THE CONTRIBUTION OF THE OPEN DATA TO THE DEVELOPMENT OF THE SMART CITIES

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Abstract: Human as an intelligent being was always searching for ways to make his life easier. The first step that brought the spark of evolution was the fire and the wheel, and as the years were passing by, when the industrial revolution took place, that was the dawn of the new age of continuous and rapid technological advancements, aiming for improvement of wellbeing. Through the recent years of the economic crisis improvement of wellbeing was also connected to the reduction of costs, responsible use of energy sources and actions that produce general benefits to the society. Within this context, the term of the smart city resurfaced. In addition the open data projects encