (chapters 4 and 6) and the urban study (chapter 5). However, I need to stress that the case of Barcelona or Nice with its specific characteristics of sea-side metropolis and a large proportion of built infrastructure can limit the extrapolation of the collected results to other cities. Having said that, we recommend entrepreneurs to consider our findings related to the value creation and capture in the Nice digital ecosystem before starting any business based on an IoT platform (chapter 4). We suggest also managers of public sector to revise the results obtained in the Barcelona social entrepreneurship model (chapter 6) as worthful inputs for their strategy to revitalise the local and small businesses in their urban area.

Chapter 2

Literature review

'We have now entered the century of the city' (Seto and Sánchez-Rodríguez, R.; Fragkias, 2010).

The cities are facing a continuous immigration from the rural zones. The global urban population exceeded the rural one for the first time in history in 2008 (Crossette, 2010). The trend has been similar in the whole planet and not depending on the geographical zone of the world or the industrialization level of the country. In Europe, the break even point when urban proportion equalled to urban one was reached in the 1950's and in 2009 the urban population was yet 70% of the overall (DESA, 2009). In Latin America, the urban growth has been exceptional and data from the United Nations (UNPD, 2001) indicate that in the period between 1972 and 2000, the percentage of the total population living in urban zones increased from 58.9% to 75.3% and forecasts to reach 83% in 2030, a percentage that will be similar to the expected for the highly industrialized countries (Rodriguez and Bonilla, 2007).

Due to this frenetic expansion, Assadian and Nejati (2011) observe cities have been facing three major concerns related to the environment, the competitiveness of its economy, and the quality of life offered to the citizens. We respectively develop each of them in the following lines:

- Madlener and Sunak (2011) state that cities are responsible for around 75% of the overall resource consumption and thus of the environment problems even if they occupy no more than 2% of the land (Miller and Hanzel, 2007). The recent report of the World Bank (2010) corroborated it, estimating that metropolitan areas account for 70% of CO2 emissions in the world. Cities are impacted by the global warming and the climate change. Rising sea levels are one of the consequence and directly impact urban areas lying less than 10 meters above sea level. As far as it concerns industrialized countries, a first estimation targets 70% of Europe's largest cities (e.g. Paris, London, Amsterdam) or megacities like Tokyo or New York City will be impacted. In emerging countries, Kolkata (formerly Calcutta, India), Shanghai and Guangzhou (formerly Canton, China) are pointed out. Besides, China alone has more than 78 million people living in vulnerable low elevation cities (McGranahan et al., 2007).

- Cities have usually had a profound impact on the economical competitiveness of a country, performing better than the national indicators average (Assadian and Nejati, 2011). The city of Tokyo is responsible for 40% of Japan's GDP while receiving only 28% of the country's population. Similarly, Paris covers 30% of France GDP, with only 16% of the French population living there. Even among developing countries, similar examples can be found. The Nigerian capital, Lagos, forms 30% of the country's output, while only 8% of the country's population inhabit there. However, the performance of the city can not be disconnected to the general business situation of the country (Economist Intelligence Unit, 2011). The existence of transparent national business rules and regulations are among one of the most important economical motivations in attracting new investments in the city (Economist, 2013). They are conditions for the sustainability and the competitiveness of the industry and services companies present in the city.

- Poverty, hunger and sanitation problems affect drastically the lives of millions of people in the world. The last financial worldwide crisis initiated in 2010 has deteriorated the existing situation pushing a lot of citizens into the poverty (United Nations, 2014). The quality of life is largely related to the economic conditions of living. Poverty remains one of the challenging and lasting problem in the city and provokes exclusion from society and social systems (World Bank, 2006). It causes also psychological deficiency amongst the people who fail the essential for them and their family (Mwenda and Muuka, 2004).

2.1 The emergence of Smart City as an answer

Miller and Hanzel (2007) observe that an adequate urban strategy and planning can have a direct impact on the quality of life, the environment and the business competitiveness. He illustrates it presenting data from the Economist Intelligence Unit (2011) which compares the population sizes and air pollution rates in different large cities. The report shows how Tokyo with a population of 35 million people is much less polluted than Delhi with roughly 16 million. Indeed, albeit the twice of population, a better urban management has allowed the Japanese capital to be 4.3 less times polluted than Delhi.

The concept of Sustainable City started in 1980's as a possible answer to the three city challenges here-above presented. A sustainable development is defined by World Commission on Environment and Development (1987) as the 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. The sustainable development is usually broken down into three components which are the environment, the society and the economy (Giddings et al., 2002) which confirm the complete alignment with the city concerns. Different sustainable campaigns were launched by the United Nations to tackle problems of poverty, hunger and proper sanitation. Their goals were to minimize the inequalities, to provide a fair access to the resources and opportunities for all the citizens (Pourezzat and Nejati, 2008).

However, the development of intelligent or smart technological solutions for the problem of the city have been around for many years. Caragliu et al. (2011) propose to include it formally and the Sustainable City becomes Smart City. He suggests this following definition (which has been since broadly shared): 'a Smart City invests in transport and Information and Communication Technological (ICT from now) infrastructure but also in human and social capital in order to fuel sustainable economic development and a high quality of life, as well as to achieve wise management of natural resources, through participatory action and citizens' engagement'.

2.2 The different domains and features of Smart Cities

Defining how is a Smart City is a difficult task. Determining which are the best Smart Cities harder. However, different rankings exist such as the IESE[1] or the Juniper Research Institute[2]. On May 2016, Juniper Research updated their classification and revealed Singapore, Barcelona, London, San Francisco and Oslo as the top 5 world wide best Smart Cities. Their rankings were compiled following extensive studies of cities around the globe covering usually the domains of Energy, Transport, Living, Open Government and Economy. Furthermore, Neirotti et al. (2014) propose to order the domains and features of a Smart City. They conclude on a classification based on two opposite approaches.

2.2.1 Top-down Smart Cities initiatives

On one hand, they are the top-down initiatives where priority is done on the urban infrastructure. They combine a set of 5 domains which usually are: transportation, energy, water & waste water, healthcare and safety & security. Technologies role is to optimize the use and exploitation of the natural resources, the energy distribution or the citizens transport. These initiatives have as common characteristic to be governed by the City Hall in an unidirectional (top-down) approach and are ICT oriented. Bakici et al. (2012) consider them as the foundation of the Smart Cities. The high profile domains are:

1. Energy grids where ICT allows to manage and integrate in the common network multiple power sources: roof equipped with solar cells, wind turbine, strength of the tide. Technology allows to understand the users' consumption behaviour in real-time and to influence it in order to reduce the peaks during the day (e.g. Chourabi et al., 2012; Correia and Wünstel, 2011; Steria, 2011).

2. Environment where ICT allows to better protect environmental resources and control pollution as illustrated by many papers (e.g. Atzori et al., 2010; Chourabi et al., 2012; Inayatullah, 2011; Nam and Pardo, 2011; Tiwari et al., 2011).

3. Transport where ICT provides users with information on the traffic and public transportation condition as described by many papers (e.g. Correia and Wünstel, 2011; Dirks et al., 2009; Giffinger et al., 2007; La Greca et al., 2011; Munuzuri et al., 2005; Nam and Pardo, 2011; Steria, 2011).

4. Healthcare where ICT helps preventing and diagnosing diseases and reducing sanity costs. It can also give remote assistance in case of urgency as commented by many papers (e.g. Accenture, 2011; Atzori et al., 2010; Correia and Wünstel, 2011; Dirks et al., 2009; Nam and Pardo, 2011).

[1] http://citiesinmotion.iese.edu/indicecim

[2] http://www.juniperresearch.com/researchstore/key-vertical-markets/smart-cities/energy-transport-lighting

5. Public security where ICT helps to protect citizens' integrity and their belongings feeding real-time information to fire and police departments as illustrated by many papers (e.g. Accenture, 2011; Dirks et al., 2009; Nam and Pardo, 2011; Washburn et al., 2010).

6. e-Government and administration where ICT promotes digitized public administration in order to enhance citizens empowerment and involvement in the public affairs as analysed by many papers (e.g. Bakici et al., 2012; Correia and Wünstel, 2011; Giffinger et al., 2007; Odendaal, 2003; Washburn et al., 2010).

In this first approach also called ICT-based Smart Cities (Marsa-Maestre et al., 2008), sophisticated systems that 'sense and act', manage a great volume of real-time information and integrate them across multiple processes, systems, organizations and value chains to optimize operations and inform authorities on incipient problems. Sensors provide the data, wireless and ubiquitous technologies allow to transit them and software application to manage the ocean of data and convert it into information thanks to 'big data' solutions (e.g. McKinsey, 2011; McAfee and Brynjolfsson, 2012).

2.2.2 Bottom-up Smart Cities initiatives

On the other hand, bottom-up Smart Cities initiatives encourage access to data and allow citizens to develop their own initiatives (Lorusso et al., 2014; Garriga and Medina, 2014). New technology deployment is not the main objective but rather citizens' cooperation in order to eliminate injustice, give (back) societal rights, mitigate inequalities while helping the integration of excluded people, give assistance to disabled, elder or younger citizens or provide access to culture and education to disadvantaged people. In the chapter 5, we describe and analyse in detail one of these initiatives.

This approach considers the cities not only a grid of intelligent sensors and a list of services but having an unique character reflected in the citizens daily life and culture. Cities are the people that inhabit them, their memories, stories, concerns and the experimentation developed through social interaction. The domains are related to education, culture and healthcare. Social initiatives that meet also financial value are usually described in the scientific literature as social entrepreneurship (Leadbeater, 2006) and fostered by social innovation (Neirotti et al., 2014). We analyse this new phenomenon in the chapter 6. The term sociable is often added to Smart Cities suggesting that smartness is people-oriented and ICT plays a limited role. Christopoulou et al. (2014) say 'Sociable Smart Cities make the city different while Smart Cities share the same modern infrastructure and offer similar functions. Technology issues are considered easy to fix as rapid corrective or enhance developments to solve issues of the present'. The challenge is to foster a new collaborative attitude, a participatory approach to allow people to interact with their cities in novel ways, to enable them to design and decide the future of the city (Komninos et al., 2012), and to have a proper infrastructure that supports this social fabric (Mulder, 2014).

The domain of public transport can be taken to illustrate the difference between ICT Smart Cities and Sociable Smart Cities (Christopoulou et al., 2014). Citizens flow is amongst the dominant problems for the cities (Hillier et al., 1993). Armeni and Chorianopoulos (2013) identify how the pedestrian can be unsatisfied by an ICT application which proposes fast-track paths based on GPS technology (e.g. Google Map, Michelin, Mappy) when the pedestrian can prefer subjective itineraries dynamically crowd sourced by other social media users (e.g. Facebook, Twitter or Instagram). They propose so an alternative approach planning tourists' activities based on 'I like it' tags and comments on social media networks. Experiences, knowledge, memories and people become connected across a Sociable Smart City.

The cooperation between citizens may be organized inside what is usually called Living Laboratories (Living Labs), a shared physical space with the objective to engage users in a creative and collective perspective. Milan along with Lisbon, Aalborg and Birmingham was the first city to implement this concept. This lab located in the north west of the capital of the Lombardy region, in the neighbourhood of Quarto Oggiaro, employs prototyping mechanisms that allow the design of complicated and new things and to make them sense while visualizing in different ways (Manzini and Rizzo, 2012). Different projects have been launched in this Living Lab (e.g. My City Project).

Initiated on January 2013, My City Project includes the understanding of the context of the borough, the demography, the population profile so as to identify the main challenges of the neighbourhood. The Living Lab allowed the idea generation and selection through different co-design meetings with urban planners, designers, citizens, associations, municipalities and university, leveraging the long tradition in design research and in urban planning of Milan Polytechnic University. The result was to implement two co-design services called 'Quarto Food' and 'Quarto Gardening' with the same characteristics to increase the collaboration between citizens. Quarto Food service gives the opportunity of young people from the Hostelling School of the neighbourhood to provide to elderly citizens a meal carefully prepared and enjoyed in a pleasant location. Quarto Gardening gives the chance of Quarto Oggiaro Agricultural School to take care of part of the green areas in the neighbourhood, along with, decreasing the costs of the maintenance, regenerating old public spaces and developing new job opportunities for young people (Rizzo and Deserti, 2014). These initiatives improve the quality of life of the citizens where ICT investment was very low.

2.3 Cases of analysis: two Smart Cities

2.3.1 The case of Barcelona

The urban policy of Barcelona has been analysed from various points of view: housing (e.g. Garcia J, 2011), urban policy (e.g. Leon, 2008; Mazzoleni, 2010), environment (e.g. Domènech and Saurí, 2011), employment (e.g. Garcia-López and Muñiz, 2010) and knowledge economy (e.g. Hospers, 2003). The first stone of the urban transformation or regeneration of Barcelona was initiated early 1980's with the aim at preparing the 1992 Olympics games and with a serious infrastructure deficit as handicap. Today, Barcelona is a leading Smart City recognized worldwide (Marshall, 2000). Result of this regeneration, a new district was born: the 22@ district (Leon, 2008) that during the Olympic Games hosted the international participating athletes and the member of the international committee.

In 2000, the Smart City concept embraces projects to answer to remaining deficiencies regarding public transportation, dwelling, environment, sanitation, water and energy issues. The main initiatives of Barcelona Smart City model can be broken down into four main characteristics: Smart Governance, Smart Economy, Smart Living and Smart People (Bakici et al., 2012). Smart Governance represents the Open Data initiative giving a better access to the citizens of the government information. Smart Economy means the creation of innovation clusters like Digital, Media, Energy, Housing, Design and Biomedical involving universities, companies and public sector (Batlle et al., 2011). Smart Living is the improvement of life for the citizens through the penetration of new technologies. Smart people deals with training programmes provided by Barcelona Activa organisation[3] or application contests for the digital transformation of the services of the city. The Barcelona 22@ is the selected district for most of all the projects launched by the City Hall. It is the corporative name given to an urban renewal area in Barcelona's formerly industrial area of Poblenou, in the district of Sant Marti, nicknamed 'the Catalan Manchester' in the 19th century. Many infrastructure projects were launched to implement optical fibre, sensors network and public WiFi. Other projects in the public area (called e-government) were defined in order to transform the business processes of public administration and made them more accessible, efficient, and effective (Leon, 2008).

The Barcelona Urban Innovation Lab & Dev (BUILD) programme encourages the Smart City model development (Batlle et al., 2011) and the co-participation between private and public sectors for the development of Living Labs also referred as 22@Urban Lab. These Living Labs aim there at developing innovative products and services related to improvements in the urban space management. Fourteen pilots have been launched in the neighbourhood since 2001 and developed in various domains such as environment, mobility and telecommunication. They are the implementation of twelve outdoor public street-lighting points, an ecological digital system with sensors of vibration, temperature, humidity, sound and pollution, different charging points for electric cars. Recently, Barcelona has launched other living labs such as LIVE, i2Cat LivingLab (related to Polytechnic School of Catalonia), FabLab (linked to IAAC architecture school), Hangar and Citilab-Cornellá (Bakici et al., 2012).

Barcelona Smart City program includes also the implementation of different advanced technology centres such as the Barcelona digital[4] in the field of ICT, offering proposals of innovative services to business and society through applied research and technology transfer in the sectors of Health, Security, Mobility, Energy and Environment. Its mission is to constitute a broader innovative ecosystem, both national and international. The Barcelona digital organizes a yearly conference specialized in the field of mobility, strategy and mobile applications where the latest emerging technologies of the digital world are discussed and culminate with the award of the best innovative mobile application.

The recognition of Barcelona as a Smart City leader has been clearly demonstrated by the choice to hold the Smart City Expo & World Congress since 2011. Nevertheless, Bakici et al. (2012) identify 5 challenges that the city needs to face:

1. The skilled human capital level is not enough to comply with the needs of industry clusters.
2. The level of local entrepreneurship is lower against any other country in Europe.
3. Venture capital funding is not sufficient to attract firms and finance new ventures.
4. The number of large companies to lead innovation is low.
5. The global business connection of Barcelona is poorer compared to other European cities.

[3] http://www.barcelonactiva.cat
[4] http://www.bdigital.org

2.3.2 The case of Nice

The French Riviera capital, the city of Nice presented in 2010 a vision of sustainable, environmentally friendly economic development for the urban area. This vision led to the smart city project 'Connected Boulevard', initiated by 'Nice Cote d'Azur' metropolitan authorities and Nice City Council. Connected Boulevard, the world's first Internet of Everything intelligent platform for Smart Cities, is a joint project with multinational Cisco company, and the Think Global Alliance. Think Global is a collaboration, a business ecosystem (Anggraeni et al., 2007) between global start-ups and large enterprises with innovation as a common denominator. It offers adjustable, timely, and scalable end-to-end solutions that need to meet local urban needs based on IP open standards and protocols with the aim of facilitating seamless integration and interoperability.

Li (2009) observes that Connected Boulevard comes with four interoperable layers: sensors and networked devices with mesh technologies, which promote seamless integration of emerging context-aware sensors and devices as the need for new city services arise. Then, the data is captured, processed, stored and computed using analytics combined with integrated and open standard application programming interfaces (APIs). Finally, new and innovative applications and services are developed and integrated by a myriad of private companies for city managers and residents. The purpose of the project is to optimize the city's energy and environmental management, with the main focus on improving the efficiency of public and private transportation within the city. The system provides the city's inhabitants with many practical services such as enabling streetlamps to light up autonomously, one by one, according to passing traffic flows; making suggestions to car drivers on where to park in the neighbourhood; and signalling the amount of rubbish and the temperature inside the public garbage depositories so as to prevent fires breaking out.

The project enables several new applications and services that benefits the citizens. All along the boulevard Victor Hugo in the city centre of Nice, more than 200 sensors, with an average lifetime of 8-10 years, have been installed on street-lights, in the roadway, and on garbage depositories. These sensors collect real-time information on traffic flows, public lighting, cleanliness and the quality of the environment in the city centre. Data are aggregated and sent via a WiFi network to the city's computer centre or directly to citizens using related apps. Another solution is related specifically to transport. More than 5.000 parking spots were attached with a sensor that sends the parking spot's availability status and location to the City Data Hub, in real time. Then, parking information is further sent to the citizens through a smartphone app, called 'Nice City Pass'. The drivers can then find the available parking spot, without driving around while searching for it. We analyse this business ecosystem in the chapter 4.

2.4 Emerging technologies

Bakici et al. (2012) suggest the City Hall, while creating the physical foundations of the Smart City with the development of large ICT infrastructures, provides the conditions for the rise of a new service economy. They add that this new economy through the interactions with industrial and service companies deliver the expected benefits for the citizens. Gallouj et al. (2014) analyse the emerging dynamics of this future service economy taking into consideration two sectors: knowledge based intense economy and wholesale and retail Trade. Their conclusions are that ICT becomes one of the major driving forces of services development that transforms traditional services and promotes innovative services and new services delivery routes (along with the market globalization). They compare the emerging technologies as opening avenues for new and innovative business models to companies and final consumers. They highlight also that these innovations reshape not only businesses, public services and leisure time of individuals, but also the way how knowledge is created, produced and propagated; how employees communicate within business environments and how citizens interact with other citizens or institutions. The real challenge for the whole society is investigated in the chapter 3.

Perboli et al. (2014) provide taxonomy of Smart City emerging technologies and highlight two large trends can be highlighted. First, Cloud Computing and its different flavours such as Infrastructure as a service (IaaS), Platform as a service (PaaS), Software as a service (SaaS), Network as a Service (NaaS), Storage as a service (STaaS), Sensor as a Service (SSaaS). Secondly, Database Management System (DBMS) enhanced by recent Big Data solutions makes possible to efficiently and effectively manage a large set of structured and unstructured data coming from web applications, sensors or users' portable devices and to transform them into a trustful information for a reflected decision (Li et al., 2015).

These emerging technologies considered as a whole are usually described as a new technological revolution (Gallouj and Savona, 2009; Barras, 1986), the last cycle of the economical growth curbs usually called 'Kondratieff waves'. The Data that fuels the ICT solutions becomes the new oil of this third and coming industrial revolution as Huberty (2015) states it while making an analogy with the role of petrol and electricity for the first and second industrial ones. However, the key adopter sectors in that case are likely to be the service industries of the Smart City, rather than the manufacturing sectors which have dominated previous technological revolutions (Miles, 1993; Gallouj and Savona, 2010).

The McKinsey Global Institute Report (2013) presents amongst a lot of possible candidates drawn from academic journals, business and technology press, analysis of published venture capital portfolios, and hundreds of interviews with relevant experts and thought leaders, a list of a dozen economically disruptive technologies. Each candidate is assessed according to economical and technological impact criterias, eliminating some that are too narrow and others that seem unlikely to start having significant economic impact within the upcoming 5 years. It finally shows that 12 potentially economically disruptive technologies have potential to affect billions of citizens, hundreds of millions of workers, and trillions of dollars of economic activity across industries. They are all listed in the table 2.1.

2.5 Urban innovation system

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. In some countries, they have been effective vehicles for government-sponsored research initiatives that lead to major commercialization successes, such as the transistor, RFID, or internet. Nevertheless, Engel (2015) and Fini et al. (2009) identify a new change in university and other educational institutions asserting they can be effective catalysts and loci of technology commercialization, and innovation community development. Other scholars (Rizzo and Deserti, 2014; Etzkowitz and Zhou, 2008; Etzkowitz, 2004) go further and include a third role that they relate to motivate students in the

Table 2.1: Twelve technology trends from the McKinsey Global Institute Report (2013)

Technology Trends	Description
Mobile Internet	Increasing inexpensive and capable mobile computing devices and internet connectivity.
Automotion of knowledge work	Intelligent software that can perform knowledge work tasks involving unstructured commands and subtle judgments.
The Internet of Things	Networks of low-cost sensors and actuators for data collection, monitoring, decision making, and process optimization.
Cloud Technology	Use of computer hardware and software resources delivered over a network or the internet, often as a service.
Advanced robotics	Increasingly capable robots with enhanced senses, dexterity, and intelligence used to automate tasks or augment humans.
Autonomous and near-autonomous vehicles	Vehicles that can navigate and operate with reduced or no-human intervention.
Next-generation genomics	Fast, low-cost gene sequencing advanced big data analytics, and synthetic biology (writing DNA).
Energy storage	Devices or systems that store energy for later use, including batteries.
3D printing	Additive manufacturing techniques to create objects by printing layers of material based on digital models.
Advanced materials	Materials designed to have superior characteristics (e.g. strength, weight, conductivity) or functionality.

path of the entrepreneurship and the creation of jobs through academic spin-off (ASO).

Etzkowitz & Leydesdorff (2000) represent in their Triple-Helix thesis the national innovation system as the interaction of two historical forces: private companies and public administration adding the role of the university as a third force and positioning it in a central role in the innovation process. Their thesis describes different configurations of interactions between the 3 forces based on growing level of controls from the public sector and advises that on the opposite of a 2-factor interaction model, a third force leads that the sources of innovation are no longer a priori synchronized. In other words, the technology innovation generated by private companies or new innovative service requirements from public administration do not generate an order for university to prepare students for the Smart City purpose.

In my doctoral thesis, I've decided to use this Triple-helix model as a starting point to analyse the urban innovation system and explore the role of each of the three actors: university, companies and public sector (see chapter 3). The consequence of the recent financial crisis in Europe, resulting in economic downturn and a growing array of social problems, has raised new questions about the financing of the services in the city. Social insurance schemes and tax-financed services are monetarily constrained and are unable to respond effectively to growing societal needs. Smart City is therefore an opportunity for entrepreneurship (see chapter 6) and the urban development has moved from a public managerial focus to an entrepreneurial one (Richter et al., 2015). The Nice project shows that the creation of a business ecosystem led by the City Hall creates entrepreneurial opportunities in the city (chapter 4). The example of Barcelona projects stress also the necessity to define a standard platform of services which are used by business developers to build innovative software applications (chapter 3). Dirks et al. (2009) describe the consequent new supply chain as a 'system of the systems' more complex than the classic Porter's industry value chain (see chapter 4 for more detail).

Besides, the originality of my thesis reside to introduce the active role of the citizens and include it in the triple helix model. Few authors (e.g. Park, 2014; Carayannis, 2010; Ivanova, 2014; Angelidou, 2014) have already extended the Etzkowitz et al. (2000) 's model to 4 or even n actors' helix but the literature is scanty to present Smart City initiatives launched by citizens (Callahan, 2007; Garriga and Medina, 2014). To fill this gap, in the chapter 5, we describe the project of school road in Barcelona led by parents' association and which aims at improving the autonomy of 8-12 year old children in their path between school and home. Kakabadse and Kakabadse (2005) attribute to the last waves of outsourcing in Europe having generated a lot of unemployment and pushed citizens to create their own business even if it is a dangerous venture. The risk is occasionally reduced if the localisation of the shop is optimised according to the attractiveness of the street where it could be opened (Hillier, 1996). Theories of Complexity science applied to Network theory (Newman, 2010) make possible to consider cities as a network of lines where links (i.e. streets) attract more or less flow of visitors depending on their position in the grid (Hillier et al., 1993). They tend to improve the success rate of the entrepreneurship process in the city based on the geo-localisation of the vacant store in the urban plan as we analyse it in the chapter 6.

In a nutshell, this research deals with exploring, describing and analysing different forms of innovation and entrepreneurship in the city. I analyse the process of business value creation and capture and the role played by the four actors of a new designed urban innovation system (university, private companies, public administration and citizens). Moreover, I study the lever that constitutes the emerging technologies in the process of innovation. These works are developed observing deeply the cases of two Smart Cities internationally recognized which are Barcelona and Nice.

CHAPTER 3

THE ALIGNMENT OF UNIVERSITY CURRICULA WITH THE BUILDING OF A SMART CITY. A CASE STUDY FROM BARCELONA

This study 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 principal emerging technologies. Nevertheless, we demonstrate that the universities curriculum is not aligned with the City Hall 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-phase method along with a framework with pre-filled templates and protocols of interviews to analyse universities that pursue the objective to support Smart Cities implementation.

3.1 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 and 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 (e.g. 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 (e.g. 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 analyse 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 study 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 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 Information and Communication Technology (ICT) companies. Finally, we conclude the level of alignment and draw different recommendations.

3.2 Literature review

3.2.1 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).

3.2.2 Connected city

The 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 (e.g. Caragliu et al., 2011; Gershenson, 2013; Hollands, 2008; Komninos, 2006; Vespignani, 2009). They highlight three 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 (e.g. 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. Greefield (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.

3.2.3 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). Yigitcanlar et al. (2008) identify 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 et al., 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) foresee 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 so-called Triple-Helix model). However, Campbell (2012) analyses the mechanisms of breakthroughs in innovation for urban environments and provides with a matrix crossing the impact levels with the different types of learning event: in-house or consultant firms seminars, university courses, city-to-city exchanges, reports or publications. He reaches the conclusion that the academic circles (along with consultant firms) come out at the bottom in the impact scale: 'they have just remained in the surface networks already operating in cities'. As a consequence, city leaders search outside for ideas and visit other cities to share information and learn from others. They do so because they know that their local university can hardly provide the useful knowledge and it is cheaper and less risky than pursuing untested ideas. In other words, the disruptive innovation generated by technology private companies or new innovative service requirements from citizens do not always push university to investigate and find answers and solutions.

This study aims at evaluating the relationship between the current Spanish university academic programs and the technologies that the innovative services of the future knowledge-based economy require in a context of Spanish Smart Cities. Moreover, it provides a framework of pre-filled templates based on the most recent documents published on Smart City and a 3-phase method that all together constitute an universal approach to analyse any situation occurring in other Smart Cities inside Spain or other European countries with its respective universities. Many papers have documented the main roles of the university (Rogers, 2003; Markman et al., 2005; Marzo-Navarro et al., 2009), but the literature is scanty concerning the matching with Smart City requirements.

3.3 Methodology

In our study, we analyse the consistency between the current Spanish university curriculum and the new Smart City services and raise the question about the relevance of the teaching content received by the students. As said previously, the lack of preceding papers complicates the beginning of an answer and transforms the problem into a complex issue. Consequently, we decided to orientate our epistemological works on selecting and holistically analysing the case of an urban organization which for its efforts and its topology make possible the acquisition of results and the extrapolation of our findings to other Smart Cities in the world (to some extent as we detail in the academic conclusion section). For this study, we shortlisted the case of Barcelona based on the conditions stated before and confirmed by the outstanding ranking amongst the top 5 Smart Cities in the world in the recent IESE Cities in Motion index, 2015[1]. Since we know that mobility of Barcelona graduated students towards other region of Europe/Spain is quite low (Ministerio de Educacion Cultura y Deporte, 2012), the students of today will be the future workers of the knowledge-based services companies. Therefore, we can also restrict the scope of our empirical study to the universities of Barcelona.

Barcelona has four universities which are Universitat Politécnica de Catalunya (UPC), Universitat Pompeu Fabra (UPF), Universitat Ramon Lull (La Salle and IQS) and Universitat de Barcelona (UB). Since our study deals with technological innovation, we also confine our analysis to the programs directed to the technology learning and management which are split into six fields: Industrial Engineering, Civil Engineering, IT and Telecom Engineering, Physics and Mathematics, Technical Architecture and Business administration for ICT companies. Nevertheless, these universities form part of the Spanish educational system whose programs are directly managed by the central government like the rest of the regions. Therefore, it permits to extend our results to the rest of the Spanish territory and provides conclusions at a national level.

The absence of a model to transfer the Smart City requirements to the university leads us to conduct an interpretivist and deductive method where our primary sources of information are the interviews carried out on Smart City experts. The sampling of interviewees is chosen equitably as per the Triple-Helix model to get a balanced opinion from possible contradictory points of view. Indeed, we interview seven experts from private companies, six from public sector and six from university. In the private sector, we opt also for an equitable panel of professionals with different profiles but all assessing and developing knowledge and material on the subject for the Barcelona City Council. Two are international consulting firms investing largely on the Barcelona project for the marketing interest that the city represents to their international clients. Two are local consulting firms with a close contact with Barcelona environmental context, and two are ICT companies providing the City Council with a technological assessment for the

[1] `http://citiesinmotion.iese.edu/indicecim`

required solutions.

In the public sector, we interview the utmost level of management in charge of the Smart City program: the Barcelona Smart City Director & Deputy CIO, the Director of urbanism and three important leaders of Smart City innovation centres: the Vice President of the International Association of Science Parks and Areas of Innovation (IASP), the sub-Director of a non-profit research and innovation centre (i2CAT promotes mission-oriented R+D+i activities on advanced internet architectures, applications and services) and the Director of Barcelona Fabric Laboratory (FabLab). Finally, on the university side, we select and meet managers who help us understand the different program curricula and validate our analysis.

We prepare a protocol to interview public and private area managers to understand their vision and strategy of Smart City. This protocol is based on two outstanding documents: the 'Smart Cities readiness guide' (Smart City Council, 2015) and the 'McKinsey Global Institute Report' (2013). The first one lists the state-of-art for the new services of a Smart City and provides best practices all over the world. The second one classifies twelve technology trends ranked according to their economical potential (i.e., the revenues forecast for the private companies) and their gap in terms of the technological change. This list contains mobile internet, automation of knowledge work, internet of things, cloud technology, advanced robotics, autonomous and near-autonomous vehicles, next-generation genomics, energy storage, 3D printing and advanced materials. We have included the protocol in the appendix A.

We analyse secondary sources to complete this methodology such as the 2014/2015 program curriculum of the different universities. To understand the Spanish context, in our discussion with local politicians, we carefully read the last OCDE report regarding the university education status in Catalonia and two published documents on innovation in Catalonia: the first one comparing the US model with the European one: 'ICT Research and Innovation systems in the US and Europe' issued by I2Cat foundation and the second one suggesting the specified role that the public sector has to take: 'Administració pública com a tractor d'innovació' (in English, the public Administration as an innovation driver).

3.4 Results

3.4.1 Emerging technologies for innovative services

The interviews with Smart City managers aim at determining the services that the citizens claim to be improved in Barcelona and where actions are considered urgent. As an illustration, the maximum responsible for Barcelona urbanism states that the citizens want better energy and water services, the responsible for i2CAT innovation centre, better building environment and health and mobility services. Various initiatives respond to their needs like the mobile parking payment application, the 3D-printing studio network (called 'Ateneos'), or the development of an alternative and greener heating system for the poorest zones of Barcelona. They also mention working on a framework that they call 'city anatomy' aimed at shaping all the future services demanded by the citizens. The Smart City Director & CIO Deputy compares the benefits to draw an anatomy of a city to the labour done by the doctors in medicine while effectuating the same exercise for the human body, are able to understand how the human system is running.

The progress consists in providing for the first time a holistic vision of the city services with its different structures: private or public built domains (like houses, public parks, libraries, schools) where different transformations take place related to the different lifecycles of the water, the matter, the energy and in which information flows through communication networks and people on the move are geo-localized through their different mobility solutions (cars, bus, bike, trains, and metro). This vision is aligned with the recent works realized by Neal (2013) that demonstrate how networks, as observable patterns of relationships, influence cities and enable to understand urban needs and life issues. We note also the proximity with the Complexity science, the new science of cities (Samet, 2013) to understand and predict the cities characteristics and flows even if it was not mentioned during the interviews. During the anatomy exercise, the Barcelona city services are laid down to design a set of standard and scalable solutions that the service providers of the city are requested to invent and develop. Their requirements are based on an open-source software which make accessible for any single professional citizen create and build its proper and new services for the city. The choice to impose an open technology displaces the current one-way consumer role of the citizens into a co-creating role merging producer and consumer: the 'prosumer' role as described by Seran (Potra) and Izvercian (2014). In doing so, they give an equivalent chance between the independent hardware and software local engineers and the foreign private laboratories of international ICT companies to develop and commercialize the technology that equip the new services of the city.

Barcelona City Hall nourishes the ambition to share this framework with other cities across the world to take advantage of cost-effective and scalable solutions and enable the connections of services between cities. Therefore, we consider for our study the city anatomy as an optimal holistic description of the urban innovative services. Their classification includes five elements which are: living in a safe and secure house, improving transport solutions for people and goods, receiving care and health assistance, receiving education and services from the city, and better shopping experience with easier payment services.

3.4.2 Technologies for the built environment

We arrange several one-to-one meetings with C-level positions of consulting firms and ICT companies that are currently working on Smart City technological solutions and on their implementation. We prepare a protocol of interview with the objective to ask them which of the 12 technologies of the McKinsey Global Institute Report 2013 represent the main drivers for the five innovative services defined in the Barcelona project. Their opinions correspond to the real potential perceived in the field which may differ from the theoretical estimation carried out by a multinational management consulting firm. We also remark during the interviews that at least in Spain one technological project that embraces a complete transformation of the services of the city does not exist. We decide that the optimal way to analyse their opinions is to follow the classification of the five innovative services described in the city anatomy document. For each of them, we present the key messages before resuming the complete answers in a matrix table.

3.4.2.1 The living services

Technology like sensors and meters are key assets to efficiently monitoring a large range of building functions like lighting, energy, water, heating ventilation and air conditioning (HVAC). The configuration of their embedded software allows reacting against dangers like fire, intrusion, elevator dysfunction and increasing security and safety services of the city. Besides, the CEO of an ICT start-up comments that

Robotics drastically increases the capacity to collect information for the living services. He is currently working on Drones that, equipped with mini-sensors, provide 3D visualization of the Built environment (building, streets, avenues, etc.) and restitute city maps of heat, contamination, or pollinating rate in high resolution. This brand new company counts with several clients in the world with a presence also in USA. The original idea to create this company comes from a family issue. Indeed one of his daughters (along with other students of the same class) was suffering repetitive headaches in her school for an unknown reason. His profession as an architect and his master in robotics technology (in UPC) led him to experiment the use of Drones to determine the contamination role in this pathology when traditional ground technologies were completely blind. He converts himself into the 'prosumer' of an innovative living service for the city.

3.4.2.2 Transport solutions

Web portals improve the working conditions in cities providing online business services and reducing the need of transportation for workers and lengthy journeys between work and home. Barcelona city provides an on-line web application for future entrepreneur streamlining the different paperwork with public taxes department (opening, tax return and closing). Social Media and Mobile services allow to know the city transport health and to offer alternative mobility solutions. One interviewee comments the results of the 'Grand Nancy' project launched by an important French consulting firm and Nancy, a medium-size city in the north-east of France. They allow the workers to daily optimize their movement using the different mobility alternatives of the city and to report incidences in the public infrastructure during their transport. He adds that the complexity of such project resides in converging different existing solutions providing ad-hoc information of different resources of the city (bike-sharing service, tramway and bus geo-localization, and parking slots available) in order for the citizens to be able to rely on an end-to-end application to select and book mobility alternative solutions or to know a transport duration estimate. The application is quoted very positively by its users and new features are in progress to include the claim for assistance in case of lost objects and to also support entrepreneurs in the decision to localize their office and facilitate their employees in their daily commutation. Another interviewee also comments that 3D printing and Drones have a positive impact on transport reducing the move of physical goods and materials that pollute the air.

3.4.2.3 Care and health assistance services

We observe during the interviews the recent success of the 'Vincles' initiative, a Barcelona project awarded by the Bloomberg foundation in 2014 for the large contribution into the improvement of the health for the elderly. This project consists in providing a digital link through a private social media between the elder people alone at home and the rest of the city community (family, neighbourhoods, storekeepers) reducing the isolation risk and allowing to access medical advice via telephone or videoconference from home. Another interesting project is the Smart Citizen sponsored by the FabLab of Barcelona which seeks for deploying small meteorological platforms (equipped with NO2, noise, humidity, temperature, particle and CO2 connected captors) in every single Barcelona house capable of providing a full awareness of the city streets atmospheric conditions and empowers the citizens to select their preferential transport mode.

3.4.2.4 Education and services of the city

We see for this service domain that the consultancy business is oriented to provide interactive online courses for the workers like Coursera or ITunes Academy and actually many universities already have their own MOOC solution. The progressive deployment of the fiber in the large and medium cities by ICT companies allows watching a movie or a theatre play in high resolution through on-demand Internet streaming media provider (e.g. Filmin or Netflix companies). Moreover, sensors and cameras technology solutions permit to collect information on the city security and safety parameters and to immediately react against risks like fire, terrorist attack, uncontrolled demonstrations, or robbery. The recent project in Rio de Janeiro shows how the implementation of a thousand cameras and digital sensors dramatically decreased the incidents of security yearly reported in the city.

3.4.2.5 Better shopping experience with easier payment services

Most of the interviewees comment B2C Companies are investing hugely in consulting projects to better understand the consumer online shopping behaviour. These initiatives place the digital 'onlooker' in the middle of an systematic analysis of its actions in the social networks and websites so as to obtain detailed information of its interests and the potential articles he wishes to try and buy. The commercial brands while getting this feedback are able to determine buying behaviours and associate them to their customer value propositions. The connection to internet of the articles present in the physical stores through RFID technology informs which of them are really acquired by the potential on-line prospect. The convergence of information from off and online channels make possible, through Big Data solutions, to validate or refine the different customer buying patterns and to modify the marketing strategies in order to fit better with the desire of the clients.

This run of interviews provides a table of results that we submit to the private managers for validation. We receive their answers jointly with an important change. Indeed, they stress the transversal and essential role of Big Data/Analytics for all the five innovative services of the city. This statement was previously reflected in our table for the service related to better shopping experience. But they argue that Big Data while transforming large volumes of data into relevant information and leveraging the capacity limit of data collection to infinite, permits to operationally optimize all the business processes (transport, care, education, etc.) of the city, increasing their compliance by integrating business analytics, business rules and workflows. They confirm Mayer-Schonberger and Cukier's views (2013) that Big Data is a revolution event comparable to Gutenberg printing press and definitely part of the solution to resolve the critical problems of the cities. They share also their concern regarding the dark side to Big Data: 'privacy has become more and more difficult to protect. The ability to capture personal data is often built deep into the tools we use every day, from web sites to smartphone applications. And our interviewees give examples where Big Data solutions propose to clients enhanced tariff due to predictive analysis of their future purchasing behaviour, with the final goal to alter their conduct. They add the challenge resides that the clients are really informed and consent on the use of their data. We integrate all these comments which lead us to the final results displayed in the table 3.1.

Table 3.1: Relationship between new disruptive technologies and services of the Smart City

	Mobile	3D-Printing	IoT	Big Data	Drone (Robotics)	Renewable Energy
Living in a safe and secure house	Required		Required	Required	Required	Required
Improving transport solutions for people and goods	Required		Required	Required	Required	
Receiving care and health assistance	Required		Required	Required		
Receiving education and services from the city	Required		Required	Required		
Better shopping experience with easier payment services	Required		Required	Required		

3.4.3 Alignment of technologies with academic fields

The university system is divided in three different cycles which are the bachelor, the post-graduation and the continuous education for professionals. Our approach consists in analysing the program curricula and checking the presence of modules related to the learning of the six emerging technologies defined previously. For each of the six academic fields of our study, we present the key findings before resuming the complete answers in a matrix table.

3.4.3.1 Industrial Engineering

Since the first cycle, UPC introduces Python and other open-source programming languages and trains the students to create applications and web services. IQS introduces Visual Basic 6.0. 3D design and printing are part of IQS and UPC university programs but as an optional module in both cases. Analytics is only covered by an optional module in UPC where it is introduced as elements of statistical learning: data mining, inference, prediction and linear and non-linear models but not as the Big Data complete theme. We don't see either mobile or multi-dispositive applications technology covered by any module for the engineer graduation. In the second cycle, Robotics and smart mobility (IoT) are introduced as an optional module when in the third cycle, user experience design and mobile solutions are covered.

3.4.3.2 Civil Engineering

The only university in Barcelona graduating civil engineers is the UPC which however starts introducing emerging technologies modules only from the second university cycle. For postgraduate, UPC proposes two masters in sustainability. One is related to the oceanography and the smart management of the marine resources. The other is part of an Erasmus program which deals with flood risks and its management in urban and rural zones. In the continuous education cycle, UPC offers 3 diverse programs in smart mobility, Smart City and sustainable urbanism where Mobile, IoT and Big data themes are taught. The classes leverage the leading position of Barcelona involving different actors of the Barcelona Smart City innovative ecosystem (City Hall, regional government, transport metropolitan company, and start-ups provider of smart solutions).

3.4.3.3 IT and Telecom Engineering

UPF and La Salle train IT and Telecom students in diverse open-source and proprietary programming languages covering how to install and maintain servers, networks, web applications, database and create user-friendly front-end which correspond to the standard R/3 client-server architecture as first designed by the SAP software vendor in early 2000's. Multi-dispositive mobile applications, robotics, Internet of Things and sensors are also covered even if they are optional modules in UPF. In their post-graduate cycle, La Salle covers a large spectrum of smart services and technologies associated to E-Health, Big Data, Energetic Efficiency, Sustainable Architecture, Mobility, Robotics, Domotics and Smart Grid. Their alignment with the six fields of my study is unique; the strongest compared to the other Barcelona universities and position them as leader in the learning of Smart City technologies.

3.4.3.4 Building construction science and technology degree

UPC and La Salle train students to become technical architects promoting the ethical responsibility by the use of renewable energy solutions as part of sustainable construction. La Salle's master for the urbanism management introduces new applied technologies to the urban planning and solid waste management. It covers the presentation of the Spanish Integrated Management System (SIG) for the selective collection and recovery of packaging waste for subsequent treatment, recycling and upgrading. More than 12,000 companies have joined the SIG in Spain. Its shareholders include 57 companies and groups comprising all of the sectors which participate in the management of packaging, from manufacturers and packagers to distributers, manufacturers of raw materials and recyclers. The UPC proposes in the continuous education cycle a master of 3D printing along with a Smart City one which includes basic elements of geo-referencing and Internet of Things solutions.

3.4.3.5 Business Administration for ICT

Students of UPC learn on mobile marketing technologies, digital survey method, the use of social media and web for ecommerce solutions. Big Data technology is introduced in La Salle to the graduating students. The UPF Master of science in IT Strategic Management emphasizes the role of this technology with concrete examples of applications for the Smart City and every year gives excellent opportunities to the students to apply for internships or full-position jobs in consulting firms or international ICT companies (Accenture, IBM, Everis). The Master in Information Technology Management from La Salle gives a specific focus on the digital transformation occurring in the enterprise while its Master of Science in IT Management prepare to the tasks related to R&D and is a path to develop a career in the innovative technologies subject of our study.

The six emerging technologies covered in this study are not present in the Mathematics and Physics program curricula in the Barcelona universities. As a summary, we present the complete results in the table 3.2.

Table 3.2: Relationship between new disruptive technologies and academic program curricula

	Mobile	3D-Printing	IoT	Big Data	Drone (Robotics)	Renewable Energy
Industrial Engineering	Continuous education	Bachelor	Post graduate		Post graduate	
Civil Engineering	Continuous education		Continuous education	Continuous education		Bachelor & Post graduate
IT&Telecom Engineering	Bachelor & Post graduate	Post graduate	Bachelor & Post graduate	Post graduate	Bachelor & Post graduate	Post graduate
Technical Architecture			Post graduate			Bachelor & Post graduate
Business Administration	Bachelor		Post graduate	Bachelor & Post graduate		Post graduate
Physics & Mathematics	Not present	Not present	Not present	Not present	Not present	Not present

3.5 Discussion

The purpose of this study is to analyse the matching between the university program curricula and the innovative services so as to identify potential gaps in the current university model. Our empirical methodology permits to get respectively in tables 3.1 and 3.2 a relationship between new technologies and the services of the Smart City and between new technologies and academic fields. Therefore, we achieve the final goal merging the information of both tables and using technology as a pivot column. The relationship table between the innovative services of a Smart City and the academic fields is presented in table 3.3.

As an illustration, the merge reveals that 'Living in a safe and secure houses services' needs knowledge that is taught in the bachelors preparing Civil engineering, IT/Telecommunications and Technical architecture careers. Nevertheless, it appears insufficient because this service also needs the understanding of Big Data technological solutions that is missing in all these bachelors. The table shows also that post-graduate or continuous programs permit for graduated engineers to acquire knowledge that is missing in their bachelor cycle and so cover the whole technological spectrum required for Smart City innovative services. For instance, mobile technologies is learnt in bachelor for IT/Telecommunication engineers but not for industrial ones but the UPC provides continuous program education for them to cover this field. Besides, La Salle offers a Big Data master for all Engineers. For our discussion, we decided to focus only on the bachelor cycle because it gathers the huge majority of university students and thus represents the most impactful academic program to permit the learning of Smart City new services requirements.

Table 3.3: Relationship between services of the Smart City and academic program curricula

	Cycles	Industrial Engineer	Civil Engineer	IT-Telecom	Technical Architect	Physics & Maths	Field missing
Living in a safe & secure house	1st		Bachelor	Bachelor	Bachelor		Big Data
	2nd	Post graduate	Post graduate	Post graduate	Post graduate		None
	3rd	Continuous education	Continuous education	Continuous education			None
Improving transport for people & goods	1st	Bachelor		Bachelor			Big Data
	2nd	Post graduate	Post graduate	Post graduate	Post graduate		None
	3rd	Continuous education	Continuous education	Continuous education			None
Receiving care & health assistance	1st			Bachelor			Big Data
	2nd	Post graduate		Post graduate			None
	3rd	Continuous education	Continuous education	Continuous education			None
Receiving education & services from the city	1st			Bachelor			Big Data
	2nd	Post graduate		Post graduate	Post graduate		None
	3rd	Continuous education	Continuous education	Continuous education			None
Shopping experience with easier payment services	1st			Bachelor			Big Data
	2nd	Post graduate		Post graduate	Post graduate		None
	3rd	Continuous education	Continuous education	Continuous education			None

3.5.1 Breaking the silos of university programs

The first result is that university first cycle programs today don't prepare the undergraduates for the implementation of innovative Smart Cities services. The university structure based on technological departments such as Industrial, Information Technology, etc. is inappropriate for the services demanded by the citizens. The Smart City implementation needs to cross these silos and re-organize the university by business application and citizens' needs. This new approach faces an important resistance to change that Awbrey and Awbrey (2001) classify into two main barriers which are the wrong academic reward system too oriented to research and not to application along with a trivializing of the integration, built on the wrong idea that common sense should suffice to achieve the necessary synthesis of the specialized in-silo knowledge. Moreover, our results also show that Business Administration graduation doesn't incorporate the awareness of the six emerging technologies studied (only mobile and Big Data are covered). The gap between technology and business science should be also reduced in a context of the new digital company paradigm. Indeed, the digital enterprise requires the business managers to speak the technological language fluently. Feld and Stoddard (2004) add the Enterprise 2.0 oblige them to take business decisions on IT subject. Our results suggest the IT and business alignment is no longer the issue but rather the challenge of a full IT strategy integration at company board level (Coertze and von Solms, 2014).

3.5.2 Mathematicians and physicists can contribute also to the Smart City debate

The Complexity science as the new science of cities (Samet, 2013) introduces a framework to analyse the Smart City structure (built surface, dwelling cost per m2, density by zone) and its population characteristics. It argues the features of a city is not deducible from the characteristics of an individual household or an establishment but measuring and analysing the dynamical flows and topological properties of the networks that innervate the different layers of the city (railway network, streets, power grid, telecommunication systems). Complexity science applied to networks (Newman, 2010) provides the conceptual view and the tools to establish predictive methods of interactions and flows and resolve urban issues. Mathematicians and Physicists in their graduate careers learn these theories that they could apply placing the urban problematic in the heart of their expertise and domain of competence. They have the opportunity to contribute also in the rise of the Smart Cities.

3.5.3 Big Data technology is missing in the engineer careers

Our analysis of all the universities curricula show Big Data technology is not learnt in any engineer graduation careers but is present in the second and third cycle of few universities (like La Salle for instance). As one consultant explained us, the exponential number of people and things connected to the city make Big Data technology essential in the implementation of the future services of the city. As we have said before, Barcelona through the city anatomy model considers the urban zone as a sum of networks interrelated which raises diverse questions of management and resilience for the city. Big Data allows to monitor the current flows and to make proven predictions such as what would happen to the basic services of the citizens (water, electricity, wastewater, etc.) if for three days the number of inhabitants of Barcelona increase by 100.000+ due to an international congress or an international sport event. Or what would be the impact for the services of the city (telecommunication, energy services, waste services, etc.), of the arrival of 50.000+ tourists for a large musical concert. Engineers have developed large 'hard' skills to work on Big Data algorithms and develop models of answer. It is an opportunity for them to form part of the strategy change argued by Huberty (2015) to allow the cities to jump to the third industrial revolution so much announced but still not started.

3.5.4 IT/Telecommunication play a central role for the Smart City services

Our results show that IT/Telecommunication engineers are central in the realization of the innovative Smart City services compared to the rest of careers (Industrial, Civil, Architecture, etc.). This role consists in the creation of online applications to improve services such as transport or making cheaper and faster professional services like care and health assistance for the citizens. In a period when government is looking for savings to reduce debt and public deficit, this IT lever can't be neglected. Software engineers should acknowledge the social mission of their future profession. When we met one of the City Hall managers, he pointed out the paradox that the successful social media application called 'Vincles' and already cited (an 100% IT project for improving the life of elder people in Barcelona), was not an idea from the IT department of the Barcelona City Hall but from the Health one ('Bienestar') although this latter does not own any IT professionals and capability in their teams. This is a clear evidence of the existing chasm.

Some initiatives try to resolve this issue. Kurland et al. (2010) present a project launched by the California State University Northridge (USA) which trains all their students of seven specialized colleges in business management, science, and technology on the sustainability subject during a 14-week course. Their objective is to ensure that each single undergraduate acquires an interest on the global sustainability issues and how his specialization matters for the everyday living. Kurland et al. (2010) observe the success of this initiative accredited by positive students' surveys but enlighten that this interdisciplinary course faces challenges. They list amongst others a lack of leadership on the program content or an increasing entropy of administrative tasks. They add that this initiative is not isolated since in 2010, 19 undergraduated and 60 graduated business similar programs existed in USA. Sustainability awareness joins a previous and older discussion related to the general ethic mission of the engineer. Passino (2009) declares concerning this subject that unfortunately little has been done so far in engineering universities to support humanitarian efforts. He points the limited results of various pedagogical strategies introducing codes of ethics or moral frameworks that after his opinion have rarely encouraged engineers to serve later as volunteers for the service of the community or the city.

3.5.5 We need scientists to become engineers to invent technologies that don't exist today

Our results show that Physics and Mathematics program curricula are not influenced by the emerging technologies. Nevertheless, the scientific literature shows us that important technological inventions were discovered also by scientists in the past. Their research leads them to become engineers imagining the tools able to validate the scientific model that they build theoretically. Haeusler (2012) recalls that Alan Turing was first a recognized mathematician graduated at King's College in Cambridge in 1934 dedicating his research to the mathematical view of intelligence and life. But his name is mainly associated to his works on the development of the computer science, and the technological invention of an universal machine able to compute the algorithms developed by other machines, which is considered as the model of the first computer (Turing, 2009).

Biomedicine has recently offered two examples that show this field is progressing leveraging the nexus between technology and science. Trepat et al. (2009), Doctor of Physics, worked on the physic laws that exist at nanometric scale with the objective to prevent the metastasis generation establishing a theory of forces along with the construction of a 'technological machine' to measure and validate it. Trepat received in 2014 the Sabadell bank prize for the investigation. The Centre for Genomic Regulation (CRG) (the international biomedical research institute of Barcelona) provides our second example. Indeed, Gómez et al. (2010) investigate on the DNA patrimony and on the bacteria 'Mycoplasma pneumoniae', one of the main causes of pneumonia for the children. Using different physical equations of fluids and a 3D mathematic model, they identify and localize the different regions of the chromosome and finally understand the functioning of transcription and translation processes in the cell. Their aim now is to invent the technological machine, the engineer therefore being who validates their physical scientific model.

3.5.6 3D printing innovates the manufacturing services

Starting in the early 1990's, the outsourcing wave of our capacity of production from Occident to Asia regions has progressively vanished our efforts achieved after two industrial revolutions to master techniques to build and manufacture any functional objects or machines. It is also the cause of massive job loss in Europe and USA. Moreover, Kakabadse and Kakabadse (2005) comment that both European and US companies consider outsourcing as critical to their organizational strategy and overall report higher levels of satisfaction than expected.

Our results show 3D printing is not systematically included in the academic engineering programs. Only the Industrial Engineering program has this module as an option for their students. We observe universities have not yet identified the opportunity residing in the 3D printing to revert the past outsourcing trend and repatriate the jobs lost in the manufacturing sector modifying the equilibrium of forces in this market. Indeed, the first contribution of this technology lies in moving the battle field from massive to small market groups and to manufacture in a cost-effective way compared to the low-salary productive countries (Berman, 2012). The second contribution is to modify the bargaining power between competitors. Mohajeri et al. (2014) say 3D printing is a lever to produce customized products and to match more successfully to the rapidly changing needs of the customers, while giving them a more interesting role from passive to being fully active agents in the manufacturing of the products ('prosumer' role again). Many cities in Europe have implemented Fabric Laboratories (FabLab) where residents have the capacities to prototype their invention and manufacture products. University curricula should be re-designed to take large advantage of this new available infrastructure. Today in Barcelona, the IAAC school of architecture is for instance partnering with the local FabLab.

3.6 Conclusions

The objective of this study was to analyze the matching between the university curricula and the innovative services of the Smart City that aim at improving the quality of life of the citizens. Due to the complexity of the question involving important and vast themes like Smart City, university, innovation and the role of technology, our decision was to limit our study to the case of Barcelona. The leading position of the Catalan capital and the international ranking of its university motivated this choice for the possible extrapolation of the collected results. We followed an interpretivist and deductive method based on a set of interviews with public, private and university managers, being in full compliance with the innovative model largely known as Triple-Helix. These interviews drove us to also consider a list of secondary sources like the city anatomy or the McKinsey Global Institute Report (2013) which contributed to the elaboration of the following results.

This study demonstrates the innovative services that the City Hall of Barcelona is working on for the benefit of its citizens are supported by six emerging technology trends which are: Mobile, 3D-printing, Internet of Things, Robotics, Renewable Energy and Big Data. Except the last one, we have found all of them present in the curricula of the four universities graduating engineers in Barcelona. This leads us to conclude that these curricula should be revisited to insert also the knowledge of Big Data technology. Secondly, our findings demonstrate the organization of the university today in technological silos is a strong barrier to provide a complete set of competences to the engineers for implementing the future services of the Smart Cities. The Industrial Engineering career was created for the second Industrial revolution; we suggest developing Smart Engineering careers for this next revolution.

Thirdly, Physics and Mathematics graduating curricula seem to be living isolated today from the transformation occurring close to them. Nevertheless, they could play an important role by applying the Complexity science to networks and so redesigning the services that address the current challenges of the cities. We so recommend to introduce in their curriculum a technological and business application perspective of their science. Recent examples in biomedicine present outstanding results that make sense to be reproduced. Fourthly, our results highlight the Business Administration careers incorporate only the learning of Mobile and Big Data technologies and should insert the four remaining technologies of our study. These students should speak technology fluently and understand the relevance of IT for the generation of new business opportunities building the so-called Digital Enterprise or Enterprise 2.0.

Fifthly, IT and Telecom graduating careers play a central role in providing these new social services which could be seen far from their technological concerns. IT/Telecom engineers' curricula should be redesigned to include social, ethics, and sustainable responsibility and permit the awareness of the social purpose of their field. This initiative would surely promote the emergence of new ideas and applications for the future of the cities. Sixthly and finally, university has not yet acknowledged the historical opportunity that 3D printing offers to build the objects of the Smart City. The potential benefits are however to increase the customization of the services provided, reduce the manufacturing costs and promote the re-localization in Europe of the jobs lost during the last outsourcing era.

Our investigation proposes a methodology composed of pre-filled templates and describes a three-phase approach that could be reused for analyzing the situation of other Smart Cities in Spain or even further considering European urban agglomerations. Anyway, the characteristics of Barcelona's situation, a sea-side metropolis of more than 1.5 million inhabitants with a large proportion of built infrastructure could limit the comparison of the collected results with other European cities. The choice of universities has been restricted to the Barcelona-based ones. It could be interesting to check the conformance of our conclusions with the rest of the large universities close to Barcelona city like for instance the 'Universitat Autonoma de Barcelona' or the 'Universitat Rovira i Virgili' where the CIO of Barcelona City Hall regularly teaches. As a final word, we stress the importance of our suggestions being based on the aim of preparing university to address the revolution that occurs in the city, our results and respective conclusions are relevant to the extent that university pursues this objective and not a different one.

CHAPTER 4

VALUE CREATION IN INTERNET OF THINGS ECOSYSTEM. THE CASE OF NICE SMART CITY

Internet of Things provides a lot of possibilities to develop platform of services and creates digital business ecosystem. This study investigates the process of value creation in the specific context of a Smart City transport initiative. The originality of this research resides on considering if a business ecosystem may contribute to social, environmental and economical objectives all together. Our method consists on analysing the specific case of 'Connected Boulevard' initiative in Nice City. The project consists on the deployment of 5.000+ sensors on parking slots to improve the urban movement. The results show an improvement of the quality of life for the citizens and a growth opportunity for the local business. Our conclusions can be extrapolated to other Smart Cities to some extent as we discuss it in our conclusions. Therefore, we suggest to business developers eager to start providing innovative services in the Smart City to revise their business model according to our results.

4.1 Introduction

The study of the Smart City concept (e.g. Chapin, 2012; Morandi et al., 2015; Caragliu et al., 2011) suggests that one common model does not exist but different approaches or phases which encompass the implementation of intelligent mobile applications, interactive display screens in the City, or an ubiquitous WiFi infrastructure. However, they all share the goal to provide the foundations of a new society economy in which the receivers of the technology innovation are no longer the industries but the services companies and the motor of the growth is no longer the petrol but the data. This knowledge-based economy (e.g. Miles, 2005; Komninos et al., 2012) resides on - through the application of emerging technologies such as Big Data, Mobile, Social Media and Internet of Things - the innovation of traditional historical services of the city related to the living conditions, transport solutions for people and goods, health and assistance services.

Recently, Richter et al. (2015) suggest to consider Smart Cities as an environment for entrepreneurship and an answer to the decrease of public investments capacity (Hoppe et al., 2013). Consequently we decided to consider this public-private partnership as a 'business ecosystem' led by the City Hall and whose contributors are the private service companies engaged in the urban development. The Internet of Things (IoT) is the most hyped technology in growth today, according to Gartner (2015) and provides a lot of possibilities for the private corporations to develop platforms of services and create different Information Technology (digital) business ecosystems. Nevertheless, the literature is scanty to determine and measure the value creation of these platforms and to quantify their benefits (Rong et al., 2014). In our study, we propose to analyse it through two axes: the revenue growth for the service companies and the improvement of the quality of life for the citizens.

Our approach is inspired to the recent Adner's works regarding the value creation process (2013) that we have adapted to the Smart City context to propose a model of digital business ecosystem. Our methodology is based on the analysis of Nice Smart City project, classified 4th in the Juniper Research world ranking[1]. The case study allows to test our hypotheses of value creation and understand the roles of the different stakeholders. Our findings show the contribution of an IoT platform to the social, environmental and economical objectives that the city faces. They conduct to make diverse suggestions regarding the business model of these new service companies and especially how to handle the citizens' role as an innovation force. Anyway, the characteristics of the case can limit the extrapolation of the collected results as we explain it in our conclusion.

4.2 Literature review

4.2.1 Business ecosystem

Moore (1993) introduced for the first time the concept of business ecosystem like a collaboration to create and deliver solutions that meet the full package of value to customers. Few years after, business ecosystem was considered as a stream of theory in strategic management (Lengnick-Hall, C.A. and Wolff, 1999). More recently, Adner (e.g. 2013, 2006) adds business ecosystems allow firms to create value which no single firm could create by itself. Each participant is specialized in an activity and it is the collective efforts of many participants that constitute value, while efforts individually have no value outside the common effort. Private businesses have also started to give considerable attention to the concept (Eisenhardt and Brown, 1999) and networks sharing elements of both cooperation and competition have been emerging for many years and link companies across products, services, and technologies (e.g. Ebay, Amazon, Wallapop).

The business ecosystem model we have used is based on the theory of Iansiti and Levien (2004b). It is composed of four components namely: leaders, contributors, users and environment. Leaders also called hubs or central contributors are chokeholds that coordinate the activities of other ecosystem members (e.g. Moore, 1993, 2006). One of the most critical roles is providing the platform as the backbone/skeleton of the business ecosystem where the different parties involved can leverage tools, frameworks, assets that assist them in conducting innovation and improvement of their performance (Iansiti and Levien, 2004a). Contributors are independent, private organizations or individuals that are engaged to the evolution of the business ecosystem, carrying out tasks related to various areas from design, to production, operations,

[1] `http://www.juniperresearch.com/researchstore/key-vertical-markets/smart-cities/energy-transport-lighting`

distribution and delivery of products, solutions and services while all depending on each other to survive and to improve their performance (Iansiti and Richards, 2006). Users are individuals or businesses who purchase the products and services that business ecosystems are formed to produce. Their capacity to buy these services depends on the value received from the ecosystem. The environment surrounding leaders, contributors and users forms the conditions in which the business ecosystem evolves. Yu et al. (2011) categorize entities forming the environment around a business ecosystem to at least six groups namely: economic, technique, natural, law, cultural and social. Eisenmann et al. (2006) add that in the digital ecosystem the users move from a passive to an active role where platforms become two-sided businesses that need both contributors (developers) and users in order to succeed. This role change has been enabled by emerging technologies like Internet of Things.

4.2.2 Internet of Things platform

Sundmaeker et al. (2010) define Internet of Things (IoT) as a technology that connects physical objects to the internet, and enables interaction capabilities between these objects and other systems. They name it as the third phase of the internet revolution, after the World Wide Web (www) in the 90's and the mobile internet in the 2000's, even if they consider IoT as the most disruptive of them. The consulting company McKinsey (2014) estimate that there existed more than nine billion connected devices in 2014 and estimate 50 billion by 2025. This growth of connected devices creates endless possibilities in terms of how to apply the technology. Connected cars, smart connected homes, smart electricity grids and meters, smart parking solution, connected pacemakers and data-driven maintenance in factories are just among a few of the possible use cases (Sundmaeker et al., 2010).

A smart parking solution constitutes to attach each parking slot with a sensor that sends in real time the parking spot's availability status and location through a Cloud infrastructure covering the whole city. The citizen is therefore kept informed on the status of the urban parking availabilities through an ad-hoc smartphone application. He is then able to find empty parking spots, without driving around while searching for it. Emmino (2012) presents estimates from San Francisco project, stating that cruising (i.e. circulating to find an empty location to park) is the reason for 30% of traffic in downtown, which the smart parking solution can largely reduce. IBM (2015), after conducting a survey in 20 international cities, also estimates that drivers searching for parking spots creates 30% of traffic congestion and proposes different solutions to reduce it. Since the IoT platforms are relatively new, only few studies have been conducted to measure the effects, however they all believe that the area expected to receive the biggest impact is the Smart Cities (e.g. Murthy and Kumar, 2015; Badalian, 2015).

4.2.3 Smart City as a business ecosystem

Scientists observe two major trends that lead to a human congestion in the city: the global population is increasing drastically and the inhabitants move from rural to urban zones (UNPD, 2001). In Europe, in 2009, the urban population was yet 70% of the overall (DESA, 2009). Due to this frenetic expansion, cities are responsible for 75% of the overall resource consumption even if they occupy only 2% of the land (Madlener and Sunak, 2011). The City Halls are coping with preserving the environment, giving acceptable conditions of life to the citizens sharing a space smaller and smaller and with resources more and more limited.

Smart City concept represents a multi-disciplinary field of research to answer to these challenges. It combines theories related to spatial planning (e.g. Chapin, 2012; Morandi et al., 2015), economic geography (Bunnell and Coe, 2001), knowledge economy (Zygiaris, 2013), urban technology (Allwinkle and Cruickshank, 2011; Caragliu et al., 2011) and marketing (Doel and Hubbard, 2002). Although these multitudinous studies, academic research is at an early stage and lacks a homogeneous and comprehensive definition. Recently, Richter et al. (2015) in a disruptive approach consider Smart City as an opportunity for entrepreneurship and argue that the urban development has moved from a public managerial focus to an entrepreneurial one particularly in western cities. While developing common platforms of services, companies are able to generate new business opportunities. Dirks et al. (2009) describe the consequent new supply chain as a 'system of the systems' more complex than the classic Porter's industry value chain (1991).

In this study, we prefer to consider Smart Cities through the lens of a 'business ecosystem' composed of a technical environment provided by an IoT platform. Literature is scanty to quantify the benefits of these initiatives and so, we propose to measure the value creation through two hypotheses (which are analysed together for the first time): the quality of life for the citizens and the business growth for private service companies.

Hypothesis H1: The implementation of an IoT platform improves the quality of life for the citizens.

The impact of IoT platforms may be different depending whether the information they provide efficiently modify a service of the city. Assadian and Nejati (2011) describe transport and living services as the major challenges of the Smart City and accordingly, we decide to breakdown the hypothesis H1 into the two following ones:

Hypothesis H1a: The implementation of an IoT platform creates better transport services for the citizens.

Hypothesis H1b: The implementation of an IoT platform creates better living services for the citizens.

Hollands (2008) notes that in a digital ecosystem the customers are the active users of the public-private combined services. As an illustration, the smart card application projects of Southampton (UK) or Zaragoza (Spain) are prominent initiatives of giving access to the citizens to a few services (smart parking, smart paying, and smart Id) jointly developed by private and public efforts. Komninos et al. (2012) comment that the role of the citizens deciding the usefulness of the mobile application by adding or removing the different services was important to achieve the success of this collaborative project. We decide to quantify if an IoT implementation increases the economic value for the companies providing the actual services in the city and to determine the role of the citizens in the business value creation. Consequently, we formulate the following assumption:

Hypothesis H2: The adoption by the citizens of an IoT platform moderates the capture of business value created in the Smart City business ecosystem.

4.3 Methodology

On February 17th 2015, the French Riviera capital, the city of Nice, was classified 4th in the Juniper Research ranking of Smart cities[1] behind Barcelona, New York and London and in front of Singapore. It is the outcome of a policy started many years ago.

4.3.1 The case study of Nice city

In 2010, Nice presented an ambition of sustainable, environmentally friendly economic development for the city. This vision led to the Smart City project called 'Connected Boulevard', initiated by Nice Cote d'Azur metropolitan authorities and Nice City Council. The purpose of the project was to improve the efficiency of public and private transportation within the city, in addition, to provide citizens with new services and facilitate the economic growth of the private sector. From June 2011 until end of 2015, thousands of wireless sensors were installed in streetlights, dumpster, parking spots and high traffic roads around the city and around 5.000 parking spots were equipped with them. The sensors were constantly monitoring and sending data about the activity in the city. The network of sensors was tied and managed together by a cloud-based software platform that made the solution ubiquitous in the whole Nice. We totally extracted more than 32 million transactions from the system. It was an excessive volume of data for a standard office software so that we decided to utilize a relational database to generate the different datasets. We call in this study this complete solution the Nice IoT platform.

In this study, we propose to analyse the value creation of an IoT platform, translating the two preceding hypotheses into the case of Nice and testing if this business ecosystem generates better quality of life for the citizens (Hypothesis H1) and increases the capture of revenues while giving a moderator role to the citizens in the economic value creation (Hypothesis H2). We select the city of Nice due to the strong engagement and ambition of the City Hall (in spite of their weak capacity of investment) and the important number of start-ups involved in the Smart City project. Moreover, we believe that the topology of the solution deployed make relevant the extrapolation of the results and conclusions to other Smart Cities, to some extent as we detail in the conclusion section.

4.3.2 Data and instruments for the hypothesis H1a

Our model considers four different geographical areas. The first one is our reference and is a specific zone of Nice downtown. This zone is the unique target of the parking sensors implementation. We call it in our study 'Nice City Inside'. We compare it with three other geographical areas: a peripheral zone of Nice that is not impacted by the IoT platform implementation that we call 'Nice City Outside' and two other French cities with no similar project: 'Marseille' and 'Toulon'. We choose these two cities for their common characteristics with Nice: southern part of France, population size, on the coast of the Mediterranean sea and sunny climate. Comparing 'Nice City Inside' area with these three control groups permits to analyse the role played by the IoT platform implementation. We consider also for this study a timing scale based on two phases of the project: the one covers 01/06/2011 to 31/12/2012 when the number of sensors varies between 0 and 1.588 and another one afterwards: 01/06/2013 to 31/12/2014 when the number of sensors is

[1] `http://www.juniperresearch.com/researchstore/key-vertical-markets/smart-cities/energy-transport-lighting`

between 1.612 and 4.953. Each phase has a similar calendar profile (from June to end of the following year) and counts 19 months. Comparing these two phases aims at isolating the role of the unique fluctuating variable which is the number of sensors and so, eliminating other factors that may play a significant role in the pollution or the traffic congestion of the city. Doing so, we concretely neutralize parameters like holiday period, national or local feast, seasonality of the business activities, or daily workers' commutation.

We choose the number of traffic accidents as the variable to evaluate the influence of the project on the transport services. The French government web platform[1]offers official records of traffic accidents in France from 2010-2014. We aggregate the traffic accidents data at month level to be consistent with the standard rules used to publish traffic statistics in the country. We build a matrix compiling for the four areas 19 traffic evolution rates dividing month-to-month the number of accidents between the two parallel timing phases of the study. With this result, we conduct a T-Test analysis and check if the mean rate of the 'Nice City Inside' data is statistically lower to the other three areas. By this way, we determine if the implementation of the IoT platform in 'Nice City Inside' diminishes the numbers of traffic accidents (H1a).

4.3.3 Data and instruments for the hypothesis H1b

We measure the impact of the IoT platform regarding the urban living services (H1b) analysing the evolution of the traffic density. Several studies determine the positive relationship between NO2 and the average daily traffic (e.g. Ross et al., 2006; Zhang et al., 2013; Rose et al., 2009). We consider therefore the NO2 partial pressure as its proxy. The French governmental organization *Air Paca*[2] has several air pollution sensors installed in the South Region of France. In Nice, they have four sensors installed 1) In the city, 2) along the highway M6098 connecting the city to the airport, 3) in a suburban area outside the city center and 4) close to the airport. The different sensors are categorized according to the nearby environment, such as traffic, industrial or urban. Nevertheless, no pollution sensor has been installed in the 'Nice Inside Zone' and consequently we can't measure directly the pollution in this specific area.

As a workaround, we conduct a two step-based approach a) conducting a regression linear between NO2 pollution and the number of accidents taking as reference the highway M6098 sensor and b) leveraging H1a test that checks if a relationship exists between number of accidents and the IoT platform implementation. The combination of these two steps (pivoting around the number of accidents variable) make possible to test H1b i.e., if a relationship exists between the NO2 pollution and the IoT platform implementation. The highway M6098 sensor is chosen since it is the unique in Nice to be tagged as traffic by *Air Paca*. We collect data of pollution from the start of 2012 until end of 2014 that we aggregate according to the 24 hours of a full day to have a consistent sampling.

4.3.4 Data and instruments for the hypothesis H2

To test H2, we decide to estimate the creation of economic value for the parking services company using the variable of rotations from empty to full parking position. Indeed, the more rotations are produced, the more financial revenue are generated since the parking is occupied. For this hypothesis, we work closely with Urbiotica, an IoT company based in Barcelona that provides the most central element of the IoT

[1] `http://www.data.gouv.fr/fr`
[2] `http://www.airpaca.org`

platform which is the parking sensors solution. Urbiotica feeds us with sensor's location and installation date and parking event transactions. These data are extracted from an Apache Hadoop database (big data analytics) designed by them for Nice and which contains each transaction event, its timestamp, its location and its nature (a car is leaving or arriving at a parking spot). By combining the arrival and leaving event, we are able to calculate the duration of a parking session and count the rotations. The data model is presented in the appendix B.

We collect the rotation counts between 01/06/2011 and 31/12/2014 considering the two phases of the project. We aggregate the rotation counts at day level and calculate the rotation index variable dividing the daily rotation counts by the correspondent number of sensors. This index aims to evaluate if the rotation of the parking slots goes faster than the automatic increase of rotation counts due to the deployment of new sensors during the project. The mobile application 'Nice City Pass' went live in 01/06/2013 i.e. two years after the start of the 'Connected Boulevard' project and at the beginning of the second timing phase. The mobile application (Inqbarna) offers that the information displayed on the street through touch-screen monitors is also available on a mobile companion and in two different versions: IOS and Android. Therefore, we think the analysis of the rotation index during the second period of the study and the comparison with the first phase indicates how the users impact the process of value creation. In other words, we assume that the daily rotation index provides not only information on the creation of business value but also the pace of the users' adoption of the IoT platform through the mobile channel. Therefore, we decide to test H2 using multiple regression analysis between the rotation index and the number of sensors.

The figure 4.1 draws the Nice Smart City business ecosystem model and is inspired from the value creation model developed by Adner (2013). We have isolated the upstream suppliers like Cisco, Urbiotica, Mentis that participate into the development of the IoT platform and the downstream suppliers like Inqbarna that has developed the mobile application outside the IoT platform. Nevertheless, downstream and upstream suppliers form part of the business ecosystem to provide the new services of parking for the citizens.

4.4 Results

4.4.1 Results of the hypothesis H1a

After processing the 579 observations, we get a sampling of 76 aggregated data split across the four geographical areas (Nice City Inside, Nice City Outside, Toulon and Marseille). Since the size of the sampling is low, we need to verify if it follows a normal distribution so as to apply the corresponding statistical models. The Shapiro Test returns us that in spite of less than 30 coordinates, the four areas follow a normal distribution. Therefore, we conduct a T-test analysis whose results are in the table 4.1.

The first two parts of table 4.1 shows at 0.9 level of significance that the means of the number of accidents of 'Nice City Inside' is statistically significant lesser than the two other cities Toulon and Marseille without IoT sensors in the car parks. On the other hand, the third part of the table 4.1 shows

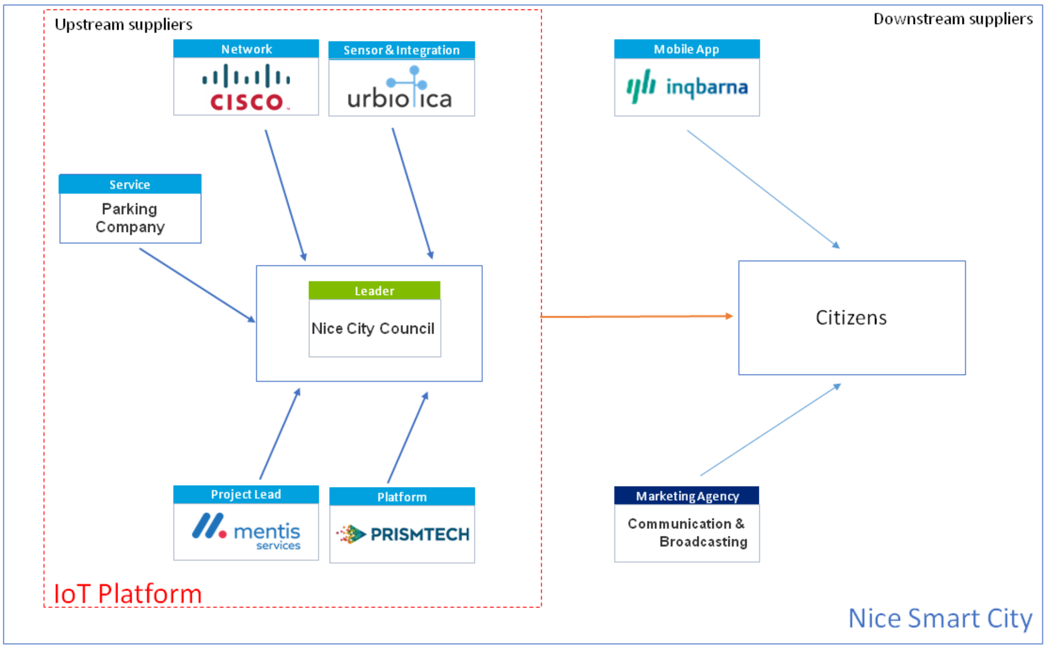

Figure 4.1: Nice Smart City business ecosystem model

Table 4.1: Results of t-test and descriptive statistics for accidents

Part 1	Nice City Inside			Toulon					
	M	SD	n	M	SD	n	90% CI	T	df
Accidents	.85	.22	19	.99	.20	19	-Inf, -.06	2.19*	36
Part 2	Nice City Inside			Marseille					
	M	SD	n	M	SD	n	90% CI	T	df
Accidents	.85	.22	19	.97	.10	19	-Inf, -.05	2.19*	36
Part 3	Nice City Inside			Nice City Outside					
	M	SD	n	M	SD	n	90% CI	T	df
Accidents	.85	.22	19	.92	.16	19	-.18, .03	1.23	33

Note *p<.1

that the null hypothesis of the two independent samples means between 'Nice City Inside' and 'Outside' is accepted. Therefore, there is no statistical significant difference in the mean between the samples 'Nice City inside' and 'Outside'. These results suggest that the average evolution rate of accidents in both zones of Nice city are the same.

4.4.2 Results of the hypothesis H1b

After analysing visually the gathered data, we decide to create two models separating the number of accidents data between weekday and weekend periods and to conduct two simple linear regression analysis to test the relationship between the number of accidents and the NO2 pollution. All the results are presented in the table 4.2. There is a positive relationship between traffic accidents and NO2 pollution and the NO2 variable explains 41% of the traffic accidents variance during the weekends and 51% during the weekdays.

Table 4.2: Results of simple linear regression analysis

Measure	weekend	weekdays
1. Intercept	-21.402	-9.475
2. NO2	1.359***	1.442***
3. R-squared	.413	.508
4. Adjusted R-squared	.408	.501
5. n	138	69

Note ***p<.001

4.4.3 Results of the hypothesis H2

After analysing visually the gathered data between the daily rotation index and the number of sensors, we decide to conduct a simple linear regression for the first phase of the project and a quadratic regression analysis for the second one. The results are gathered in the table 4.3.

In the first timing phase, the rotation index decreases over time with a significant drop and the results of the regression analysis shows that the sensors implementation explains 50.4 % of the rotation index variance. In the second timing phase, the results of the regression analysis indicates that the rotation index increases over time in a quadratic way. Focusing on this second phase, we highlight a non-significant slope after the go-live of the mobile application for around 6 months (between 3.000 and 4.000 sensors milestones) then an important increase over time (with a factor of 4.9) between 4.000 and 5.000 sensors milestones. The implementation of the sensors explains 70.4% of the rotation index variance in phase 2 and 50,4% in phase 1.

Table 4.3: Results of polynomial linear regression analysis

Measure	Phase 1	Phase 2
1. Intercept	5233.4	-1.179e-14
2. Number of sensors	-0.902***	-9.391***
3. Number of sensors squared		9.926***
3. R-squared	.504	.704
4. Adjusted R-squared	.503	.702
5. n	332	241

Note ***p<.001

4.5 Discussion

The aim of our study is to analyse and quantify the value creation of an IoT platform as part of a Smart City initiative. We issue two hypotheses that we translate into the case of Nice city. We test if the IoT business ecosystem generates better quality of life for the citizens (Hypothesis H1), increase the value creation of the car parking business and if this value creation is moderated by an active role of the citizens (Hypothesis H2).

4.5.1 Improvement of the quality of life for the citizens

The results obtained in the first part of the table 4.1 show that the frequency of the traffic accidents in the zone of sensors implementation ('Nice City Inside') decreases along with the implementation of the IoT platform and with a rhythm higher than the two other cities observed (Toulon and Marseille) as control groups. However, we unexpectedly note that statistically the decreasing rates of the traffic accidents are not significantly different between 'Nice City Outside' and 'Nice City Inside'. The positive impact of the 'Connected Boulevard' Smart City initiative covers all the geographical zones of Nice city. Nevertheless, it does not reach the two other cities situated tens of kilometres away. Therefore the first part of the hypothesis 1 (H1a) is confirmed. Diverse scholars (e.g. Chan and Singhal, 2015; Petridou and Moustaki, 2000; Stutts et al., 2001) comment that the primer reason for traffic accidents is distracted drivers, accountable for at least 35-40 % of all accidents. Their studies show that the sources of distraction causing traffic accidents are 25% coming from an outside person, an object on the road or an event like another accident. Amongst the possible objects, they emphasize that searching for a parking spot is one of the most common distraction. Our results suggest that the citizen going straight foreward to his 'waiting' parking slot while using his mobile companion, have the benefits to make him conduct less time, pay more attention to the circulation and react better to any uncontrolled event, causing finally less accidents.

Other factors like street lighting or traffic speed are not part of our study but obviously are important parameters to consider while we analyse the movement of vehicles in the city. To the best of our knowledge, literature has not yet studied their respective impact inside the urban area but only between cities. Martin (2002) observing in the French interurban motorways the link between crash rate and hourly traffic, concludes that the severity of a crash incidence increases at night time, stressing the important role of the lighting. Hiselius (2004) conducts a large study observing and analysing 82 road sections in Sweden, where passing vehicles are continuously counted by the Swedish national road administration system. He categorizes his results into four types, based on the speed limit and numbers of lanes on the road where the observation takes place. He concludes that only accidents on one of the road categories, with speed limit set to 70 km/hour and a width between six and nine meters is increasing. For the other types of road, wider or with a higher speed limit, the accident rate shows little or no change. We believe future lines of research could extend this analysis to Nice urban specific environment determining the possible mediator role played by the traffic speed and the lighting on the traffic accidents.

We have demonstrated with H1a that the parking sensors implementation and the traffic accidents are negatively correlated. However, the table 4.2 shows the positive relationship between the NO2 pollution and the traffic accidents variables, so pivoting around traffic accidents we conclude the NO2 pollution decreases along with the parking sensors implementation. The second part of the hypothesis 1 (H1b) is therefore confirmed. The IoT technology by connecting a variety of things or objects around us and interacting with each other (mobile, parking slots, display screens, cars, etc.) is an opportunity for the co-creation of platforms that improve the transport and living services of the Smart City. Chesbrough (2007) advances that new technological innovation per se has no inherent value so that a healthy ecosystem needs to be developed in order to fully realize commercial potential of the new technology. In our study, this unified urban-scale digital platform led by the City Hall but built between private companies provides an example of cross-industry collaboration (Construction, Transport, ICT...), transforming a city into an innovation platform able to capitalize on new business opportunities and social benefits together.

Our study focus on transport and living services as the factors to improve the quality of life to the citizens. However, we recognize that this choice can be largely discussed. Jacobs (2009) observes that the quality of life is closely linked to the ability of a community to self determine its everyday conditions. He adds the greater is self-organization ability, the wider are the possibilities of producing social capital. Future lines of research should analyse the role of the IoT platforms on other types of applications which improve services related to the health care, the urban surveillance, or the social inclusion for instance. However, our findings have also showed that the value creation of the business ecosystem extends the geographical limited area of the 'Connected Boulevard' project impacting positively the 'Nice City Outside' area in terms of traffic accidents reduction. Future researches should analyse why the IoT effects are perceived in the whole Nice but not in Toulon or Marseille, tens of kilometres away from the city.

4.5.2 Revenue generated by the Smart City business ecosystem

The results of the table 4.3 show the relationship between rotation index and sensors is positive once 1) all the IoT platform is fully available including the 'Nice City Pass' phone application and 2) after a stabilization period of around six months (coinciding with the 4.000 sensors milestone) in the phase 2. This means that under these two conditions, the more sensors are implemented, the more rotations of parking slots occur and consequently, the more revenue is accrued for the parking private company.

The business model for the parking service company has changed and includes a factor of value capture between sensors and rotation. We calculate this factor that rounds 4.9. The director of the parking company can no longer consider his business as stand-alone but part of an ecosystem inside the Smart City environment. The figure 4.1 represents it. Upstream suppliers like Cisco, Urbiotica, Mentis, etc. while delivering their proper services, form also part of a value chain that gives an unified service to the citizens. We confirm therefore Richter's view (2015) that Smart City generates an environment for entrepreneurship and we observe in the case of Nice IoT platform that the value of the service increases as the number of people using it, grows. Eisenmann et al. (2006) call it network effects, which they add, are amongst the most powerful strategic resources for technology-based companies.

However, we may notice this Nice digital business ecosystem is not formed by any international software firms. Indeed, the City Hall decided to use an open platform developed by small and medium firms like Urbiotica or Prismtech and basically for two main reasons: the possibility to share their project with other cities and the wish to keep the main and lead role in the project. Indeed, recent interviews realised with public sector managers corroborate Smart Cities initiatives could be misused by marketing departments to communicate and sell their offering deviating the initial message of social benefit for the

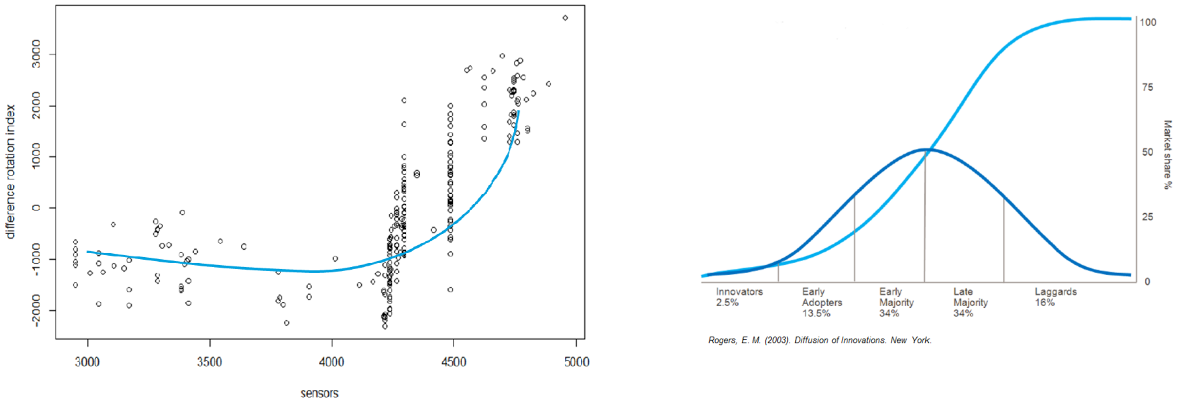

Figure 4.2: Rotation Index versus Roger's S-curb diffusion model

city and converting the citizen to a client (e.g. Paroutis et al., 2014; Iansiti and Lakhani, 2014).

The results of table 4.3 suggest also the citizens play an active role in the IoT platform implementation. In the first phase, when the 'Nice City Pass' is unavailable, there is a negative correlation between the rotation index and the number of sensors. The IoT platform is not yet adopted by the citizens and its implementation doesn't increment the parking rotation frequency. The unavailability of the mobile application is a clear bottleneck for the IoT Nice project. Our findings suggests that a phone application plays the role of corner stone for a successful implementation of an IoT business ecosystem (Zahra and Nambisan, 2012). We believe that a better mobile strategy would have diminished the observed delay. In summer 2013, at the beginning of the second phase 'Nice City Pass' mobile goes live but our results still show a slight descent until 4.000 sensors milestone is reached (six months later) and the expected growth of rotation index is still not happening. The next period (after 4.000) shows a positive correlation between the rotation index and sensors increase. We observe that even if the mobile application is available, it still needs a period of six months to be known, accepted and used by the citizens (see the graph on the left side of the figure 4.2).

Looking at the patterns of both phases, we think to recognize Rogers' S-curb diffusion model (2003). The comparison is done in the figure 4.2. Phase 1 is seen as the period of Early Adopters while Phase 2 is the stage of Early Majority. We note the six months are the transition period for the pragmatic citizens to cross the 'chasm' using his mobile application to understand the whole service concept and position it in their daily life (Moore, 2014). We conclude that the rotation index is a good estimate for the users' growth of the IoT platform and deduce that the adoption by the citizens of the IoT platform moderates the capture of business value created in the Smart City business ecosystem. Therefore the hypothesis H2 is confirmed.

More largely, these results evoke to include the citizens inside the process of innovation. Eric Von Hippel proffers multiple examples of user innovation in his book 'Democratizing the innovation' (2005). He adds that user communities arise, freely communicate with each other, advance ideas and sometimes even 'drive the manufacturer out of product design'. He believes this widely distributed inventing bug is a good trend because users ’tend to make things that are functionally novel’. Not only is it ’freeing for individuals’ but it also creates a ’free commons’ of product ideas, parallel to the more restrictive world of intellectual property governed by less creative manufacturers.

Etzkowitz and Leydesdorff (2000) represent the national innovation system as the interaction of three historical forces: private companies, public administration and universities. Grimaldi and Fernandez (2016) state the implementation of emerging technologies like IoT or Big Data have opened up a potential ’second university revolution’ comparing it to the first that occurred at the beginning of the 19th century due to the electricity discovery. Our results demonstrate that the revolution is not only academic but also individual where the citizens form part of the technology transfer and part of the innovation in the city. In the field of knowledge economy, this new model of interaction has been recently called quadruple helix (Park, 2014) and our study sums to the list of articles that have started to analyse it (e.g. Angelidou et al., 2012; Ivanova, 2014).

4.6 Conclusions

In our study, we considered the Smart Cities through the lens of a digital business ecosystem based on an IoT technological platform. Our model determined first the different actors, their role as either contributors or leader in this ecosystem. We built a methodology to measure the creation of value, raised two hypotheses and examined the case of Nice IoT parking platform project to test them. Our findings show that the Smart City business ecosystem delivers three outcomes: less traffic accidents, less NO2 pollution and a change of business model for the parking services in the city. Accordingly, this ecosystem contributes respectively to social, environmental and economical objectives improving the quality of life for the citizens along with an opportunity for the urban business growth. Our study suggests that the service companies working in the Smart City need to revise their business model in order to take into account the role of the citizens as an additional motor of the innovation process (von Hippel, 2005). Finally, we wish to comment that our investigation proposes a method that could be reused for analysing the situation of other smart transport initiatives in France or even further considering international urban agglomerations. Anyway, the characteristics of Nice’s situation, a sea-side metropolis of 300+ thousand inhabitants with a large proportion of built infrastructure could limit the extrapolation to other cities.

CHAPTER 5

THE SCHOOL ROAD PROJECT. THE CASE OF BARCELONA

Mobility of the young population between 6 and 10-year old has been continuously decreasing the last decades causing problems of health (obesity) and decreasing the development of spatial skills along with the sense of community. This study focuses on the road between school and home and deals with a specific project called 'camino escolar' (school road) which helps parents to take the decision to authorize their children to go and walk alone. The empirical case is developed in Barcelona where 136 school road projects exist but more precisely we analyse two specific districts. The methodology is divided into two phases. In the first phase, we conduct an exploratory study based on interviews with the different stakeholders of the education system and conclude on a list of barriers against the development of the 'school road' project. In the second one, we ask for the parents to prioritize these barriers. The results show the different barriers can be classified into four clusters which are physical insecurities, emotional insecurities, the city infrastructure quality and the project management quality. The study concludes on recommendations to mitigate these impediments. Moreover, one of the further lines of investigation recommended in the conclusion section is handled and analysed in the chapter 6 of this thesis.

5.1 Introduction

Two or three decades ago, the mobility of the children between 6 and 10 year old was similar to that of his parents (Tonucci, 1979). Today, several studies (e.g. Salmon et al., 2005; Van der Ploeg et al., 2008; McDonald, 2007) appoint the decreasing rates of walking/cycling between home and school in developed nations and its substitution for the displacement by car. Armstrong (1993) finds that 50% of girls and 30% of boys aged between 10 and 16 are regularly driven by their parents and walk less than ten minutes a day. Parents tend to control thus most of the experiences of their children, deprive them of all opportunities to take risks or to be doomed to long periods of solitude (Tonucci and Rissotto, 1999). More consequences exist. USDHHS (2001) observe increasing rates of overweight and obesity among children for the last ten years. Trost (2005) stresses the transport is fundamental for children's mental listing its value for the development of psychosocial skills, the facilitation of cognitive skills (Burdette and Whitaker, 2005; Tamis-

LeMonda et al., 2004), the social prowess (Ginsburg, 2007) or the emotional intelligence (Bunker, 1991). Rissotto and Tonucci (2002) add a reduced children's mobility diminishes considerably the development of spatial and navigational skills as well as a sense of community (Prezza et al., 2005; Prezza and Pacilli, 2007).

Parents' habits driving their children to school have also an environmental and social impact. Indeed, their decision go in the opposite way to the vital and mandatory efforts to reduce carbon emissions, to lessen our dependency on fossil energies and to combat the climate change (Bauman et al., 2008). The air is turning more polluted as it was recently recalled in the 2015 UN Climate Change Conference in Paris. The city becomes noisier, the traffic increases and the streets become more dangerous for the pedestrians. The disappearance of the children from the streets represents also a serious handicap for the city itself. If there are no children, public spaces can be converted to the level of traffic lanes and parking slots such as already occur in various American cities (McDonald and Aalborg, 2009). The city loses its characteristic of a place of meeting, people shut themselves up in their homes and the fear of crime increases (Prezza et al., 2005).

The project of the Italian psychologist Francesco Tonucci (1999) aims at fostering children's participation in the town of adults and becoming an instrument of change for the city. He proposes different activities such as the 'children's council' where children in fourth and fifth grade of the primary school discuss with an expert on themes and political strategies for the town development; alternatively, the 'participated planning' where students plan the improvement of the urban environment with the support of their teacher and urban planner. Through these actions, the objective is to increase children's confidence, to restore their autonomy bringing them back into the streets and squares. The initiative started in 1991 in the small Italian coastal town of Fano and then it was copied by different European countries and under different names. In Spain, it was first introduced in Madrid and Barcelona in 2000 under the name of 'el camino escolar' (the school road from now). The city of Barcelona, considered amongst the top 5 Smart City in the world according to 2015 Forbes ranking[1], has been pioneering the development of this initiative. Nevertheless, to the best of our knowledge, no scientific assessment has been already conducted to analyze the difficulties or challenges of such project. Therefore, the objective of our study is to identify, classify and prioritize the barriers against the development of the school road project.

5.2 Literature review

5.2.1 School roads in Barcelona

Since 2000, the department of Education of Barcelona City Hall has launched several projects to improve the education and the mobility of the young generation. Some of them are designed to be run inside the schools, others are related to activities occurring outside the school. At the end of 2015, 43.629 students between third (8 years-old) and sixth grade (11 years-old) of the primary school were involved in 136 school road projects. Sant Marti and Sant Andreu districts counted respectively 20 and 7 of all these projects and 7.147 and 1.572 students enrolled. In terms of magnitude, they are respectively the second and third most important zone just behind the district of Sarria-Sant Gervasi situated on the north-west of the city. The

[1] http://www.forbes.com/sites/peterhigh/2015/03/09/the-top-five-smart-cities-in-the-world

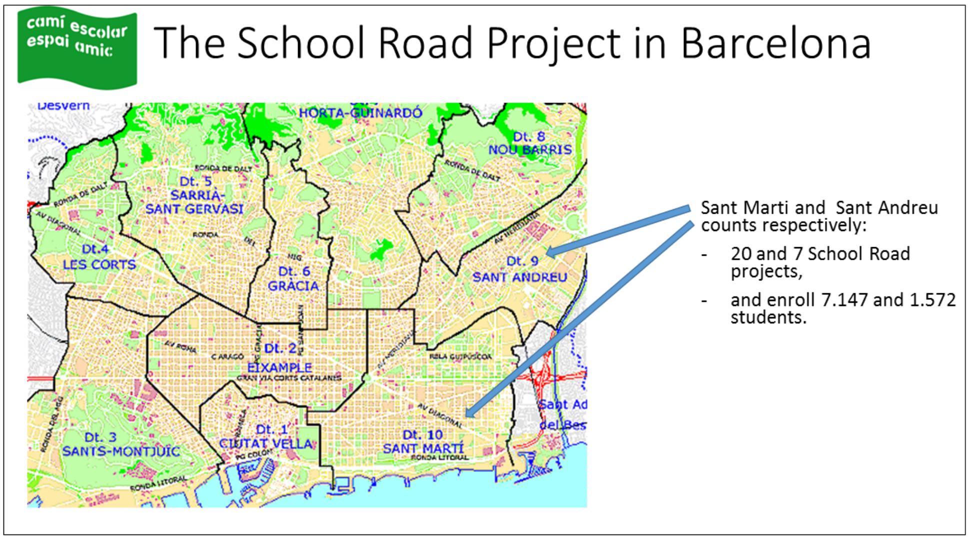

FIGURE 5.1. The school road project in Barcelona

figure 5.1 situates these two districts in the Barcelona city map. We can also split the 136 projects into four phases as detailed hereunder. Each phase describes a level of project maturity between 1: low and 4: high. As of 2015 end, 22 were in phase 1, 17 in phase 2, 81 in the third phase and no one was in the fourth or final phase.

The first phase encompasses the preliminary actions required to ensure a correct launch of the project. It consists on aligning all the stakeholders restating the objectives, defining the organization and the management system with its different committees. It defines the method of work, the place and frequency of the meetings. One of its main outcome is the commitment of the different participants which usually are the direction of the school, the municipal services (City Hall, police department, etc.), the parents and neighbour entities (like parents' association). The second phase is the one of diagnosis when information is recompiled on the habits of the students, ways to move in the district, perception of (un)security and possible conflicts or dangers already identified. All this information is analysed along with a study of the configuration and condition of the streets of the borough, the surroundings of the school and the main roads to reach it. A report is also requested to the services of Barcelona streets maintenance.

The third phase is largely dedicated to share all the results of the performed analysis (even if the committees regularly meet during the previous phases of the project) and validate an action plan prioritized in function of the urgency of the required actions. One of the first action is usually to clearly identify the main and most direct access to the schools by painting in green zebra crossings (see figure 5.2). The phase 3 finishes also by providing to the families with a map of the streets considered in good condition. This map of streets is usually called by the parents green spider network because it is printed and delivered in a green paper support (see figure 5.3).

The kick-off of the project is held during an ad-hoc event in the school. The fourth phase supposes to

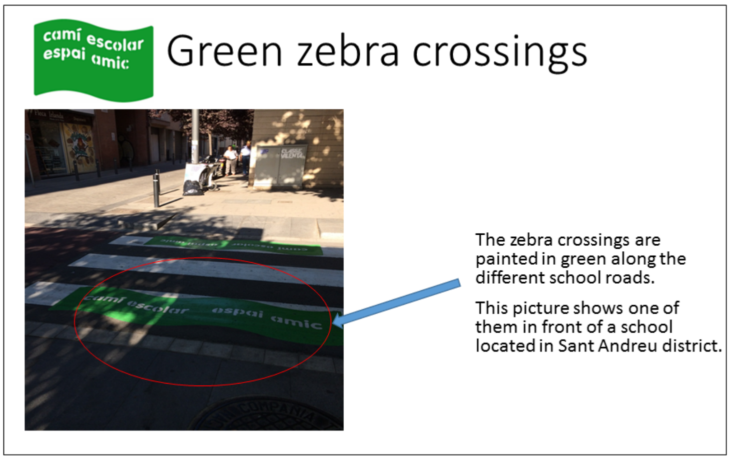

FIGURE 5.2. Green zebra crossings

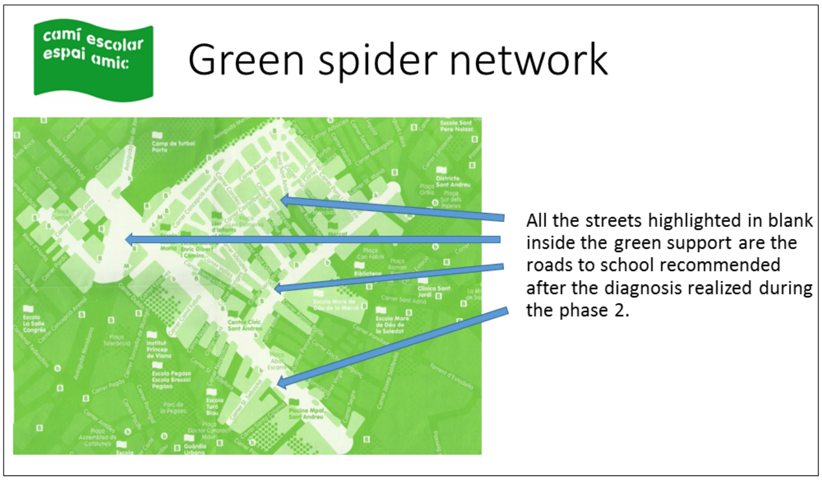

FIGURE 5.3. Green spider network

be dedicated to the assessment, the following-up and the corrections of the actions decided and started in phase 3. From now, amongst the 136 projects launched, null project has reached such level of maturity even if the ambition is to start to evaluate the benefits of the project during 2016.

5.3 Methodology

To respond to the research question, we design and conduct an exploratory (section 5.4.1) and then a confirmatory analysis (section 5.4.2). The first one is based on an interpretivist and inductive method where our primary sources of information are interviews with the different stakeholders involved in the education system (e.g. teachers, politics and parents). The second one is fuelled by the conclusions of the first study which are a list of barriers against the development of the school road project. The data collection method of the first part of the study is a set of semi-structured individual interviews. As said previously, the lack of preceding papers complicates the beginning of an answer and transforms the goal of our study into a complex and large issue. Consequently, we decided to orientate our epistemological works on selecting and holistically analysing the case of Barcelona city, more specifically two of its popular districts Sant Marti and Sant Andreu located on the eastern side of the city because both have a long experience in the school road project. Sant Marti has a population of 224.472 habitants which makes it the second most populated district in Barcelona with a size of 10,8 km2. Sant Andreu has a population of 145,678 inhabitants and a size of 6,5 km2. These data come from the recent 2015 Barcelona census[2].

In the first analysis, our data collection follows a non-probabilistic strategy of quotas sampling. We engaged all project stakeholders: parents, parents' associations, department of Education of Barcelona City Hall, and schools' faculty and staff. Wende (2007) defines 4 specific roles in a project: Responsible, Accountable/Leader, Consultative, and Informing and uses the abbreviation of RACI. We build the table 5.1 in order to map and verify that our quota strategy with 22 interviewees covered all these four possible roles. The choice of the parents also respects quotas in terms of gender representation, range of age and to have at least one child 'eligible' to the initiative, i.e. older than 8 years. Due to the nature of this research, all the interviewees have to have lived the three phases of the project.

As a result, the final sampling is composed of 4 members of parents' association (AP1, AP2, AP3 and AP4), 4 managers in charge of this initiative in the two schools (S1, S2, S3 and S4), 10 parents (four fathers: F1, F2, F3, F4 and six mothers M1, M2, M3, M4, M5, M6) and 4 managers and technicians of the department of Education of Barcelona City Hall directly accountable of this initiative (B1, B2, B3 and B4). The meeting with the parents took place at their homes for their personal comfort. An unexpected event made that one of the fathers couldn't receive us according to the schedule of visits and we decided to interview his wife (M1) so as not to lose a possible feedback. All the interviews were realized according to a protocol based on the recent works of the professor He (2013) on children's mobility. Our objective was to understand the scope, the ambition of this initiative, to get a return of experience and to grasp a complete and holistic view of the project.

The protocol is a semi-structured interview designed with open-questions and for an one-hour duration in order to capture barriers or drivers perceived by the different stakeholders, to receive possible unexpected results and to redirect the interview according to the responses. The protocol is divided into four parts. The first part is a short introduction of the authors, then the study that we are conducting and finally the interview conditions definition. We inform that the interview is anonymous and confidential since parents may be afraid to share the information that their children go alone to school. The introduction

[2] http://www.bcn.cat/estadistica/angles

is also a good time to explain that we are not pursuing any commercial objective like for instance the purchase behaviour of the inhabitants of the district. The second part aims at checking their level of engagement in this project and validates their opinion is adequate to the objectives of the study in terms of subjectivity (they are personally and directly concerned) and experience (they have been involved for at least 4 years). We collect also demographic information like gender, age, and academic level.

In the third part, we ask the respondent to answer to a series of pre-established questions. The questions are based on a first set of barriers identified by Prezza et al. (2001) regarding the influence of psychosocial and environmental factors on children's independent mobility. However, we consider the questionnaire as semi-structured since we ask open-ended questions to give a large room for variation in response. All the respondents receive the same set of questions asked in the same order of sequence. Moreover, according to the new barriers perceived and added by the interviewees, we expand the scope of our questionnaire for the following interviews. The interviewer plays a neutral role, never interjecting his opinions of the respondent's answers and perfect a style of 'interested listening' to gain trust. The fourth and last part deals with giving our thank you for accepting this meeting and sharing this information but informing also that in the coming weeks a survey will be sent to prioritize the results obtained (see section 5.4.2).

Besides, the interviews were saved by an audio recorder. The protocol also includes the annotation of interviewees' reactions (e.g. behaviours or non-verbal communication) while they are responding to questions. The department of Education of Barcelona City Hall provided us with secondary sources of information during the different meetings that we read before to improve our understanding of the initiative (e.g. the list of commercial shops by district committed to participate to the initiative; the different network maps with the priority streets to go to school; a report as of end of 2015 with the number of schools, students and families engaged in all Barcelona; a complete description of each phase and a work detailed description). They told us this information had been previously created to promote, support and assess the schools in their action to conduct the change. It was largely built by the company ETCS [3] that Barcelona City Hall contracted few years ago to respond to the demand of the project documentation generated by the schools. We transcribed all interviews through the Express Scribe transcriber software following a process of double peers' review. We added in the transcribed text the non-verbal communication to remind it during the following analysis process.

We codify the interviews through the methodological proposals of Bogdan and Biklen (2007) using the qualitative data analysis software called MaxQDA (version 12). The first step of interviews coding is to identify the blocks and paragraphs where the interviewees speak about barriers or drivers of the initiative (just two codes: BAR->Barriers and DRI->Drivers). The second step consists in assigning to the paragraphs (or a part of them) a list of preconceived codes from the theoretical framework of the research. The initial list of codes contains 4 items (traffic, infrastructure, low lighting and sickness) where the codes represents concepts of information transmission: challenges, drivers, barriers or family concerns. The third, and final, step consists in coding the paragraphs with an inductive approach (encoding in-vivo), recoding the same interview as better codes emerge. At the end, the final code book contains 14 codes (e.g. traffic density, low lighting, hour of openings and closing, pavement, unsecured zones, fight, sickness, adult

[3] http://etcs.coop

with wrong intention, etc.) grouped into 6 categories: Traffic, Infrastructure, Fear, Distance, 'Youngest son' and Project management (see table 5.2).

We build a checklist matrix to coherently organize the different components for each case. These matrices show the different sources of data (interviews) in rows and the codes in columns. They display the interviews of the codified elements and their reliability, frequency and importance according to the number of sources that corroborate them. Consequently, we identify some gaps in the interviews like for instance the responsibilities of the different departments of the Barcelona City Hall engaged in this project (like district area, department of Education, etc.) are not perfectly understood by the families. We so decide to meet parents who form part of the neighbourhood City Hall to clarify it. We acknowledge also some inconsistencies like for instance parents are usually claiming that traffic density is an important barrier not to let their children go alone but in some cases they prefer to drive them to school encouraging therefore the traffic congestion that they fear. For this reason, we decide to interview 4 additional parents (F2, M3, F4 and M6) making triangulation and validation of our previous findings. The first part of this methodology allow us to come out with a list of barriers of the table 5.2.

Table 5.1: Typology of two school road projects

'Sant Marti' area	Interviewees	Responsibility
Parents	F1,F2,M1,M2 and M3	Informed
AMPA	AP1 and AP2	Responsible
Manager of schools	S1 andS2	Consult
Department of Education	B1*,B2* and B3	Responsible

'Sant Andreu' area	Interviewees	Responsibility
Parents	F3,F4,M4,M5 and M6	Informed
AMPA	AP3 and AP4	Responsible
Manager of schools	S3 and S4	Consult
Department of Education	B1*,B2*,B4	Responsible

*Note: B1 and B2 are managers in the department of Education in charge of the school road project. However, each area has a technical person to locally support the initiative (B3 and B4)

After proposing a list of barriers against the school road initiative, we conduct a second and quantitative analysis which aims at ordering them according to their level of importance. We design a questionnaire focused on the parents whose children have been enrolled in one of the 123 school road projects. To improve the representativeness of the sample, we submit the questionnaire to four schools of Sant Marti and Sant Andreu districts. Each school has one class of students per academic year with around 25 boys and girls by class. The potential number of answers is approximately around 400. Two schools requested to present in person the motivation of the research study and we were invited to do it during a parents' association committee meeting. One school rejected to participate without giving any kind of explication and capacity to explain them the purpose of the study. One school asked for digitalizing the questionnaire using a web-based survey tool, inspired by a sustainable and paper-free strategy and philosophy. For your consideration, the survey questionnaire is presented in the appendix C.

The original questionnaire items were constructed in Spanish since it was the common language of the authors. Since two schools requested it, the questionnaire had to be translated into Catalan. To ensure the accuracy of the translation, we followed a translation, back-translation procedure (Nunnally and Bernstein, 1994). Moreover, five cognitive interviews were conducted in order to ensure an accurate interpretation of the questionnaire items, as this technique allows understanding how respondents perceive and interpret questions, and to identify potential problems that may arise in prospective survey questionnaires (Drennan, 2003). Cognitive interviews permitted us interpreting which items were beyond the theoretical framework of the constructs to be analyzed (Collins, 2003; Drennan, 2003). By means of verbal probing and thinking aloud (Somaya and Williamson, 2008) participants were asked to verbalize their interpretation of the statements and to comment on their wording in an effort to identify ambiguous or poorly worded questions. Based on their comments, minor stylistic and semantic changes were made.

The questionnaire has two parts. In the first part, demographic and background characteristics are collected to gain a deeper understanding of the composition of the sample. This information encompasses first of all the gender, age, and education level of the respondents. Moreover, we collect the age of the children, their respective grade and the average duration and distance between home and school. The second part includes a list of 12 statements which each of them is related to one of the barriers identified in the first part of this study. We request to the parents to give their level of adherence for each statement and to grade it according to a Likert-scale between 1 (totally disagreement with the statement) and 5 (totally agreement with the statement). We also measure if this initiative provides tangible results querying if the actions realized so far made them change their mind and let their children go alone to school.

5.4 Results and Discussion

5.4.1 Exploratory analysis and identification of the barriers

After analysing the whole information, we identify the traffic as the most common idea from the retrieved codes. Indeed, the traffic density appears to be a large concern for the families. It confirms previous studies on children's mobility (Armstrong, 1993; He, 2013; Rissotto and Tonucci, 2002). Moreover, traffic and accidents are adjacent inside the same paragraph in all the cases. 80% of the respondents refer to it but express their concern in different manner. Few of them refer to the insufficient number of speed control dispositive or the scarce presence of policemen in the streets. They add that many cars exceed the speed limits of the district: 30 km/hour in pedestrian zone and 50 km/hour in general. Other refers that the borough is an old one with small pavement and perpendicular crosses which drastically diminish the visibility and the reaction time should a car arrive. The code 'traffic' concurs with the code 'low lighting of the street' in 75% of all the cases. Their comments highlight that especially during wintertime, children have to go to school before the sunrise, increasing the risks of accidents with a motorized vehicle. Consequently, we suggest 'traffic density' and 'low lighting in the street' as two barriers of school roads projects.

The second code that our analysis reveals is related to the infrastructure conditions of the borough. The two areas selected by our study are the locus of a large spatial transformation where green or no-urban zone are transformed to schools, residential buildings or green parks. The scripts of our interviews show the repetitive occurrence (70%) that the unsustainable financial conditions of the public administration have reduced the maintenance budget of the streets and consequently many pavements suffer large zone of deterioration. One interviewee tell us (expressing himself with large movement of arms as we recorded with a memo): 'within the financial crisis where our country is still immerged, our city has drastically cut off its functioning budget and this austerity policy has not only reduced the superfluous but also the actions that guarantee the minimum conditions of living in the city and maintenance of our streets and green parks'. He adds: 'This situation can't guarantee that the children are always safe and secure even if they walk respectfully on the pavement of the streets'. Clark et al. (2010) stress efforts to create 'walkable' neighbourhoods are often pushed by decreasing the 'automobility' which necessarily divides workplaces from the home producing lengthy commutes, splits home and shopping and destroys local retailing outlets. Urry (2004) adds and calls 'Smart Growth' this movement to build more pedestrian streets in the city. Nevertheless, in spite of the financial restrictions, all the interviewees agree that the achievement of the phase 3 in both districts allowed to improve the access to school. We suggest that 'small or damaged pavement' and 'need to cross unsecured zone' are two additional barriers to the school road project.

The third code that our analysis stress concerns with the health and integrity of the children during their way to school. F2, F3, M2 and M3 mention their fear that their children meet an adult with wrong intentions or that their children fight with others. F3, F4, M2, M3 and M4 state they are afraid that their respective children feel sick during their way to school and can't find any support if they need it. 'Fear' word appears 66% in all the meetings. Three causes of fear appear simultaneously in 33% of all the cases and only two interviewees F4 and M2 mention all the four types of fears during the 1-hour discussion. We decide to further analysing these two specific interviews (F4 and M2) and to look for a common pattern between the families. We find out that they both live far from the school (more than 1km) and in the most conflictive area of the borough. Finally, we propose that 'fear they meet adult with wrong intentions', 'fear they fight with other pupils', 'fear they feel sick on their way to school' and 'fear they can't ask for support should they need it' are four additional barriers to the school road project. We register and classify them as four sub-codes of the code 'fear'. Carver et al. (2005) corroborate that reasons of parents to bring their children are commonly linked with road safety and perceived danger from strangers. We asked if more security is the solution but all the interviewees rejected the argument claiming that only the distance is the reason of their decision to take their car.

Distance is also a repetitive argument that we identify during the revision of the interviews. 50% of the interviewees mention it. 'Distance' and 'traffic' are codes that appear in 70% of the cases adjacent and inside the same paragraph. In 20%, only one paragraph separates them. The parents argue that they prefer to drive their children to school since they don't want them to arrive tired or late. This result confirms the decreasing rates of walking and cycling between home and school in developed nations (McDonald, 2007; Salmon et al., 2005; Van der Ploeg et al., 2008). However, using their car appear in complete contradiction with the first main argument that they express during the interviews related to traffic congestion and danger. We pay a special attention on this paradox asking few additional questions to the parents but the interviews didn't allow us to clarify this fact. Specific research on this issue should be developed in future works.

Furthermore, interviewees comment us their huge interest and concern on the environmental and pollution subjects which again enter in contradiction of their behaviour. Walking/cycling instead of driving as Bauman et al. (2008) highlight it, are reasonable efforts which permit to decrease the carbon footprint and its negative effects on the environment. Based on these comments, we redirect the remaining interviews including in a protocol a question that highlights that for 66% of the remaining interviewees (12 people), sustainability appears as an important concern and message that they transmit to their children. Considering the whole of the previous interviews, we suggest 'distance' as a new barrier.

In the third interview with parents (F3), we discover a new barrier of autonomy that we call the 'effect of youngest son'. Indeed, families who still have a young boy or girl below 8 years are compelled to bring them to school. For this reason, the eldest son/daughter which shall be able to go alone is usually accompanied with their youngest son/daughter. One interviewee told us: 'since I need to bring my little daughter to school, his brother come with us and we can discuss all together on the road'. We modify so the protocol to include a question related to this effect. The results show that 20% of the remaining interviewees (10 people) agree to bring the eldest son or daughter due to the so called 'effect of youngest son'. We definitely consider this finding as a barrier.

While meeting the two parents' associations (AP1 to AP4), we perceive an important civic engagement coming from both districts. We observe that other initiatives exist like the 'CitizenSqkm' initiative, a communicative ecology project wherein digitized and geo-located information is collected, stored, and processed via a community network (Garriga and Medina, 2014). This online community network is made up of antennas, nodes and computers, but above all of students, teachers, citizens, local entities and public administrations like different research centres of Catalonia (Centre for Research in Environmental Epidemiology, Unit Center of Respiratory and Environmental Research and Hospital del Mar Research Centre). This network is designed to function as a decentralized entity, self-managed by the community members with the goal to improve citizens' life. Our meeting give us the opportunity to compare both initiatives and come to the conclusions that even if each school road project is different by its characteristics and constraints, the leadership has to come from the parents and the management of the schools.

The members of the parents' association add Sant Marti is considered as a 'success story'. Started 7 years ago, this district has reached today the largest number of initiatives compared to any other ones. Indeed, 17 projects are up and running today in phase 3. Behind them, the district of Sarria-Sant Gervasi is the second one with 14. They comment this success is due that the parents satisfied by the first results of the initiative have maintained a constant and solid effort to convert it into a larger success. They believe accordingly 'this continuous and stable engagement is a real challenge'. Even if this comment is present in only two interviews, we consider it important and we record 'Project Management' as a sixth impediment. This barrier can be summarised in that way: 'the absence of a strong project monitoring able to measure and retro-feed the process, understand the gap between the expectations and the real results and decide the corrective actions.' They conclude recommending the Barcelona department of Education to develop a family satisfaction survey as an assessment tool. Interestingly, this confirms Wang's study (2001) which comments that using surveys and focus group discussions improves effectively the ability to ensure citizen's satisfaction.

Finally, the management of the schools (S1 to S4) points out an issue that we haven't listened so far and which is related to the quality of the project deliverables. They comment us that the documentation is usually too much rigid and not enough customized for each specific school context. They state moreover the actions realized by the Barcelona City Hall is missing somehow a bit of efficiency. They refer to the complexity to have different departments of the same public administration working together (i.e. the services of street maintenance, the department of Education and the departments in charge of the districts). Although this comment comes from 4 interviewees, we see it important and decide to include in the previous barrier 'Project Management' registering two sub-codes 'absence of project adequate documentation' and 'inefficiency of the City Hall organization and governance model'. Finally, the table 5.2 shows a proposal of barriers classification.

Table 5.2: Classification of the identified barriers

N	Group of barrier	Barriers of the school road projects
1	Traffic	Traffic density Low lighting in the street They go out from school too late or enter at school too early
2	Infrastructure	Small and damaged pavement Need to cross unsecured zones
3	Fear	Fear they meet adult with wrong intentions Fear they fight with other children Fear they feel sick during their way to school Fear they can't ask for support if they need it
4	Distance	They have to go by car since the school is far from home
5	'Youngest son' effect	The eldest son shall go but I need to bring the youngest one, so I bring both of them
6	Project Management	The absence of project monitoring The absence of project adequate documentation The inefficiency of the City Hall organization and governance model

5.4.2 Prioritization and classification of the barriers

The second phase aims at asking for the parents to order the different barriers according to their level of importance. The respondents (31.25% men and 68.75% women) are kept anonymous. The average age of the parents is 43,7 years old. As regards as education level, 63% have a university level, 31% and 5% respectively a secondary and primary one. The survey shows that the average age of the children is 10.9 years (SD = 2.7). 43% of them go alone to school and 16% are autonomous thanks to the school road initiative. On average also, it takes them 9.1 minutes (SD = 6.5 minutes) to go to school.

The results of our survey show that the first barrier of the school road project is the fear that children may enter in contact with people with wrong intentions. The punctuation is very high (4.1) and far from the rest of the evaluated barriers. It confirms what many scholars (Burman et al., 2000; Hillman et al., 1990; Matthews, 1995; Mullan, 2003) describe and call 'stranger danger'. With reference to their own childhood, parents believe that children now face more risk due to adult or strangers' presence (Scott et al., 2000). The state of the infrastructure surprisingly results to be the lowest scored (low lighting = 3.1; pavement = 2.8 and unsecured zones = 3.2). These results have to be interpreted taking into account the low duration of the path to school (9 minutes) reported. This can explain why these results are divergent from another qualitative study realized by Valentine and McKendrck (1997) in England that concludes that 'road safety' and 'stranger danger' have the same weight concerning the cause of restriction of children's mobility.

Violence between pupils is also considered as a high barrier ('fight with other children' weighted 3.4). Many factors may explain it. O'Brien (2011) analyses the 'bullying phenomenon' which is the behaviour of children that wish to punish those who don't conform with the common norms of their social groups. Based on a large survey from eight mixed-sex British state secondary schools, she compares two styles of bullying that literature has been considered. Indeed, social scientists (e.g. Brooks, 1982; La Fontaine, 1991; Rigby, 1996; Thorne, 1993) have been studying group-based ones while others (e.g. Janoff-Bulman and Hanson Frieze, 1983) have been analysing the effects related to individual-based ones. Her conclusions are aligned with our results that group-based is more insidious, more damaging and more capable of generating the violence between children that the parents fear.

Table 5.3: Typology of two school road projects

N	Barriers against the school road project	M	SD	n
B1	Meeting adult with wrong intentions	4.1	1.2	177
B2	Feeling sick in the street	3.4	1.4	177
B3	High traffic density	3.4	1.5	177
B4	Fighting with other children	3.4	1.4	177
B5	Feeling alone. No access to any adult for help	3.3	1.4	168
B6	Crossing unsecured zones	3.2	1.4	177
B7	Entering to school too early or going out too late	3.2	1.4	177
B8	Low lighting in the street	3.1	1.5	177
B9	'Youngest son' effect	2.9	1.4	162
B10	Small or damaged pavement	2.8	1.4	177
B11	School too far from home	2.6	1.5	168

We realize an analytical classification to better understand our findings. We observe three clusters of barriers, 2 out of them are based on the grades of danger and the last one on the quality of the service. The first grade is related to the physical insecurity and health threats should the risk inherent to the barrier occur. The associated barriers are B1, B2 and B4. The second grade is linked to a more diffuse risk, to an emotional insecurity and the feeling that the situation in which the children are involved during the school road may generate a physical danger. The associated barriers are B3, B5, B6, B7 and B11. The third cluster is related to the quality of the city infrastructure which may generate the conditions for physical or emotional insecurities. The associated barriers are B6, B8 and B10. We think a relationship exists between these 3 clusters that we draw it in the figure 5.4.

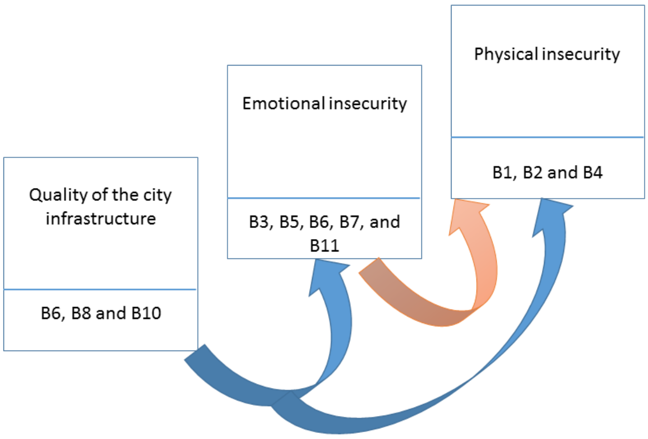

FIGURE 5.4. Relationships between the three clusters of barriers

5.5 Conclusions

The objective of this study was to identify and order the barriers related to the school road project. We first listed them through a qualitative study based on one-to-one meetings with all the project members. Then, we performed a quantitative analysis aimed at prioritizing the identified barriers in the first phase according to the opinion of the parents. Consequently and as further line of investigation, we suggest to compare this priority list with the opinions of the other project stakeholders (the children themselves, the parents' association or even the school management). Besides, the section 5.4.2 of our study classifies the different barriers into three clusters which are respectively physical and emotional insecurities along with the city infrastructure poor quality. However, according to the first part of the study (section 5.4.1), the project management quality is also a group of barriers. We need so to consider it as the fourth and last cluster. Finally, we believe that our diagnostic constitutes the preliminary step to estimate the gap and develop accordingly solutions to reduce these barriers. A first analysis leads to the suggestion to increase the presence of adults in the paths to school. In that sense, we believe that the owners of the local commerce could represent an opportunity. Their shops are located in the street and most of the time, they are open during the hours of children's movement. Nevertheless, we observe that their role have been 'overlooked' in most of the school road projects. This issue represents a new line of research which is analysed in the following chapter.

CHAPTER 6

Social entrepreneurship. Analysis of the growth of the small business in the Smart City. The case of Barcelona

The recent Complexity theory provides theoretical structure for city development and analysis. This study focuses on the problematic of Smart Cities analysing the localization as possible factor of success or failure in the process of firms creation by an entrepreneur. Our approach proposes an heuristic that prioritises the opening of future small and local shops based on their geo-localization. The aspects that our study covers are not only according to the potential sustainability of the business activity but also the possible contribution of the shops' owner into a social project in the field of the education services. Our result is a list of 50 shops that each of them has a citizen's attractiveness superior to the average of the neighbourhood and occupies a position in the urban grid which improves the movement conditions of the children between home and school. This article echoes to the recent study realised and presented in the chapter 5 of this thesis on the Barcelona school road project and responds to a line of proposed further investigation. Our findings are important inputs for the entrepreneurs to better select the localization of their future ventures. It is also an opportunity to improve the public-private relationship by suggesting how public investments can foster the social responsibility of the private sector.

6.1 Introduction

Cities are one of the largest and most complex artefacts that humankind has made. Smart city concept is originated from a theoretical understanding of the towns and citizens' needs. Actually, it can be considered a consolidation from various brands such as 'Intelligent City', 'Knowledge City', 'Digital City', and 'Ubiquitous City' (Caragliu et al., 2011; Gershenson, 2013; Hollands, 2008; Komninos, 2006; Vespignani, 2009) where all share that technology is a key driving force in delivering innovative online services (Lee et al., 2013). Yigitcanlar et al. (2008) introduce the concept of Smart City within the context of knowledge economy. They observe a Smart City built with an industrial network and clusters creates a relationship space, a network of business or social interactions between private companies, institutions and City Hall. This interaction extended to the citizens eventually creates a Knowledge Society (Bakici et al., 2012).

Cities are also urban grids where the technological revolutions have connected its various systems through different networks (road, telecommunication, railway, energy or water supply). Newman (2010) applies the Complexity science for the Networks theory and show how the 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. Our study leverage his conclusions.

Moreover, the aftermath of the recent financial crisis, resulting in economic downturn and a growing array of social problems, has raised new questions about the financing of the services in the city. Social insurance schemes and tax-financed services are monetarily constrained and are unable to respond effectively to growing societal needs. While the national economy of Catalonia is slowly recovering (ChamberofCommerce, 2015), the role of the entrepreneur takes a paramount interest and implies that many studies analyse the possible factors of success or failure in the process of firms creation. Amongst them, the localization of the shops keeps an interesting question (Kolympiris et al., 2014; Minai et al., 2011). One of the contribution coming from the Network theory shows that the position and the freedom degree of a line may either increase or decrease the attractiveness and the sustainability of the local and small businesses that are domiciled in the street (Hillier, 1996). Nevertheless, no paper aims at determining a method to prioritize the creation of new companies based on their localization. Consequently, we propose in our study to fill this gap. However, the originality of this study resides on including a social criteria and perspective along with the business criteria. Our conclusions suggest an innovative relationship between the public and private sectors in order that this latter may contribute in the improvement of the services for the citizens.

For this purpose, we consider the Smart City as a Complex network where streets are links and street intersections are nodes. We develop a heuristic that determines and prioritizes opportunities of new ventures according to their geo-localization in the urban grid. We include as a second variable for our heuristic of localization that the new businesses participate in the improvement of the service of education in the city. This study develops a line of investigation suggested by the recent study developed in the chapter 5 concerning a Smart City initiative called 'Camino escolar' (school road in english) to support children to go to school in an autonomous way.

6.2 Literature review

6.2.1 Localization as a business aspect

Cities are also towns and physical objects, stocks of buildings linked by space and infrastructure. They form an urban grid which Hillier et al. (1993) define as an 'organization of groups of contiguous buildings in outward-facing, fairly regular clumps, amongst which is defined a continuous system of space in the form of intersecting rings, with a greater or lesser degree of overall regularity'. These buildings permit large number of people to live in high dense concentrations without getting on each other's nerves and minimize the effort and energy needed for meeting. Cities are also functional systems where providers offer economic, social, cultural and environmental different services to satisfy citizens' needs. Functional and physical aspects have different dynamics. Forms change indeed slowly while service changes rapidly (Pushkarev and Zupan, 1975). Set up in this way, we could see them as two independent things (Kruger, 1989). Nevertheless, Hillier (1996) analysing deeply their relation defines the principle of natural movement. Natural movement is the proportion of movement on each line that is determined by the structure of the urban grid itself rather than by the presence of specific attractors or magnets. He adds cities are means-ends connected systems in which the means are physical and the ends functional. We apply this model for our study considering the means as streets and the ends as locals and analysing the dynamics of movement.

Every trip in an urban system has three elements: an origin, a destination, and the series of spaces that are passed through on the way from one to the other. Passages through these spaces are by-products of going from a to b (Freeman, 1977; Richter, 2009). The development of city planning as a discipline has been deeply informed by the idea that services and shops of different levels should be consistently located in places of a corresponding level of 'importance' or 'prominence' (Wiener et al., 2008). Location in the grid therefore has a crucial effect. It either increases or diminishes the degree to which the movement by-product is available as potential contact. This applies not only to individual lines but to the groups of lines that make up local areas. Thus there are more or less integrating areas, depending on how the internal structure of the area is married into the larger-scale structure of the grid, and this means also areas with more or less by-product (Dalton, 2003). In other words, some locations have more potential than others because they have more by-product and they therefore tend to have higher densities of business development.

Entrepreneurs, through the creation process of new firms, contribute to economic growth, productivity, and renewal of productive and social networks (Casson, 1982; Baumol, 1993). They help to revitalize local identity creating employment opportunities through a continuous innovation destructive process (Schumpeter, 1934; Audretsch and Thurik, 2001; Kantis et al., 2002). Kolympiris et al. (2014); Minai et al. (2011) suggest that localization is one of the factor that entrepreneurs need to take into account during the process of opportunity definition and analysis. Socio-economic forces shape the city primarily through the relations between movement and the structure of the urban grid. Well-functioning cities can therefore be thought of as 'movement economies' (Hillier, 1996) and the location is a key success factor for the prosperity of the small and local business or its ignition.

6.2.2 Localization as a social aspect

However, many scholars (e.g. Brondi et al., 2012; Kremer-Sadlik et al., 2010; Berti, 1988) propose to pay a different attention to the localisation of the shops on the streets examining the social role that can play a local commerce in the city. The chapter 5 analyses an innovative project developed in Barcelona called 'school road' which aims at securing the movement of 8-12 old children and promoting they go alone to school without any parents nor adults. This experience is present in different countries (e.g. France, Italy, Portugal, Greece) and is based on the recent works realized by Tonucci (1979). In the chapter 5, we determine the different barriers of implementation and ask for a large panel of parents living in the neighbourhood to prioritize them. We observe first of all that the fear that children meet a person with wrong intentions is largely the main concern that limits the success of such initiative. The complete results show however the barriers can be classified into separate clusters such as physical insecurities (e.g. fight between children or injuries) or emotional ones (e.g. crossing unsecured zones or low lighting in the street).

Finally the conclusions of the chapter 5 suggest that a 'trustful adult' could reduce these fears while highlighting this role can be played not only by parents, family or close members deployed all along the school road but also by owners of local shops. They suggest consequently the small business could improve the success of this initiative.

Indeed, local commerce correctly distributed along the different school roads are so many additional 'eyes and arms' that could look what is occurring outside their shops in the streets and provide assistance or support in case of emergency. Children are observed and can interact with adults in order to voice problems. A different experience in the suburban and residential area of Padova involving three classes of 12-year-old shows however the same outcome, that a better interaction between children and adults provide real improvements for the neighbourhood (Dallago et al., 2010). In fact, they could decrease the barriers related to the physical risks that the children are exposed, avoiding fights between youth or alerting on any strange behaviour coming from an adult in the street. Their presence and the light deployed by their shops could help the children to feel more secure to walk alone in the street even very late or early in the morning. By this way, children are able to participate into extracurricular activities which have an important role in order to prepare them for adult life and to emphasize competition as Kremer-Sadlik et al. (2010) conclude it based on a recent study in Los Angeles and in Rome.

As we have seen in the chapter 5, it already exists few shops involved in the school road project that are called 'project-friendly' but we observe the involvement of the local commerce is still limited. Therefore, we may guess the increase of shops involved and their correct localisation to be a key success factor for this school road educative project. Besides, we believe an improvement of the participation could benefit both sides. Indeed, the children while appropriating the district, know its local production and commercial activities and may attract their family and close relationship to visit these 'friendly' shops and influence positively on the business activities of the neighbourhood. Many scholars (e.g. Brandabur and Aldea, 2013; Davidson and Hudson, 1988; Belch et al., 1985; Hawkins and Coney, 1974) agree that young generation have usually an influence regarding the decisions in their families. Informational explosion during the last decade has generated an increasing pressure from the children over their parents in order to obtain various products.

In summary, the localisation of the small shops in the city has been converting in the recent years in a paramount issue for two principal reasons. The entrepreneurship dimension and especially the opportunity identification are the first one and is due to the natural attractiveness factor of the streets inside the complete urban grid (Kolympiris et al., 2014; Mohajeri et al., 2014). The second one is based on the social responsibility that the private companies should assume in front of the civil society (Makovere and Ngirande, 2016; Mcwilliams et al., 2016). However, to the best of our knowledge, no study has considered to analyse both objectives together. While the national economy of Catalonia is slowly recovering (ChamberofCommerce, 2015), entrepreneurs are wondering where to open their new businesses. The aim of the study is to develop a method capable to determine and prioritize new opportunities of ventures for entrepreneurs wishing to succeed covering business and social perspectives.

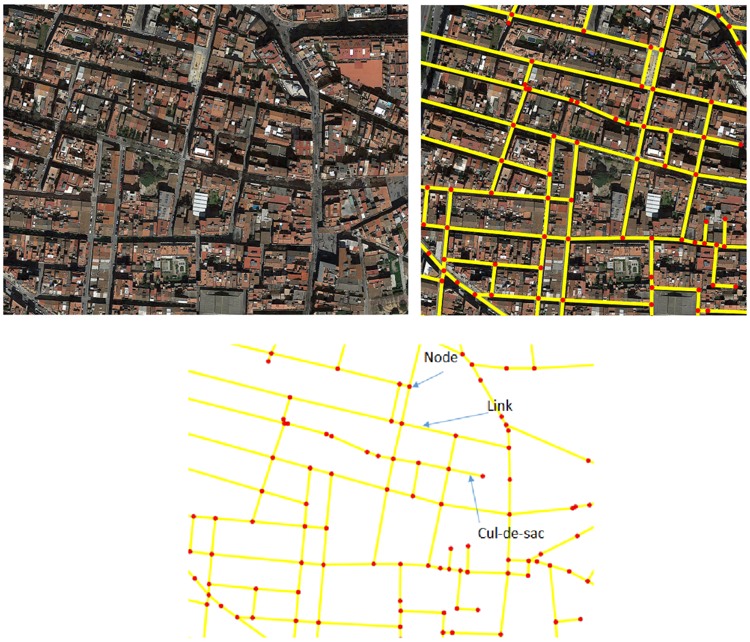

Figure 6.1: Network modeling process

6.3 Methodology

To respond to this objective, our methodology consists on determining a heuristic which recommends and prioritizes amongst the current vacant premises of a same neighbourhood which are the opportunities of entrepreneurship that cover simultaneously business and social criteria. We decided to select the neighbourhood of 'Sant Andreu' in the city of Barcelona to test the effectiveness of our heuristic. We develop hereunder the criteria used.

6.3.1 Business perspective

The vacant shop has to be situated in a street that attracts enough clients to ensure a stable and profitable activity. The relationship between the built environment and walkability has been extensively studied in several knowledge fields, from the purely urban planning realm (Durand et al., 2011) to epidemiological and public health studies (Lee and Moudon, 2006; Nagel et al., 2008). As for our methodology, we have chosen the growing field of studies which models the street layout as a network. All networks are made up of a set of nodes connected together by links. In our case, nodes correspond to intersections between streets. Links are streets joining all nodes or cul-de-sac. Modelling the street layout and the built environment as a network allows us to calculate several measures of network accessibility and flows following the seminal works that Shimbel (1953); Freeman (1977) applied to telecommunications. The figure 6.1 illustrates the modelling process applied for a small area of the case study chosen as an example.

In complex networks, not all nodes are equally important since they are affected by different connections. The quantity of these connections can be a starting point to determine the rank or centrality of each node of the complex network. However, connectivity does not inform about the importance of the node in the network (Barthelemy, 2004). Closeness and betweenness are forms of spatial network analysis grounded in a long standing tradition of measuring accessibility and flow potential. Each measures a form of centrality based on shortest paths through the network; with closeness measuring potential for 'to-movement' while betweenness measuring 'through-movement' (Freeman, 1977). Since our research is intended to analyse the flows of pedestrians and routes to school instead of identifying potential of 'to-movement' (in our case the to-movement is determined by the location of schools), we have focused in betweenness centrality metrics. Betweenness is a form of spatial network measure to calculate flow potential of people by determining routes between all points on the network using the shortest path. It measures the through-movement potential of a street link and is proportional to the estimated count of movement passing through the link from and to all other parts of the network (Sarkar et al., 2015). This measure shows high correlations with vehicle flows (Turner, 2007) and pedestrian movement (Hillier and Iida, 2005; Chiaradia et al., 2014).

Besides, we decide to use as shortest angular path, the route that minimizes angular change, which is widely used as a measure of potential movement (Turner, 2007; Cooper et al., 2014; Dalton, 2003). The reason is that routes with fewer turns are usually easier to remember, reducing cognitive efforts (Richter, 2009; Haque et al., 2007; Wiener et al., 2008). Based on this previous choice, we model the morphology of the built environment using morphometrics calculated through algorithms included in the spatial Design Network Analysis (sDNA) (Chiaradia et al., 2012). We consider the Two-Phase Betweenness parameter for each street link as a proxy of probability of people-flows passing-through the street link and consequently the criteria to measure the business objective in our study area. We calculate it using the following formula:

$$TPBt(x) = \sum_{y}^{N} \sum_{z}^{R_y} OD(y,z,x) * \frac{W(z)P(z)}{totalweight(y)}$$

Where total weight(y) is the total weight in radius from each y. In this formula, y and z are origin and destination points respectively, and the origin weight is distributed over destination weights. It is thus the sum of geodesics that pass through a link x, weighted by the proportion of network quantity accessible from geodesic origin y that is represented by geodesic destination z. The difference between regular betweenness and Two-Phase betweenness is that the later assumes each origin has a fixed amount of weight it can add to betweenness. This fixed quantity is then divided proportionately among the destination weights accessible from that origin for the current radius (Cooper, 2016).

6.3.2 Social perspective

Our study proposes to introduce the possible role of the local shops owners in the participation of social projects in the city. We decided to use the school road project for our specific case study. We believe that if these shops are present and open during the hours of movement of the children, they could play the role of 'trustful adult', providing assistance in case of imminent danger and so participating into their protection. This help is nevertheless possible if the shops are located in the priority lines of the network designed for the project (see the chapter 5 and the definition of the green spider network) and the new shops have to be situated closely to the existing friendly ones. We decide consequently that the average distance walked by the children between two friendly shops is the criteria to measure the achievement of the social objective by the vacant shop.

6.3.3 Heuristic

The heuristic (see algorithm 1) aims at selecting amongst the list of vacant premises in Sant Andreu neighbourhood, the shops that cover the business and social criteria in the following manner:

- Business objective: we consider the vacant shops have to have a Two-Phase betweenness score higher than the average betweenness of all the shops of the neighbourhood to satisfactory leverage the natural movement of the urban grid.

- Social objective: several studies (e.g. Ben-Joseph and S. Szold, 2005; Keating and Dennis, 2000; Frey, 1999; Neuman, 2011; Martín-Ramos, 2012) aim at determining the suitable distance of a block inside a district. Their studies are based on environmental, social, architectonic and economic aspects. They consider parameters like the visual field or the maximum distance that can be covered without facing a physical object or obstacle. Their analysis shows that a large divergence of opinions exist regarding the 'pedestrian friendly distance'. Options vary between 80, 113 (model of the Barcelona 'Eixample' district), even 200 meters for USA cities. For our study, we decide to consider the average of one hundred (100) meters as the maximum distance that the children should walk between two 'friendly shops'. Consequently, a vacant store can become a friendly shop if it is at less than 100 meters from one of any other existing friendly shops. However, so as to avoid the 'massification' of the shops in an area of the urban grid, we introduce as additional requirement that the candidate has to be 50 meters distant at least from all other existing friendly shops. Summarizing, the social criteria defines that the vacant premises are at a separated distance superior to 50 meters to all the existing friendly shops and at least between 50 and 100 meters from one of them.

6.3.4 Method for analysing the heuristic

Adding vacant stores in the network of friendly shops has the natural effect to modify the average distance walked by the children between two friendly shops and to influence the average betweenness of the existing friendly shops. We want to validate that our heuristic is a decisive factor to decrease the average distance walked by the children and that the vacant stores that we propose to open, have an enough attractiveness to set the foundations of a sustainable business. So as to validate it, we code and execute a program which randomly selects locals amongst the list of 777 vacant ones. We run this program 100 times. We obtain a sampling of data which is statistically representative to be contrasted against the results issued by our method. The comparison has the objective to check the efficiency of our heuristic.

6.3.5 The case of Sant Andreu

We decided to select the case of Barcelona city and more specifically one of its popular district 'Sant Andreu' located on the eastern side of the city. As far as it concerns its commercial activities, Sant Andreu counts 3.435 local shops distributed as described in the table 6.1.

```
Data: List of the open shops with their localization in the neighbourhood (L_open)
Data: List of the vacant stores with their localization in the neighbourhood (L_vacant)
Data: List of the shops participating in the school road Project (SRP) in the neighbourhood
      (L_srp)
Pre-Process:
begin
    Build a matrix calculating the shortest distance between the vacant stores and the
    shops which participates in the SRP (M_com)
    Build an empty list with the partial solution where to add the selected vacant stores
    (LP_sol)
    Build an empty list with the final solution where to add the selected vacant stores
    (LF_sol)
end
Process:
begin
    while the list of vacant stores (L_vacant) is not empty do
        Select the first shop (S_vacant) from the list of the vacant stores (L_vacant)
        Select the shop (S_srp) from the list of the shops which participate in the SRP (L_srp)
        closest to (S_vacant) according to (M_com)
        if the distance between both selected shops (S_vacant) and (S_srp) is between 50 and
        100 meters then
            Add the selected vacant store (S_vacant) to the partial solution (LP_sol)
        end
        Remove the selected vacant store from the list of vacant stores (L_vacant)
    end
    Calculate the average betweenness (AB) of the network of the open shops (L_open)
    Calculate the betweenness (L_betw) of the previous selected vacant stores (LP_sol)
    Add every selected vacant stores (LP_sol) to the final solution (LF_sol) when its
    betweenness (L_betw) is greater than the average betweenness of the network of the
    open shops (AB)
end
```

Algorithm 1: Heuristic of the nearest friendly shop

Table 6.1: Commercial distribution of Sant Andreu district

Sector of activities	Percentage
Goods for house (furniture, clothes,...)	6.1%
Goods for mean & women	9.4%
Culture & Entertainment	3.5%
Eating & Drinking	15%
Professional services (lawyer, real-estate, dentist,..)	37.8%
Bars & Restaurants	16%
Private Transports (dealership, private bus,...)	5.5%
Closed locals	17.2%

Regardless the recent financial crisis that the whole country has suffered, the large works initiated in 2009 to create a fast-speed train station in the centre of the neighbourhood (called 'Sagrera') have drastically hindered the pedestrian mobility and may explain why 777 small businesses are vacant today. This neighbourhood joined in 2000 the initiative of school road and formed part of the study presented in the chapter 5. 135 shops were as of 2015 end, friendly shops. As far as it concerns its grid structure, Sant Andreu neighbourhood is comprised of 720 streets links and 1.762 nodes. We choose as scale of interest (the network radius) the distance of 1km for our betweenness computation. 1km permits to reach the whole neighbourhood and is a possible distance to travel by foot to go to work or for shopping, outdoor activities, etc. The average betweenness of all the shops is 117. Consequently, the locals selected by our heuristic have to have a betweenness above this value.

The information related to the localisation of the local shops is provided by the database developed and maintained by the Eixos Economic observatory[1]. To execute our heuristic, we use Quantum GIS (QGIS) software platform, a free and open-source desktop geographic information system (GIS) application. QGIS allows us to create maps composed of either raster or vector layers and based on the geo-localisation of all the shops (vacant or open). The vector data is stored as either point or line or poly-lines and allows to provide data viewing, editing, and analysis.

The data from Sant Andreu for the heuristic are:

- A list of 3.435 open shops with their localization in Sant Andreu (Lopen),
- A list of 777 vacant stores with their localization in Sant Andreu (Lvacant),
- A list of the 135 shops participating in the school road Project (SRP) in Sant Andreu (Lsrp).

And our results are presented hereafter.

[1] http://www.eixos.cat

Figure 6.2: Betweenness representation

6.4 Results

The figure 6.2 draws all the streets of the Sant Andreu neighbourhood. On the left, betweenness is represented by a colour code: red for higher and blue for lower scores and on the right as a heat map of colour with its intensity gradation. We observe five main and long red lines which unsurprising are the main commercial arteries of the neighbourhood. The right side is the bordering zone to the large infrastructure works realised for the Sagrera fast-speed new train station which is still in progress after many years. Many streets in this ad-hoc area are vacant off converted in cul-de-sac. That explains why they appear as blue lines.

After executing the heuristic defined in the methodology section, we obtain our results that we compare with the sampling of data randomly built. Our findings are presented in the figure 6.3. Our heuristic has precisely selected 50 vacant stores applying the business and social both criteria already explained. The situation as of today is represented in red, the blue represents the results of the heuristic while the green are the different sets of 50 locals randomly determined. We observe that our heuristic improves the average distance from 47.60 to 40.96 meters and the average betweenness from 181.41 to 236.50. Amongst the sets randomly determined, 96% has an average distance higher than the heuristic one and 100% has an average betweenness lower than the heuristic one. Consequently, the 100 datasets randomly calculated never achieved both conditions.

However, four random sets of the 50 vacant stores have an average distance inferior (means better) than the heuristic one. If we analyse them in detail, we identify a common pattern. The random process has selected four times locals that are grouped in a specific area of the neighbourhood, close to the building

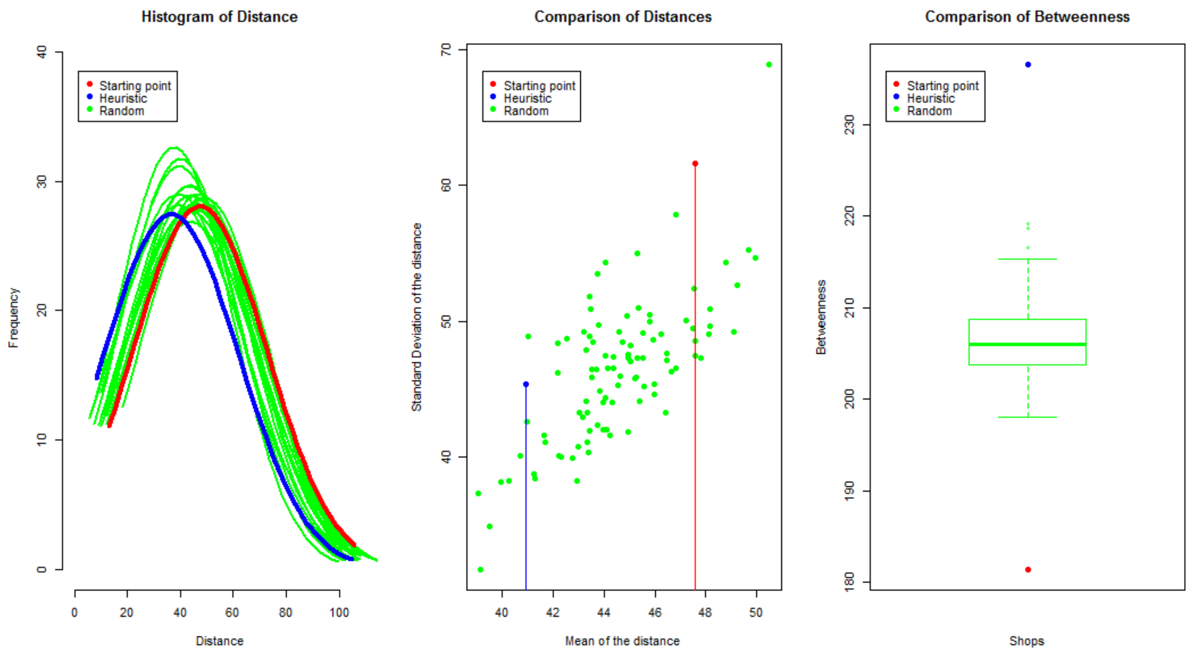

Figure 6.3: Business and social success factors

works of the Sagrera train station (see figure 6.2). This area has a large number of vacant stores (due to the negative impact that these construction works have produced) which increases the probability to be selected. But these 4 sets have the lowest betweenness average scores since the locals are badly situated as far as it concerns the attractiveness of the business that they can host. Consequently these 4 sets do not fulfil the business and social both objectives required by our methodology. We conclude our heuristic is effective in the specific case of Sant Andreu.

The figure 6.4 shows on the left with green circles the current network of 135 friendly shops and on the right, forecasts how this network would be if we add the 50 vacant stores determined by our heuristic (with red circles).

6.5 Discussion and conclusions

6.5.1 Social enterprise

In the last years, the application of entrepreneurial approaches to social issues has been institutionalized in an innovative concept called social enterprise. Nevertheless, to the best of our knowledge the field remains largely limited to anecdotal case studies and instrumental analyses of efficiency and operational best practices (Leadbeater, 1997; Bornstein, 2004; Nicholls, 2006). Moreover, the definition of social enterprise has been progressing while the debate concerning the business model was also evolving. Cornelius et al. (2008) using the definition of the UK Department of Trade and Industry understand social enterprises as new ventures with social objectives, whereby profits are reinvested in the business or other initiatives to further support social purposes. Leadbeater (2006) proposes another way to define social entrepreneurship

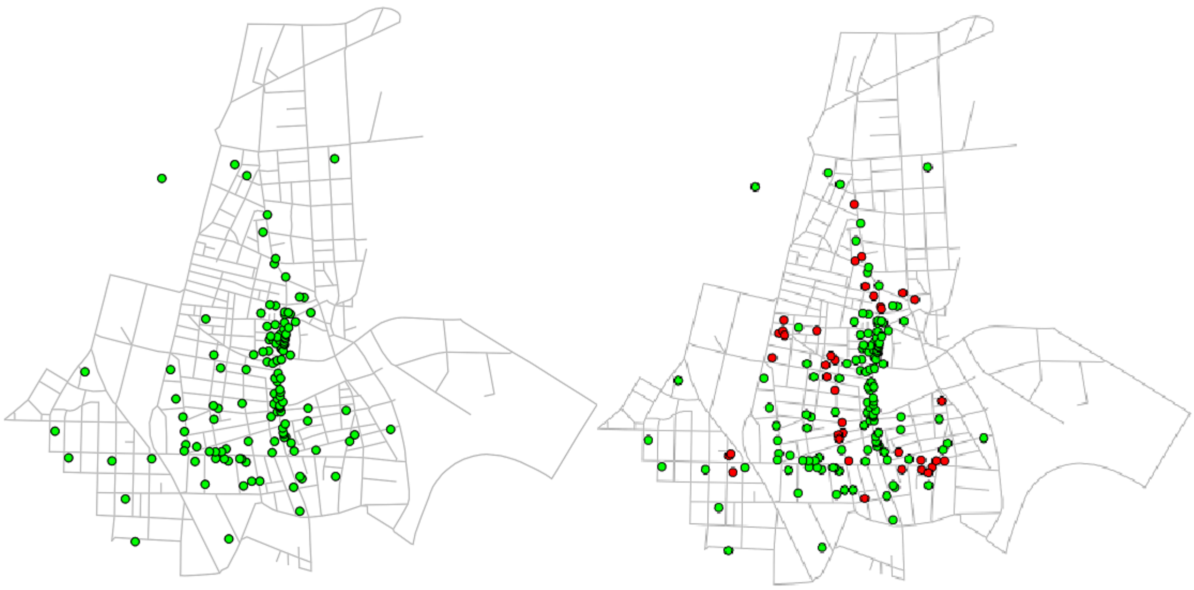

Figure 6.4: Localization of the friendly shops before and after the heuristic

through its outcomes stating the following definition: 'anyone who creates lasting social value through entrepreneurial activities'. From this perspective, we think that our case study providing a list of business opportunities able to support social objectives entitles the owners of the future shops to be named social entrepreneurs.

Nevertheless, our case study sheds light on a different model of social entrepreneurship and how it can be scaled. Nicholls (2006) introduces for the first time the concept of networked social entrepreneurship whose aim is not to grow as a single organization but to achieve greater impact through a network of collaborators and partners. In the case of Sant Andreu, the partners are the owners of the shops coordinated by the City Hall which acts as the core of the network. The district's council mobilize resources that lie in households (parents), civil society (teachers, parents' association) and private sector. Networked entrepreneurship implies a different model of leadership, governance and growth. Traditional business tools used to scale and manage organization in silos do not work (Bornstein, 2004) and so, further investigation should wonder which ones are adapted to the school road initiative.

However, it is paramount to understand how the objectives of social entrepreneurship may differ from the non-social firms. Jeff Skoll, co-founder of eBay, created a foundation and donated 4.4 million pounds to establish a research center for social entrepreneurship[2]. The Skoll Foundation comments that unlike business entrepreneurs motivated by profits, social entrepreneurs are to seize opportunities or approaches to create sustainable solutions to change society for better. Social entrepreneurs focus first on generating social value instead of maximizing profit for shareholders and other stakeholders. The social entrepreneur

[2] `http://www.skollfoundation.org`

of our case differs from this definition since financial and social value have the same level of importance. Alter (2000) analyses the recipients of a social enterprise and clarifies that 'a social-purpose business is founded to support or create economic opportunities for poor or disadvantaged populations while simultaneously operating with reference to the financial bottom line'. However, this assertion doesn't cover the environment of our study either. In our case, the receivers of these opportunities are not underprivileged class but a forgotten or abandoned group of the population with good or high literacy level. Actually, Vidal (2007) analysing the Spanish context confirms that the increasing amount of social enterprises in Spain are due to the economic crisis touching largely the young generation without regard to their academic level. As further lines of investigation we suggest to study how to empower the young citizens in a social entrepreneurship attitude as an alternative of employment.

If our study provides with a list of localizations in the urban grid, it does not cover the question related to the nature of the business opportunity. We know the opportunity to generate and capture value differs as per the type of business: some of them indeed satisfy daily and vital customer's needs (like consumer products and goods), others are commercial establishments that need to develop special offers to attract and keep retained their clients' base (clothing, pharmacy, furniture stores,...). The scientific contributions devoted to explain how social entrepreneurship ventures are identified and how the respective opportunity is managed are quite scanty. Nevertheless, most of the literature (e.g. Nicholls, 2006; Perrini and Vurro, 2006; Dorado and Haettich, 2001) agree to consider them as a process of three phases which are: the opportunity definition, the organizational launch and the financial resource collection, even if the first step is the most explored aspect (Mair and Martí, 2006; Guclu, A., Dees, J. G., & Anderson, 2002). We believe further lines of investigation could insert in the method a parameter related to the business nature. We guess that some locations are more favourable for daily businesses, others not so much and an upgraded heuristic should verify it.

6.5.2 Public entrepreneurship

Having defined what social entrepreneurship is, we focus now on the specific role that the public sector could play. Spear (2006) analyses different social entrepreneurship initiatives and observes that most of them have significant support from external stakeholders like government or City Hall structures. This point raises the question on the rationale for the public government to decide where to support geographically the local entrepreneurship and in which type of business its restricted resources can be best allocated. This decision implies an important risk of failure, so we make these two recommendations:

- New technologies like 3D printing, Big Data, Internet of things allow to produce customized products matching better to the rapidly changing needs of the customers. They are a chance to recover the jobs lost during the 1990's where our production capacities were outsourced in Asia (Grimaldi and Fernandez, 2016). Many cities in Europe have implemented Fabric Laboratories (FabLab) where residents have capacities to prototype their invention and manufacture products. We believe public managers should support in priority ventures leveraging these emerging technologies.
- The hours of opening and closing of the shops depend largely on the type of activity. Many businesses have to attract the citizens to the shops (e.g. retail), others are not public-oriented but based on appointments (professional services like lawyer, bank, insurance, etc.). In both cases and if they

want to support the school road project, their opening hours should be adapted to those of the school schedule. For instance, children are in the street to go to school from 8:30 to 9:00 in the morning while most of the retail shops starts at 10:00. Consequently, we believe public managers should proactively propose a compensation to the companies ready to adapt their hours of business.

The three management characteristics that we have just commented (risk taking, innovativeness through emerging technologies, proactiveness) are generally means of achieving less inefficiency and inflexibility through promoting managerial improvement. Suggesting to translate them for the public sector represents an important change of culture especially in the countries largely dominated by a social-democratic vision (France, Spain, Italy, Germany,...). But many scholars (e.g. Morris and Jones, 1999; Morris and Kuratko, 2002; Stevenson and Jarillo-Mossi, 1990) define precisely public entrepreneurship the action to apply these good practices into the public sector. We believe as they do that they are the requirements to revitalize local or central government performance with the final goal of creating value for the citizens.

However, important challenges exist to implement this new strategy. In the public sector, failures resulting from risk taking are less acceptable because of the need for accountability and responsiveness. As a result, public employees are inclined to avoid risky alternatives in decision making (Berman and West, 1998). We can learn on positive experience like Curitiba one, a city in central Brazil developing an entirely new urban system for dealing with waste and producing a more environmentally sustainable city (Leadbeater, 2006). The council did not develop its own proper solution but stimulated it with financial resources while proposing services of support for private entrepreneurship. Barcelona City Council should inspire from Curitiba experience, multiply the initiatives of social entrepreneurship (through the different organisms of support to the entrepreneurship like Barcelona Activa[3]) and extend them in all the fields of the city: waste management, transport, facility management, etc.

[3] `http://www.barcelonactiva.cat`

Chapter 7

Final Conclusions

In this chapter, I present the final conclusions of my doctoral thesis that I have divided into three parts. In the first part, I provide an analysis that embrace the four studies presented. In the second part, I give a feedback on the learning process that I have followed and explain how this doctoral thesis has transformed my professional life as teacher and researcher. In the last part, I propose further global lines of research.

7.1 General conclusions

The Smart City new paradigm has emphasized the role of the technology and the science in the debate of the future of the cities. The city is not only a sum of physical spaces but also of network systems and flows. Complexity science applied in the Network theory are the foundations of this new science of cities. Nevertheless, universities have remained in the surface. Indeed, the current academic curricula don't prepare the students to manage the disrupting technologies which will build the new urban services that the citizens require (chapter 3). As a consequence, urban leaders search outside new ideas fostering collaboration between cities like the RECI[1] (the Spanish Smart City association) or the Smart City Council[2]. We observe consequently the Triple-Helix concept is no longer a sufficient model and we suggest a Quadruple-Helix one including the citizens' role. However, the financial health situation of the public sector has compelled its managers to move from an administration role (in charge of budgeting and spending large State investments) to a leading role fostering the generation of business ecosystems. In that conditions, social entrepreneurship is a win-win relationship between private and public sectors which allows that economical and social objectives are met together (chapter 6).

Making business in the city does no longer follow the rules of Porter's standard supply chain model. In the chapter 4, we analysed the new conditions of value creation and capture for companies developing

[1] http://www.redciudadesinteligentes.es
[2] http://smartcitiescouncil.com

the actual services of the city. The City Hall by encouraging Internet of Things (IoT) platform of services fosters the growth of local companies. In the domain of transport, we observed in the chapter 4 also, these economic benefits were not contradictory with an improvement of the citizens' quality of life. This platform reduces the number of traffic accidents, decreases the NO2 pollution and the driving cruising time. Moreover, this study highlights the active role played by the citizens able to moderate the value creation of a business ecosystem. In the domain of the education, the chapter 5 showed that the barriers that impede the autonomy of the 8-12 years' old children in their road to school can be mitigated by the presence and the engagement of the citizens in the Smart City.

The Complexity science underpins the creation of Smart Cities by considering the urban zone as a grid where streets are links and street intersections are nodes. This theory shows that not all the nodes are equally important. The shops situated in the more central ones capture most of the movement in the city and so, are the best opportunities for an incipient entrepreneurial project. The last part of my thesis defined and validated a heuristic which covers social and business perspectives together. It demonstrates that starting a new business in the city may follow scientific and complex rules in order to evaluate the best vacant location inside the urban grid (chapter 6). It is an important asset to be considered by the storekeepers as an alternative to the common sense usually practised.

7.2 Personal implications

In 2014, I left my executive position in an international consulting company and actively looked for an opportunity to start a new professional career as teacher and researcher. I knew the first milestone was to get a Ph.D degree. I couldn't say I considered it as a huge jump at the beginning since I had been teaching for 8 years since 2006 and my job of consultant gave me some assurance in my capacity of adaptation in front of any new situation. Nevertheless, I need to confess that I was wrong. I hadn't no clue on the skills and knowledge required to a professor to conduct a good research and honestly I was not prepared at all. My first meeting with Vicenc exceeded my expectations opening me the path to the ambition I had set. I had to say (and sorry if I repeat myself) that I have really appreciated the almost three years I have spent investigating under his direction. The news were not always good like a quick desk reject of an article but I had the feeling I was progressing well. Indeed, within 16 months, our first article was accepted in a Tier 2 referenced journal.

Moreover, the richness of a subject like Smart City, the large scope of this topic that allows to cover different subjects like supply chain, digital business model, innovation, marketing, entrepreneurship generated me a lot of enthusiasm. Moreover, the availability of my advisor able to respond me quickly, providing me the necessary guidelines, made me possible to conduct a large variety of studies: quantitative researches defining and validating theoretical model and complex heuristic along with qualitative ones based on large public survey or semi-closed questionnaire. I modestly believe that in less than three years, I had to resolve many situations that a researcher could face in his professional life. Besides, by learning additional scientific tools and methods, this period changed positively my way to tutor the thesis projects of my students in masters and bachelors. Finally, I have to add that my themes of research were perfect cases studies for my courses. By sharing them, I was able to generate discussion in class on my preliminary conclusions taking away feedbacks and constructive comments from my students also.

7.3 Further researches

Cities require start-ups and new businesses that are fully aligned with the challenges they face and able to develop solutions for the citizen's sake (Richter et al., 2015). Our research shows these needs can be covered by products that are beneficial for the quality of life, social progress while keeping the economy growing at the same time. These products that form the basis of these business needs safeguard jobs in the cities and are tailored to meet the specific citizens' expectations. Considering the emerging technologies play a major role, the question arises how to meet the accompanying demand for electricity (Etezadzadeh, 2014). Overall improvements in utilities efficiency and a systemic reduction of power consumption have retained a large interest of the scientific community in the energy academic field (Bartusch et al., 2010, 2011; Derakhshan et al., 2016). However, further researches should investigate also the entrepreneurship perspective i.e. how these solutions may represent opportunities for start-ups and rise employment.

An urban energy revolution is required to accompany what we usually call the third industrial revolution (chapter 6). In a future city, power generation will be based on the implementation of a smart grid and will be decentralized. Consumers (e.g. households, public facilities, businesses) will largely produce energy themselves. Decentralized power plants operated by the municipal utility company will supplement those energy market structures to supply power to smaller consumer blocks and power units will operate on the basis of renewable energy. New business models and new value creation chains will emerge on the basis of inter-sectoral cooperation. They will be digitized. Big Data will become smart data (Rong et al., 2016). Software programs will recommend actions based on complex analyses and establish business optimization measures for entire value creation chains. Embedded systems in the form of miniature implants and subsequently in the form of nano-computers will help Web users to take decisions. Web 4.0 users will replace the actual Web 3.0 users that we are, with our portable devices and high-speed mobile access to Internet. Automated personal virtual agents will communicate with users directly and in a humanized manner. The world and its processes could be largely controlled by a supra-computer whether intentionally or not.

We described and analysed in the chapter 4 a disruptive business ecosystem aimed at improving the transport in the city and based on an IoT platform model. We examined the paramount role of the citizens which moderate the outputs of this platform limiting or exceeding the commercial results of the parking solution provider. Citizens as Web 3.0 users interact with the machines (sensors, mobile phones, parking displays, etc.) and receive in return an additional value (the positioning of a vacant parking slot). However, our study does not cover the financing model of this IoT solution. In the case of the Connected Boulevard initiative, the Cisco investments were paid by the Nice City Hall and so indirectly charged to the citizens. In the digital world, few firms (e.g. Google, Facebook, Ebay, Linkedin, Netflix, Airbnb...) have successfully found sustainable funding models (freemium, pay-on-the-go, profile-based monthly tariffs, etc.) asking directly the customers to pay for the additional value they provide. Since others still struggle to create a profitable business logic (e.g. Wallapop, Twitter, Dropbox, Spotify, Deezer, Zipcar, ...), further investigation should list, classify and study the different existing financing models and propose conditions to start a business ecosystem based on an IoT platform.

In the chapter 3, we classified the new services that the Smart City offers to the citizens and the cornerstone role of the technology. We previously commented that cities before being smart had to be connected, sustainable and human. But cities and societies are vulnerable also. Terrorist attacks such as occurred in 2015 in Paris or 2016 in Brussels or Munich and accidents due to technical failure or human error remind us of this, as do natural disasters that are more frequently today associated with climate change. Further investigations should consider that Smart City needs to be 'resilient' too. Etezadzadeh (2014) defines 'Resilience' as the ability to prevent actual or potentially adverse events from occurring, to take them, cope with them and adapt to them more and more successfully. Attacks can be cyber-attacks and resilience has to be digital as well, preventing from manipulating critical infrastructure through internet. Further lines of investigation should study how technologies enable cities to be prepared to these new risks while being self-sufficient to a certain degree which entails urban production and a local supply of food. Few start-ups have identified the resilience issue as a business opportunity and explore solutions that they already propose to the cities (e.g. the catalan Opticities startup[3]).

Please allow me to close this research with this final statement. I believe that the experiences presented all along this thesis demonstrate the existence of a first generation of Smart City (let's call it 1.0). It is time to build the second generation of Smart City (2.0) that I would describe as follows: 'it is an interconnected and integrated community of active citizens providing innovative professional services in a more resilient and sustainable way. Its behaviour is oriented to the 'pro-sumption' i.e. mixing production and consumption of the urban systems. Nothing is wasted but reused and everything participates inside a circular economy. Residents create their proper job and the university teach them about the role of the emerging technologies. They employ technical facilities provided by the public government but do not allow technology to dominate their life or acquire decision-making authority'.

[3] http://www.opticities.com

APPENDIX A

Appendix A: Interview Protocol

The goal of these interviews is to have a comprehensive understanding of Smart City initiative strategy and to understand how Information and Communication Technology (ICT) companies are currently working to provide solutions for its implementation. This questionnaire forms part of the first study (chapter 3).

A.1 Sampling

Amongst the different actors of the Smart City projects launched in Barcelona, we have selected a list of eight experts applying strictly the following rules:

- The panellists have different background/profile (city managers, global consulting company, niche and local consulting company, academic from Smart Cities master).
- They have been directly engaged in one of the main initiatives of Smart Cities in Barcelona in the last 5 years.
- They hold a senior position in their respective organization.

The selection is presented in the table A.1.

A.2 Interview introduction

'Good morning Mr or Miss XXXXX.

First of all, I'd like to thank you for accepting this meeting and sharing information with me. I know your time is more valuable. The interview will last 60 minutes and will be recorded so as to facilitate the analysis of the information provided. All the information will be handled as confidential and anonymous and stored in the project folder in such way that it is impossible to link the content with the transmitter. I'm interested in the different projects of Smart Cities launched and by the real impact perceived by the

Id.	Name	Job title
1	Josep-Ramon Ferrer Escoda	Barcelona City Council Smart City Director
2	Vicente Guallart	Barcelona City Council Chief Architect
3	Tomas Díez	Director at Fab Lab Barcelona
4	Josep Miquel Piqué	Barcelona City Council Vice President at IASP (Urban Lab)
5	Joan Manel Martin Almansa	Managing Director at Fundacio i2cat Living Lab
6	Graham Colclough	UrbanDNA startup Partner
7	Angel Talamona	Capgemini Smart City Solutions Director
8	Agustín Zaballos	La Salle Research Area Director

Table A.1: First study - list of experts

citizens. I have a questionnaire prepared that I will use as a guideline of the session to ascertain I will not forget any relevant point. So let's start and talk about the different initiatives that I'd like to understand better.'

A.3 Interview script

The interview script declines in a holistic approach the different elements that constitute a strategy taking into account an internal analysis and the external environment. For this purpose, we have used and adapted the Strategic Capabilities Network modelling technique (IBM Patent US 6249768) that breaks down a strategy into the three following disciplines: Vision and Strategy, Value, Design and Organization.

A.3.1 Discipline 1: mission, vision and strategy

This section aims at responding to how the organization creates, captures and sustains value. It allows to understand the context, the global strategy applied along with the functional strategy regarding communication and marketing areas. We want to understand the desired objectives of each Smart City initiative and detect the gap between the real and the wished situations.

1. What are the vision, strategy and objectives of this initiative?
2. Do you think this project is well pushed and with the correct sponsor?
3. Do you think you have competitors and so how do you intend to differentiate yourself?
4. Who are your clients? Do you have enough demand?
5. What are the drivers to increase the demand?
6. Do exist client to retain? To grow? To select from the market?
7. Which segments are attractive candidates/opportunities given your competition position?
8. Who are your providers? Do they meet their objectives?
9. Do exist relevant substitutes? Are you unique in Barcelona? Impact for you?

10. Do exist relevant complimenters? Who they are? Private or Pubic? Impact for you?
11. Will new or emerging technologies affecting client's demand become an issue for you?
12. Which channels used to address your clients? Are they enough?
13. Does customer value proposition match with your business model?

A.3.2 Discipline 2: value proposition

This section aims at determining the value captured of the Smart City initiatives and the economic equation result. It allows to understand if the different projects provide the capacities and the value (not only financial but also emotional and psychological) for their clients.

1. What capabilities do you have to create and capture value for your clients?
2. Do you need additional capabilities or competencies to support all customers including financing support?
3. What are the benefits for the clients? Tangible and intangible?
4. With these capabilities, do the clients benefits more services at lower price? available quicker?
5. With these capabilities, do the Clients increase his financial situation? improve their labour conditions?
6. How do you measure value captured? Are we answering to clients' needs?
7. What is the performance of your products/services?
8. Does exist a psychological or emotional value for the customer? or other intangible one?

A.3.3 Discipline 3: design and organization

This section aims at responding which kind of organization has been built to deliver the desired value. It allows to understand the current situation of the organization and the roles and responsibilities for each initiative.

1. Is the Smart City initiative organization structure aligned with client needs?
2. Who is in charge to monitor Smart Cities initiative performance?
3. How should the organization be structured?
4. What should be the roles and responsibilities between private and public sectors?
5. What do you do to increase organization performance?
6. What knowledge is available within the organization that is not used?
7. Are knowledge assets created or found?
8. How do you capture innovation?
9. Does the current technological environment support your business strategy?
10. Does exist financial barrier to deploy IT solution?

APPENDIX B

Appendix B: Data model description

In our model, we have integrated huge amount of data from several different sources and format. Urbiotica provided us with parking event transaction data, which were extracted from a Hadoop distributed file system. Since there is more than 5.000 parking sensors, constantly recording events to the system, the data amount is growing in line with the number of sensors installed. We totally extracted more than 32 million transaction from the Hadoop file system. By using Microsoft SQL Server Integration Services (SSIS), we were able to handle data quality problems, geo-code accident locations, and enable flexible and fast creation of different dataset for analyses. The data model is presented in the figure B.1. It forms part of the second study (chapter 4).

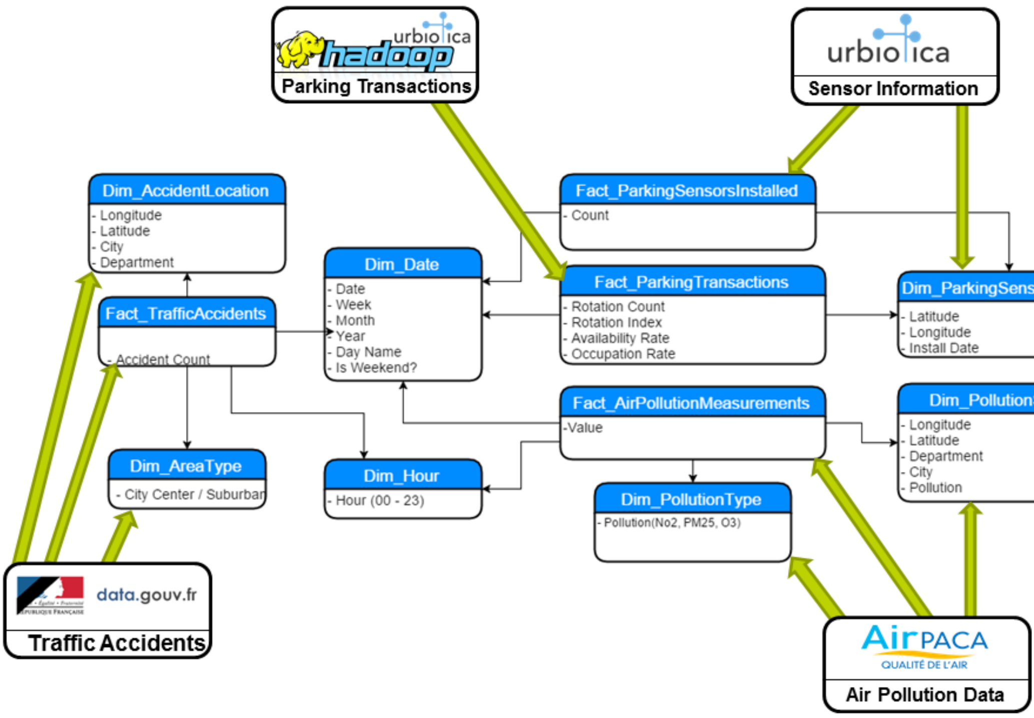

Figure B.1: Internet of Things platform data model

APPENDIX C

Appendix C: Survey template

The goal of this survey is to classify and prioritize the list of barriers against the school road project. It was conducted during the first phase of the study presented in the chapter 5. The questionnaire is enclosed below as it was distributed to the parents of the four schools of Sant Andreu and Sant Marti Barcelona districts.

C.1 Survey questionnaire

The questionnaire C.1 has two parts. In the first part, demographic and background characteristics are collected for an understanding of the composition of the sample. The second part includes a list of 12 statements which each of them is related to one of the barriers identified in the chapter 5.

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Iniciativa Camino Escolar

Soy Didier Grimaldi, profesor en la UPF e investigador en la UPC. Estamos estudiando cómo deberían ser nuestras ciudades en el futuro. Esta investigación en particular está centrada en el 'camino escolar', una iniciativa educativa para que los niños de 3º a 6º de primaria vayan solos y seguros a la escuela. Este cuestionario es anónimo y forma parte de una línea de investigación de la UPC. Le ruego que rellene el cuestionario, tan sólo le llevará 10 minutos.

¿Soy hombre o mujer?	Hombre – Mujer
¿Su edad?	_______ años
¿Su nivel de estudios?	Primarios – Secundarios – Universitarios
¿Qué edad(es) tiene(n) todos su(s) hijo(s)?	______, ______, ______, ______, ______ años
¿Cuánto tiempo tarda(n) de media para ir al colegio?	_______ minutos aprox.
¿Qué distancia hay entre su casa y el colegio?	_______ metros aprox.

Preguntas específicas:

¿En general, su(s) hijo(s) va(n) solo(s) al colegio?	**Sí** o **No**
¿Va(n) solo(s) a raíz de la iniciativa "Camino escolar"?	**Sí** o **No**

A continuación, le presento algunas afirmaciones que le pediría que valorase de 1 a 5 marcando la casilla: 1: si está completamente en desacuerdo, 2: en bastante desacuerdo, 3: sin opinión actualmente, 4: si está bastante de acuerdo, 5: completamente de acuerdo.

Afirmaciones a valorar	**1**	**2**	**3**	**4**	**5**
Me preocupa que la distribución o el sentido actual de las calles pueda provocar situaciones de peligro (accidentes, atropellos,...) camino al colegio					
Me preocupa que el estado del alumbramiento de las calles en los horarios con poco luz natural pueda provocar situaciones de peligro camino al colegio					
Me preocupa que el estado actual (el pavimento) de las calles pueda provocar situaciones de peligro camino al colegio					
Me preocupa que extraños (adultos) puedan generar situaciones de peligro (hacer daño, robar, raptar,...) a los niños camino al colegio					
Me preocupa que otros niños le puedan generar situaciones de peligro (molestar,...) a mi(s) hijo(s) camino al colegio					
Me preocupa que los niños tengan que caminar mucho hasta el colegio					
Me preocupa no estar yo mismo cerca de los niños en caso de una emergencia (dolor de cabeza, de barriga,...) camino al colegio					
Me preocupa que no puedan acudir a *alguien conocido* en caso de una emergencia (dolor de cabeza, de barriga,...) camino al colegio					
Me preocupa que no haya ninguna persona en la calle en caso de una emergencia (dolor de cabeza, de barriga,...) camino al colegio					
Me preocupa que los niños tengan que recorrer calles o espacios con poco ambiente comercial/personas (es decir, casi desérticos) camino al colegio					
Me preocupa que los niños tengan que recorrer calles a ciertas horas del día (muy temprano o muy tarde) camino al colegio					
Me preocupa tener que delegar la responsabilidad (a uno de mis hijos mayores) de acompañar a su(s) hermano(s) pequeño(s) - *Sólo si es el caso*					
Comentarios:					

Por favor, entregue este formulario a la escuela. Muchas gracias por su participación. Cualquier pregunta, no dude en contactar conmigo directamente a través del correo a Didier.Grimaldi@bsm.upf.edu

Figure C.1: Survey questionnaire to prioritize barriers against the school road project

References

Accenture (2011). Building and managing an intelligent city. *Accenture*.

Adner, R. (2006). Match your innovation strategy to your innovation ecosystem.

Adner, R. (2013). Value creation in innovation ecosystems: how the structure of technological interpedence affects firm performance in new technology generations. *Strategic Management Journal*, 894(June 2006):12.

Allwinkle, S. and Cruickshank, P. (2011). Creating Smart-er Cities: An Overview. *Journal of Urban Technology*, 18(2):1–16.

Alter, K. (2000). *Managing the Double Bottom Line: A business planning reference guide for social enterprises*. Washington, DC, pact publi edition.

Angelidou, M. (2014). Smart city policies: A spatial approach. *Cities*, 41:S3–S11.

Angelidou, M., Gountaras, N., and Tarani, P. (2012). Engaging digital services for the creation of urban knowledge ecosystems: the case of Thermi, Greece. *International Journal of Knowledge-Based Development*, 3(4):331.

Anggraeni, E., Hartigh, E. D., and Zegveld, M. (2007). Business ecosystem as a perspective for studying the relations between firms and their business networks. *Eccon 2007*, pages 1–28.

Armeni, I. and Chorianopoulos, K. (2013). Pedestrian Navigation and Shortest Path: Preference Versus Distance. *In: Workshop Proc. of the 9th Intelligent Environments. AISE.*, 17:647–652.

Armstrong, N. (1993). Independent mobility and children's physical development. *Children's transport and the quality of life*, pages 35–43.

Assadian, A. and Nejati, M. (2011). Challenges Faced by Megacities in the Future. *Information Resources Management Journal*, 24(2):76–88.

Atzori, L., Iera, A., and Morabito, G. (2010). The internet of things: A survey. *Computer Networks, 54(15),*, pages 2787–2805.

Audretsch, D. and Thurik, R. (2001). What is new about the new economy? Sources of growth in the managed and entrepreneurial economy. *Industrial and Corporate Change*, 10(1):267–315.

Awbrey, S. and Awbrey, J. (2001). Conceptual Barriers to Creating Integrative Universities. *Organization*, 8(2):269–284.

Badalian, R. (2015). IoT: The gateway to sensor data analytics. *Advancing Microelectronics*, 42(3):6–8.

Bakici, T., Almirall, E., and Wareham, J. (2012). A Smart City Initiative: the Case of Barcelona. *Journal of the Knowledge Economy*, 4(2):135–148.

Barber, B. R. (2013). *If mayors ruled the world : dysfunctional nations, rising cities*.

Barras, R. (1986). Towards a theory of innovation in services. *Research Policy*, 15(4):161–173.

Barthelemy, M. (2004). Betweenness centrality in large complex networks. *European Physical Journal B*, 38(2):163–168.

Bartusch, C., Larsson, M., Wallin, F., and Wester, L. (2010). Potential of hourly settlements in the residential sector of the Swedish electricity marketestimations of risk reduction and economic result. volume 7, pages 224–240.

Bartusch, C., Wallin, F., Odlare, M., Vassileva, I., and Wester, L. (2011). Introducing a demand-based electricity distribution tariff in the residential sector: Demand response and customer perception. 39(9):5008–5025.

Batlle, J., Majo, A., Ventura, J., Vila, M., and Ponti, I. (2011). Interviews. *Barcelona City Council*.

Bauman, A., Rissel, C., Garrard, J., Ker, I., Speidel, R., and Fishman, E. (2008). Cycling: Getting Australia moving - Barriers, facilitators and interventions to get more Australians physically active through cycling. In *31st Australasian Transport Research Forum, ATRF 2008*, pages 593–601.

Baumol, W. (1993). Formal Entrepreneurship Theory in Economics: Existence and Bounds. *Journal of Business Venturing*, 8(3):197–210.

Belch, G. E., Belch, M. A., and Ceresino, G. (1985). Parental and teenage child influences in family decision making. *Journal of Business Research*, 13(2):163–176.

Ben-Joseph, E. and S. Szold, T. (2005). *Regulating Place: Standards and the Shaping of Urban America*. Routledge edition.

Berman, B. (2012). 3-D printing: The new industrial revolution. *Business Horizons*, 55(2):155–162.

Berman, E. M. and West, J. P. (1998). Responsible risk-taking. *Public Administration Review*, (58):346–352.

Berti, A. E. (1988). The Development of Political Understanding in Children Between 6-15 Years Old. *Human Relations*, 41(6):437–446.

Bogdan, R. C. and Biklen, S. K. (2007). *Qualitative research for education: An introduction to theories and methods*. Pearson Education, Boston, 5th ed. edition.

Bornstein, D. (2004). *How to change the world: Social entrepreneurs and the power of new ideas*. New York, oxford uni edition.

Brandabur, R. E. and Aldea, R. E. (2013). Influence of the children aged 3 - 6 over their parents shopping decisions. volume 2, pages 988–997. International Business Information Management Association, IBIMA.

Brondi, S., Sarrica, M., and Nencini, A. (2012). Youth participation in environmental issues: A study with Italian adolescents. *Human Affairs*, 22(3):390–404.

Brooks, D. (1982). When is discrimination discrimination? Philosophical Papers. 11(1):15–30.

Bunker, L. K. (1991). The Role of Play and Motor Skill Development in Building Children's Self-Confidence and Self-Esteem. *The Elementary School Journal*, 91(5):467–471.

Bunnell, T. and Coe, N. (2001). Spaces and scales of innovation. *Progress in Human Geography*, 25(4):569–589.

Burdette, H. L. and Whitaker, R. C. (2005). Resurrecting free play in young children: looking beyond fitness and fatness to attention, affiliation, and affect. *Archives of pediatrics & adolescent medicine*, 159(1):46–50.

Burman, M., Brown, J., Tisdall, J., and Batchelor, S. (2000). A View from the Girls: Exploring Violence and Violent Behavior. *Economic & Social Research Council*.

Callahan, K. (2007). Citizen participation: Models and methods. *International Journal of Public Administration*, 30(11):1179–1196.

Campbell, T. (2012). *Beyond Smart Cities: How cities network, learn and innovate.* New York & Oxford, earthscan edition.

Caragliu, A., Del Bo, C., and Nijkamp, P. (2011). Smart Cities in Europe. *Journal of Urban Technology*, 18(2):65–82.

Carayannis, E. G. (2010). Triple Helix, quadruple Helix and Quintuple Helix and How do Knowledge, Innovation and the Environment Relate to Each other?

Carver, A., Salmon, J., Campbell, K., Baur, L., Garnett, S., and Crawford, D. (2005). How do perceptions of local neighborhood relate to adolescents' walking and cycling? *American Journal of Health Promotion*, 20(2):139–147.

Casson, M. (1982). *The Entrepreneur: An Economic Theory*. Towtowa, NJ, barnes & n edition.

ChamberofCommerce (2015). Economic Report of Catalonia. Technical report.

Chan, M. and Singhal, A. (2015). Emotion matters: Implications for distracted driving. *Safety Science*, 72:302–309.

Chapin, T. S. (2012). Introduction. *Journal of the American Planning Association*, 78(1):5–15.

Chesbrough, H. (2007). Business model innovation: it's not just about technology anymore. *Strategy & Leadership*, 35(6):12–17.

Chiaradia, A., Cooper, C., and Webster, C. (2012). sDNA a Software for Spatial Design Network Analysis, Specifications. *Cardiff University*.

Chiaradia, A., Cooper, C., and Wedderburn, M. (2014). Network Geography and Accessibility. *Tpm*.

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., and et al. Nahon, K. (2012). Understanding Smart City initiatives: An integrative framework. In *In 45th Hawaii international conference on system sciences, Maui, HI.*, pages 2289–2297.

Christopoulou, E., Ringas, D., and Garofalakis, J. (2014). *The vision of the sociable Smart City*, volume 8530 of *Lecture Notes in Computer Science*. Springer International Publishing, Cham.

Clark, M. I., Berry, T. R., Spence, J. C., Nykiforuk, C., Carlson, M., and Blanchard, C. (2010). Key stakeholder perspectives on the development of walkable neighbourhoods. *Health and Place*, 16(1):43–50.

Coertze, J. and von Solms, R. (2014). The Board and CIO: The IT Alignment Challenge. In *2014 47th Hawaii International Conference on System Sciences*, pages 4426–4435. IEEE.

Collins, D. (2003). Pretesting survey instruments: An overview of cognitive methods. In *Quality of Life Research*, volume 12, pages 229–238.

Cooper, C., Fone, D., and Chiaradia, A. (2014). Measuring the Impact of Spatial Network Layout on Community Social Cohesion: A Cross-Sectional Study. *International Journal of Health Geographics*.

Cornelius, N., Todres, M., Janjuha-Jivraj, S., Woods, A., and Wallace, J. (2008). Corporate social responsibility and the social enterprise. *Journal of Business Ethics*, 81(2):355–370.

Correia, L. M. and Wünstel, K. (2011). Smart Cities applications and requirements. White Paper of the Experts Working Group. *Works European Technology Platform*.

Crossette, B. (2010). The State of World Population, 2010. From Conflict and Crisis to Renewal: Generations of Change. *UNFPA, United Nations Population Fund, New York, USA*.

Dallago, L., Cristini, F., Perkins, D. D., Nation, M., and Santinello, M. (2010). The adolescents, life context, and school project: Youth voice and civic participation. 38(1):41–54.

Dalton, R. (2003). The Secret Is To Follow Your Nose Route Path Selection and Angularity. *Environment and Behavior, Geographics*, pages 107–131.

Davidson, D. and Hudson, J. (1988). The effects of decision reversibility and decision importance on children's decision making. *Journal of Experimental Child Psychology*, 46(1):35–40.

Derakhshan, G., Shayanfar, H. A., and Kazemi, A. (2016). The optimization of demand response programs in smart grids. 94:295–306.

DESA (2009). World Urbanization Prospects. The 2009 Revision. *Proportion Urban Population. United Nations, New York*.

Dirks, S., Keeling, M., and Dencik, J. (2009). How smart is your city. *IBM Institute for business*.

Doel, M. and Hubbard, P. (2002). Taking world cities literally: marketing the city in a global space of flows. *City*, 6(3):351–368.

Domènech, L. and Saurí, D. (2011). Comparative appraisal of the use of rainwater harvesting in single and multi-family buildings of the metropolitan area of Barcelona (Spain). *Barcelona City Council*.

Dorado, S. and Haettich, H. (2001). Social Entrepreneurial Ventures: Worth a Careful Look.

Drennan, J. (2003). Cognitive interviewing: verbal data in the design and pretesting of questionnaires. *Journal of Advanced Nursing*, 42(1):57–63.

Durand, C. P., Andalib, M., Dunton, G. F., Wolch, J., and Pentz, M. A. (2011). A systematic review of built environment factors related to physical activity and obesity risk: Implications for smart growth urban planning. *Obesity Reviews*, 12(501):173–182.

Economist (2013). Mining the urban data. http://www.economist.com/news/21566408-cities-will-become-smarter-different-ways-many-people-expected-mining-urban-data (last access:04/09/2016). Technical report.

Economist Intelligence Unit (2011). 2004-2011 Quality of Life Index. https://www.economist.com/media/pdf/quality_of_life.pdf (last access:04/09/2016). Technical report.

Eisenhardt, K. M. and Brown, S. L. (1999). Patching. Restitching business portfolios in dynamic markets. *Harvard business review*, 77(3).

Eisenmann, T., Parker, G., and Van Alstyne, M. W. (2006). Strategies for two-sided markets.

Emmino, N. (2012). Mobile app does the impossible-locates open parking spaces on crowded city streets.

Engel, J. S. (2015). Global Clusters of Innovation. *Entrepreneurial Engines of Economic Growth around the World*, 57(2):36–42.

Ergazakis, K., Metaxiotis, K., and Psarras, J. (2006). A coherent framework for building successful KCs in the context of the knowledge-based economy. *Knowledge Management Research and Practice*, 4(1):46–59.

Etezadzadeh, C. (2014). *Smart City 2.0 as a Liveable City and Future Market*. Number 1.

Etzkowitz, H. (2004). The evolution of the entrepreneurial university. *International Journal of Technology and Globalisation*, 1(1):64–77.

Etzkowitz, H. and Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and 'Mode 2' to a Triple Helix of university, industry, government relations. *Research Policy*, 29(2):109–123.

Etzkowitz, H., Webster, a., Gebhardt, C., and Terra, B. R. C. (2000). The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm.

Etzkowitz, H. and Zhou, C. (2008). Introduction to special issue Building the entrepreneurial university: a global perspective. *Science & Public Policy*, 35(9):627–635.

Feld, C. S. and Stoddard, D. B. (2004). Getting IT Right. *Harvard Business Review*, 82(2).

Fini, R., Grimaldi, R., and Sobrero, M. (2009). Factors fostering academics to start up new ventures: An assessment of Italian founders' incentives. *Journal of Technology Transfer*, 34(4):380–402.

Freeman, L. (1977). A set of measures of centrality based upon betweenness. *Sociometry*, 40(35):35–41.

Frey, H. (1999). *Designing the City: Towards a More Sustainable Urban Form*. E & fn spo edition.

Gallouj, F. and Savona, M. (2009). Innovation in services: A review of the debate and a research agenda. *Journal of Evolutionary Economics*, 19(2):149–172.

Gallouj, F. and Savona, M. (2010). Towards a theory of innovation in services: A state of the art. In *The Handbook of Innovation and Services: A Multi-disciplinary Perspective*, pages 27–48. Edward Elgar Publishing Ltd.

Gallouj, F., Weber, K. M., Stare, M., and Rubalcaba, L. (2014). The futures of the service economy in Europe: A foresight analysis. *Technological Forecasting and Social Change*, 94:80–96.

Garcia J, R. J. (2011). Price and income elasticities of demand for housing characteristics in the city of Barcelona. *Reg Stud*, 45(5):597–608.

Garcia-López, M. and Muñiz, I. (2010). Employment decentralisation: polycentricity or scatteration? The case of Barcelona. *Urban Studies 47(14)*, pages 3035–3056.

Garriga, M. and Medina, E. (2014). An experimental methodology to promote and evaluate the use of community networks for civic engagement. pages 47–62.

Gartner (2015). 2015 Hype Cycle Special Report. The Hype Cycle for Emerging Technologies. Technical report.

Gershenson (2013). Living in Living Cities. *Artificial Life*, 19(3/4):119–140.

Giddings, B., Hopwood, B., and O'Brien, G. (2002). Environment, economy, and society:fitting them together into sustainable development. *Sustainable development, 10(4), 187-196*.

Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., and Pichler-Milanovic, N. Meijers, E. (2007). Smart Cities: Ranking of European medium-sized cities. Vienna, Austria. *Centre of Regional Science (SRF), Vienna University of Technology*.

Ginsburg, K. R. (2007). The importance of play in promoting healthy child development and maintaining strong parent-child bonds. *Pediatrics*, 119(1):182–91.

Gómez, S. O., Ymbert-Pellejá, L., Busquets-Monge, R., Álvaro-Lozano, M., González-Cuevas, A., and Martínez-Roig, A. (2010). Estudio clínico y epidemiológico de las neumonías por mycoplasma pneumoniae y adenovirus en un hospital de barcelona. *Pediatria de Atencion Primaria*, 12(46):199–214.

Greefield, A. (2013). *Against the Smart City: the city is here for you.* New York, kindle edition.

Grimaldi, D. and Fernandez, V. (2016). The alignment of University curricula with the building of a Smart City: A case study from Barcelona. *Technological Forecasting & Social Change*.

Guclu, A., Dees, J. G., & Anderson, B. B. (2002). *The process of social entrepreneurship: Creating opportunities worthy of serious pursuit. Center for the Advancement of Social Entrepreneurship (CASE)*. Fuqua scho edition.

Haeusler, E. H. (2012). A celebration of Alan Turing's achievements in the year of his centenary. *International Transactions in Operational Research*, 19(3):487–491.

Haque, S., Kulik, L., and Klippel, A. (2007). Algorithms for Reliable Navigation and Wayfinding. *Spatial Cognition*, pages 373–389.

Hawkins, D. I. and Coney, K. A. (1974). Peer group influences on children's product preferences. *Journal of the Academy of Marketing Science*, 2(2):322–331.

He, S. Y. (2013). Will you escort your child to school? The effect of spatial and temporal constraints of parental employment. *Applied Geography*, 42:116–123.

Hillier, B. (1996). Cities as movement economies. *Urban Design International*, 1(1):41 – 60.

Hillier, B. and Iida, S. (2005). Network effects and psychological effects: a theory of urban movement. *Proceedings 5th International Space Syntax Symposium*, pages 553–564.

Hillier, B., Penn, A., Grajewski, T., and Xu, J. (1993). Natural Movement or Configuration and Attraction in Urban Pedestrian Movement. *Environment and Planning B: Planning and Design*, 20(1):29–66.

Hillman, M., Adams, J., and Whitelegg, J. (1990). One false move.: A study of children's independent mobility. *London: PSI Publishing*.

Hiselius, L. W. (2004). Estimating the relationship between accident frequency and homogeneous and inhomogeneous traffic flows. *Accident Analysis & Prevention*, 36(6):985–992.

Hollands, R. G. (2008). Will the real smart city please stand up? Intelligent, progressive or entrepreneurial? *City, 12(3), 303-319*.

Hoppe, E. I., Kusterer, D. J., and Schmitz, P. W. (2013). Public-private partnerships versus traditional procurement: An experimental investigation. *Journal of Economic Behavior and Organization*, 89:145–166.

Hospers, G. (2003). Creative cities in Europe: urban competitiveness in the knowledge economy. *Intereconomics 38(5)*, pages 260–269.

Huberty, M. (2015). Awaiting the Second Big Data Revolution: From Digital Noise to Value Creation. *Journal of Industry, Competition and Trade*, pages 35–47.

Iansiti, M. and Lakhani, K. R. (2014). Digital ubiquity: How connections, sensors, and data are revolutionizing business.

Iansiti, M. and Levien, R. (2004a). Strategy ecology. *Harvard Business Review*, 82(3).

Iansiti, M. and Levien, R. (2004b). The keystone advantage: What the new dynamics of business ecosystem mean for strategy, innovation, and sustainability. *Harvard Business Press*.

Iansiti, M. and Richards, G. (2006). Information Technology Ecosystem: Structure, Health, and Performance. *Harvard Business School*, 51(I):77–110.

IBM (2015). IBM Global Parking Survey: Drivers Share Worldwide Parking Woes.

IESE (2015). IESE Cities in Motion Index - http://citiesinmotion.iese.edu/indicecim (last access:04/09/2016). Technical report.

Inayatullah, S. (2011). City futures in transformation: Emerging issues and case studies. *Futures, 43(7)*, pages 654–661.

Ivanova, I. (2014). Quadruple Helix Systems and Symmetry: A Step Towards Helix Innovation System Classification. *Journal of the Knowledge Economy*, 5(2):357–369.

Jacobs, J. (2009). *Common Ground?* Routledge, London.

Janoff-Bulman, R. and Hanson Frieze, I. (1983). A theoretical perspective for understanding reactions to victimisation. *Journal of Social Issues,*, 39(2):1–17.

Kakabadse, A. and Kakabadse, N. (2005). Outsourcing: Current and future trends. *Thunderbird International Business Review*, 47(2):183–204.

Kantis, H., Ishida, M., and Komori, M. (2002). Entrepreneurship in emerging economies: The creation and development of new firms in Latin America and East Asia. *Inter- American Development Bank*.

Keating, W. and Dennis, N. (2000). Neighborhood Planning. *Journal of Planning Education and Research*, 20(1):111–114.

Kolympiris, C., Kalaitzandonakes, N., and Miller, D. (2014). Location choice of academic entrepreneurs: Evidence from the US biotechnology industry. *Journal of Business Venturing*, 30(2):227–254.

Komninos, N. (2006). The architecture of intelligent cities: integrating human, collective and artificial intelligence to enhance knowledge and innovation. In *2nd IET International Conference on Intelligent Environments (IE 06)*, volume 2006, pages v1–13–v1–13. IEE.

Komninos, N., Pallot, M., and Schaffers, H. (2012). Special Issue on Smart Cities and the Future Internet in Europe. *Journal of the Knowledge Economy*, 4(2):119–134.

Kremer-Sadlik, T., Izquierdo, C., and Fatigante, M. (2010). Making meaning of everyday practices: Parents' attitudes toward children's extracurricular activities in the United States and in Italy. *Anthropology and Education Quarterly*, 41(1):35–54.

Kruger, M. (1989). On node and axial grid maps: distance measures and related topics.

Kurland, N. B., Michaud, K. E. H., Best, M., Wohldmann, E., Cox, H., Pontikis, K., and Vasishth, A. (2010). Overcoming silos: The role of an interdisciplinary course in shaping a sustainability network. *Academy of Management Learning and Education*, 9(3):457–476.

La Fontaine, J. (1991). *Bullying: the child's view*. London, gulbenkian edition.

La Greca, P., Barbarossa, L., Ignaccolo, M., Inturri, G., and Martinico, F. (2011). The density dilemma. A proposal for introducing smart growth principles in a sprawling settlement within Catania Metropolitan Area. *Cities, 28(6)*, pages 527–535.

Leadbeater, C. (1997). *The Rise of the Social Entrepreneur (Demos Papers)*. London.

Leadbeater, C. (2006). The Socially Entrepreneurial City. In Nicholls, A., editor, *Social Entrepreneurship*, chapter 11, pages 233–246.

Lee, C. and Moudon, A. V. (2006). The 3Ds+ R: Quantifying land use and urban form correlates of walking. *Transportation Research, D: Transport and Environment*, pages 204–215.

Lee, J. H., Hancock, M. G., and Hu, M.-C. (2013). Towards an effective framework for building smart cities: Lessons from Seoul and San Francisco. *Technological Forecasting and Social Change*.

Leibovitz, J. (2004). 'Embryonic' knowledge-based clusters and cities: The case of biotechnology in Scotland. *Urban Studies*, 41(5-6):1133–1155.

Lengnick-Hall, C.A. and Wolff, J. (1999). Similarities and contradictions in the core logic of three strategy research streams. *Strategic Management Journal*, 20(12):1109–1132.

Leon (2008). Attract and connect: the 22@Barcelona innovation district and the internationalization of Barcelona business. Innovation. *Manag Policy Pract 10*, pages 235–246.

Li, D., Cao, J., and Yao, Y. (2015). Big data in smart cities. *Science China Information Sciences*, 58(October):1–12.

Li, Y. R. (2009). The technological roadmap of Cisco's business ecosystem. *Technovation*, 29(5):379–386.

Lombardi, P., Giordano, S., Farouh, H., and Yousef, W. (2012). Modelling the smart city performance. *Innovation: The European Journal of Social Science Research*, 25(2):137–149.

Lorusso, S., Scioscia, M., Sassano, G., Graziadei, A., Passannante, P., Bellarosa, S., Scaringi, F., and Murgante, B. (2014). Involving citizens in public space regeneration: The experience of garden in motion. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 8580 LNCS(PART 2):723–737.

Madlener, R. and Sunak, Y. (2011). Impacts of urbanization on urban structures and energy demand:what can we learn for urban energy planning and urbanization management? *Sustainable Cities Soc. 1, 45-53*.

Mair, J. and Martí, I. (2006). Social Entrepreneurship Research: a Source of Explanation, Prediction, and Delight. *Journal of world business*, 41(1):36–44.

Makovere, P. H. and Ngirande, H. (2016). The influence of corporate social responsibility on corporate competitive advantage: A case of zimbabwean stock exchange listed companies. 13(2CONT2):413–418.

Manzini, E. and Rizzo, F. (2012). The SEE project: a cases based study to investigate the role of design in social innovation initiatives for Smart Cities. *Planning Support Tools: Policy Analysis, Implementation and Evaluation Proceedings of the Seventh International. Conference on Informatics and Urban and Regional Planning INPUT,Italy, Cagliari.*

Markman, G. D., Phan, P. H., Balkin, D. B., and Gianiodis, P. T. (2005). Entrepreneurship and university-based technology transfer. *Journal of Business Venturing*, 20(2):241–263.

Marsa-Maestre, I., Lopez-Carmona, M. A., Velasco, J. R., and Navarro, A. (2008). Mobile agents for service personalization in smart environments. *Journal of Networks, 3(5)*, pages 30–41.

Marshall, T. (2000). Urban planning and governance: is there a Barcelona model? *Int Plan Stud 5(3):299 23. Marshall T (2004) Transforming Barcelona: the renewal of a European metropolis. Routledge, London, p 288*.

Martin, J. (1978). *The Wired Society*. Routledge, London.

Martin, J. L. (2002). Relationship between crash rate and hourly traffic flow on interurban motorways. *Accident Analysis and Prevention*, 34(5):619–629.

Martín-Ramos, Á. (2012). The Cerdà effect on city modernisation. *Town Planning Review*, 83(6):695–716.

Marzo-Navarro, M., Pedraja-Iglesias, M., and Rivera-Torres, P. (2009). Curricular profile of university graduates versus business demands: Is there a fit or mismatch in Spain? *Education + Training*, 51(1):56–69.

Matthews, M. H. (1995). Young Children's representations of the environment: A comparison of techniques. *Journal of Environmental Psychology*, (Special Issue):103–120.

Mayer-Schonberger, V. and Cukier, K. (2013). *Big Data: A revolution that will transform how we live, work and think*. John Murray, London.

Mazzoleni, C. (2010). Space of the city in reconstruction: the lawscapes of Barcelona and Berlin. *Int J Law Context, Suppl Law, Mov, Space 6(3)*, pages 199–242.

McAfee, A. and Brynjolfsson, E. (2012). Big Data's Management revolution. *Harward Business Review*.

McDonald, N. C. (2007). Active Transportation to School. Trends Among U.S. Schoolchildren, 1969-2001. *American Journal of Preventive Medicine*, 32(6):509–516.

McDonald, N. C. and Aalborg, A. E. (2009). Why Parents Drive Children to School: Implications for Safe Routes to School Programs. *Journal of the American Planning Association*, 75(3):331–342.

McGranahan, G., Balk, D., and Anderson, B. (2007). The rising tide: assessing the risks of climate change and human settlements in low elevation coastal zones. *Environ Urban 19 (1), 17-37*.

McKinsey (2011). Big Data: The next frontier for innovation, competition and productivity. *McKinsey Global Institute*.

McKinsey (2014). The Internet of Things: Mapping the Value Beyond the Hype. Technical report.

McKinsey Global Institute Report, R. (2013). Disruptive technologies: Advances that will transform life, business, and the global economy.

Mcwilliams, A., Parhankangas, A., Coupet, J., Welch, E., and Barnum, D. T. (2016). Strategic Decision Making for the Triple Bottom Line. 25(3):193–204.

Miles, I. (1993). Services in the new industrial economy. *Futures*, 25(6):653–672.

Miles, I. (2005). Knowledge intensive business services: prospects and policies. *Foresight*, 7(6):39–63.

Miller, D. and Hanzel, G. (2007). *Megacity challenges: a stakeholder perspective.* Siemens AG.

Minai, M. S., Olusegun, A. I., and Lucky, E. O. I. (2011). The moderating effect of location on small firm performance: Empirical evidence. *European Journal of Social Sciences*, 23(3):418–431.

Ministerio de Educacion Cultura y Deporte (2012). Datos Basicos del Sistema Universitario Curso Direcciones.

Mohajeri, B., Nyberg, T., Karjalainen, J., Tukiainen, T., Nelson, M., Shang, X., and Xiong, G. (2014). The impact of social manufacturing on the value chain model in the apparel industry. In *Proceedings of 2014 IEEE International Conference on Service Operations and Logistics, and Informatics*, pages 378–381. IEEE.

Moore, G. A. (2014). *Crossing the Chasm*. HarperBusiness, third edition.

Moore, J. F. (1993). Predators and prey: a new ecology of competition. *Harvard Business Review*, 71(3):75–86.

Moore, J. F. (2006). Business Ecosystems and the View from the Firm. *The Antitrust Bulletin*, 51(1):31–75.

Morandi, C., Rolando, A., and di Vita, S. (2015). *From Smart City to Smart Region Digital Services for an Internet of Places*. Springer b edition.

Morris, M. H. and Jones, F. F. (1999). Entrepreneurship in established organizations: The case of the public sector. *Entrepreneurship Theory and Practice*, 24(1):71–91.

Morris, M. H. and Kuratko, D. F. (2002). *Corporate entrepreneurship*. Fort Worth, TX, harcourt c edition.

Mulder, I. (2014). *Sociable Smart Cities: Rethinking Our Future through Co-creative Partnerships*, volume 8530 of *Lecture Notes in Computer Science*. Springer International Publishing, Cham.

Mullan, E. (2003). Do you think that your local area is a good place for young people to grow up? The effects of traffic and car parking on young people's views. *Health & Place*, 9(4):351–360.

Munuzuri, J., Larraneta, J., Onieva, L., and Cortes, P. (2005). Solutions applicable by local administrations for urban logistics improvement. *Cities, 22(1)*, pages 15–28.

Murthy, N. and Kumar, V. (2015). Internet of things (IoT): Is IoT a disruptive technology or a disruptive business model? *Indian Journal of Marketing*, 45(8):18–27.

Mwenda, K. and Muuka, G. (2004). Towards best practices for microfinance institutional engagement in african rural areas; selected cases and agenda for action. *International journal of social economics, 31(1-2), 143-158*.

Nagel, C. L., Carlson, N. E., Bosworth, M., and Michael, Y. L. (2008). The relation between neighborhood built environment and walking activity among older adults. *American Journal of Epidemiology*, pages 461–468.

Nam, T. and Pardo, T. A. (2011). Conceptualizing smart city with dimensions of technology, people, and institutions. In *Proceedings of the 12th Annual International Digital Government Research Conference on Digital Government Innovation in Challenging Times - dg.o '11*, page 282, New York, New York, USA. ACM Press.

Neal, Z. (2013). *The Connected City: How Networks are Shaping the Modern Metropolis. New York and London: Routledge.* Number 1. New York & London, routledge edition.

Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., and Scorrano, F. (2014). Current trends in Smart City initiatives: Some stylised facts. *Cities*, 38:25–36.

Neuman, M. (2011). Centenary paper: Ildefons Cerda and the future of spatial planning. The network urbanism of a city planning pioneer. *Town Planning Review*, 82(2):117–144.

Newman, M. (2010). Networks: An introduction. *Oxford University Press.*, pages 163–186.

Nicholls, A. (2006). *Social Entrepreneurship*. Oxford Univesity Press.

Nunnally, J. and Bernstein, I. (1994). *Psychometric theory*. Mcgraw hil edition.

O'Brien, C. (2011). Young people's comparisons of cross-gender and same-gender bullying in British secondary schools. *Educational Research*, 53(3):257–301.

Odendaal, N. (2003). Information and communication technology and local governance: Understanding the difference between cities in developed and emerging economies. *Computers, Environment and Urban Systems, 27(6)*, pages 585–607.

Park, H. W. (2014). Transition from the Triple Helix to N-Tuple Helices? An interview with Elias G. Carayannis and David F. J. Campbell. *Scientometrics*, 99(1):203–207.

Paroutis, S., Bennett, M., and Heracleous, L. (2014). A strategic view on smart city technology: The case of IBM Smarter Cities during a recession. *Technological Forecasting and Social Change*, 89:262–272.

Passino, K. M. (2009). Educating the humanitarian engineer. *Science and Engineering Ethics*, 15(4):577–600.

Perboli, G., De Marco, A., Perfetti, F., and Marone, M. (2014). A New Taxonomy of Smart City Projects. *Transportation Research Procedia*, 3(July):470–478.

Perrini, F. and Vurro, C. (2006). Social Enterpreneurship: Innovation and Social Change accross theory and practice. In *Social Entrepreneurship*, pages 57–85. New York.

Petridou, E. and Moustaki, M. (2000). Human factors in the causation of road traffic crashes. *European Journal of Epidemiology*, 16:819–826.

Porter, M. (1991). Toward a dynamic theory of strategy. *Strategic Management Journal*, 12(Winter Special Issue):95–117.

Portugali, J., Meyer, H., Stolk, E., and Tan, E., editors (2012). *Complexity Theories of Cities Have Come of Age*. Springer Berlin Heidelberg, Berlin, Heidelberg.

Pourezzat, A. A. and Nejati, M. (2008). E-Government and empowerment: Impacts on equal access to information and developing public language. *Lex et Scientia, 15(1), 123-127*.

Prezza, M., Alparone, F. R., Cristallo, C., and Luigi, S. (2005). Parental perception of social risk and of positive potentiality of outdoor autonomy for children: The development of two instruments. *Journal of Environmental Psychology*, 25(4):437–453.

Prezza, M. and Pacilli, M. G. (2007). Current fear of crime, sense of community, and loneliness in italian adolescents: the role of autonomous mobility and play during childhood. *Journal of Community Psuchology*, 35(2):151–170.

Prezza, M., Pilloni, S., Morabito, C., Sersante, C., Alparone, F. R., and Giuliani, M. V. (2001). The influence of psychosocial and environmental factors on children's independent mobility and relationship to peer frequentation. *Journal of Community and Applied Social Psychology*, 11(6):435–450.

Pushkarev, B. and Zupan, J. (1975). Urban Space for Pedestrians. *MIT Press, Cambridge, MA*.

Richter, C., Kraus, S., and Syrjä, P. (2015). The Smart City as an opportunity for entrepreneurship. *International Journal of Entrepreneurial Venturing*, 7(3):211.

Richter, K. (2009). Adaptable Path Planning in Regionalized Environments. In *In Spatial Information Theory*, pages 453–470. Springer b edition.

Rigby, K. (1996). *Bullying in schools: and what to do about it*. Melbourne, ACER, romero edition.

Rissotto, A. and Tonucci, F. (2002). Freedom of Movement and Environmental Knowledge in Elementary School Children. *Journal of Environmental Psychology*, 22(1-2):65–77.

Rizzo, F. and Deserti, A. (2014). *Small Scale Collaborative Services: The Role of Design in the Development of the Human Smart City Paradigm*, volume 8530 of *Lecture Notes in Computer Science*. Springer International Publishing, Cham.

Rodriguez, R. and Bonilla, A. (2007). Urbanización, Cambios Globales en el Ambiente y Desarrollo Sustentable en América Latina. *IAI, INE, PNUMA, São José dos Campos, Brasil*.

Rogers, E. M. (2003). *Diffusion of innovations*. New York, the free p edition.

Rong, C., Liu, L., and Chen, G. (2016). Big data and smart computing: methodology and practice. 28(11):3077–3078.

Rong, K., Hu, G., Lin, Y., Shi, Y., and Guo, L. (2014). Understanding Business Ecosystem Using a 6C Framework in Internet-of-Things-Based Sectors. *International Journal of Production Economics*, 159:41–55.

Rose, N., Cowie, C., Gillett, R., and Marks, G. B. (2009). Weighted road density: A simple way of assigning traffic-related air pollution exposure. *Atmospheric Environment*, 43(32):5009–5014.

Ross, Z., English, P. B., Scalf, R., Gunier, R., Smorodinsky, S., Wall, S., and Jerrett, M. (2006). Nitrogen dioxide prediction in Southern California using land use regression modeling: potential for environmental health analyses. *Journal of exposure science & environmental epidemiology*, 16(2):106–14.

Salmon, J., Timpero, A., Cleland, V., and Venn, A. (2005). Trends in children's physical activity and weight status in high and low socio-economic status areas of Melbourne, Victoria, 1985-2001. *Australian and New Zealand Journal of Public Health*, 29(4):337–342.

Samet, R. H. (2013). Complexity, the science of cities and long-range futures. *Futures*, 47:49–58.

Sarkar, C., Webster, C., Pryor, M., Tang, D., Melbourne, S., Zhang, X., and Jianzheng, L. (2015). Exploring associations between urban green, street design and walking: results from the Greater London boroughs. *Landscape and Urban Planning*, pages 112–125.

Schumpeter, J. (1934). *The theory of economic development*. Cambridge, MA.

Scott, S., Harden, J., Jackson, S., and Backett-Milburn, K. (2000). Strangers what kind of danger? Children's and Parent's Constructions of Risk.

Seran (Potra), S. and Izvercian, M. (2014). Prosumer engagement in innovation strategies. *Management Decision*, 52(10):1968–1980.

Seto, K. and Sánchez-Rodríguez, R.; Fragkias, M. (2010). The new geography of contemporary urbanization and the environment. *Ann. Rev. Environ. Resour. 35, 167-194*.

Shimbel, A. (1953). Structural parameters of communication networks. *The Bulleting of Mathematical Biophysics*, pages 501–507.

Smart City Council, C. (2015). Smart Cities Readiness guide: the planning manual for building tomorrow's cities today.

Somaya, D. and Williamson, I. O. (2008). Rethinking the 'War for Talent'. *MIT Sloan Management Review*, 49(4):29–34.

Spear, R. (2006). Social entrepreneurship : a different model ? 33(5):399–410.

Steria (2011). Smart Cities will be enabled by Smart IT. *Steria-Smart City*.

Stevenson, H. H. and Jarillo-Mossi, J. C. (1990). A paradigm of entrepreneurship: Entrepreneurial management. *Strategic Management Journal*, 11(5):17–27.

Stutts, J. C., Reinfurt, D. W., and Rodgman, E. A. (2001). The role of driver distraction in crashes: an analysis of 1995-1999 Crashworthiness Data System Data. *Annual proceedings / Association for the Advancement of Automotive Medicine. Association for the Advancement of Automotive Medicine*, 45:287–301.

Sundmaeker, H., Guillemin, P., Friess, P., and Woelffle, S. (2010). Vision and Challenges for Realising the Internet of Things. In *Brussels:CERP-IoT*.

Tamis-LeMonda, C. S., Shannon, J. D., Cabrera, N. J., and Lamb, M. E. (2004). Fathers and mothers at play with their 2- and 3-year-olds: Contributions to language and cognitive development. *Child Development*, 75(6):1806–1820.

Thorne, B. (1993). *Gender play: girls and boys in school*. Buckingham edition.

Tiwari, R., Cervero, R., and Schipper, L. (2011). Driving CO2 reduction by integrating transport and urban design strategy. *Cities, 28(5)*, pages 394–405.

Tonucci, F. (1979). Let' s go to school on our own. A proposal for autonomy. *Bulletin of People - Environment Studies*.

Tonucci, F. and Rissotto, A. (1999). Urban Mobility As a Measure. *Bulletin of People - Environment Studies*.

Townsend, A. (2013). *Smart Cities: Big Data, civic hackers, and the quest for a new utopia*. New York, w.w. norto edition.

Trepat, X., Wasserman, M. R., Angelini, T. E., Millet, E., Weitz, D. A., Butler, J. P., and Fredberg, J. J. (2009). Physical forces during collective cell migration. *Nature Physics*, 5(6):426–430.

Trost, S. (2005). Discussion Paper for the Development of Recommendations for Children's and Youth's Participation in Health Promoting Physical Activity. *Journal of Chemical Information and Modeling*, 53(9):1689–1699.

Turing, A. M. (2009). *Computing machinery and intelligence*. Springer Netherlands, Dordrecht.

Turner, A. (2007). From axial to road-centre lines: A new representation for space syntax and a new model of route choice for transport network analysis. *Environment and Planning B: Planning and Design*, 34(3):539–555.

United Nations (2014). Human Development Report. Technical report, New York.

UNPD (2001). United Nations Population Division, 2001. World Urbanization Prospects: the 1999 Revision. Key Findings, United Nations, New York.

Urry, J. (2004). The 'System' of Automobility. *Theory, Culture & Society*, 21(4-5):25–39.

USDHHS (2001). The Surgeon General 's Call To Action To Prevent and Decrease Overweight and Obesity. page V.

Valentine, G. and McKendrck, J. (1997). Children's outdoor play: Exploring parental concerns about children's safety and the changing nature of childhood. *Geoforum*, 28(2):219–235.

Van der Ploeg, H. P., Merom, D., Corpuz, G., and Bauman, A. E. (2008). Trends in Australian children traveling to school 1971-2003: Burning petrol or carbohydrates? *Preventive Medicine*, 46(1):60–62.

Vespignani, A. (2009). Predicting the behavior of techno-social systems. *Science*, (July):425–428.

Vidal, I. (2007). International Journal of Public Social Enterprise and Social Inclusion : Social Enterprises in the Sphere of Work Integration. (October 2014):37–41.

von Hippel, E. (2005). *Democratizing innovation*. MIT Press, Cambridge, MA.

Wang, X. (2001). Assessing public participation in U.S. cities. *Public Performance and Management Review*, 24(4):322–336.

Washburn, D., Sindhu, U., Balaouras, S., Dines, R. A., Hayes, N. M., and Nelson, L. E. (2010). Helping CIOs understand 'Smart City' initiatives: Defining the Smart City, its drivers, and the role of the CIO. Cambridge, MA. *Forrester Research, Inc.*

Wiener, J. M., Tenbrink, T., Henschel, J., and Hoelscher, C. (2008). Situated and Prospective Path Planning: Route Choice in an Urban Environment. In *30th Annual Conference of the Cognitive Science Society*, Washington, D.C.

World Bank (2006). A practitionner's guide - Health financing revisited. Washington, DC.

World Bank (2010). Cities and Climate Change, an Urgent Agenda. *World Bank Document, December 2010, vol. 10.*

World Commission on Environment and Development (1987). Our common future. Oxford, UK. *Oxford University Press.*

Yigitcanlar, T., O'Connor, K., and Westerman, C. (2008). The making of knowledge cities: Melbourne's knowledge-based urban development experience. *Cities*, 25(2):63–72.

Yu, J., Li, Y., and Zhao, C. (2011). Analysis on Structure and Complexity Characteristics of Electronic Business Ecosystem. *Procedia Engineering*, (15):1400–1404.

Zahra, S. a. and Nambisan, S. (2012). Entrepreneurship and strategic thinking in business ecosystems. *Business Horizons*, 55(3):219–229.

Zhang, L., Guan, Y., Leaderer, B. P., and Holford, T. R. (2013). Estimating daily nitrogen dioxide level: exploring traffic effects. *The annals of applied statistics*, 7(3):1763–1777.

Zygiaris, S. (2013). Smart City Reference Model: Assisting Planners to Conceptualize the Building of Smart City Innovation Ecosystems. *Journal of the Knowledge Economy*, 4(2):217–231.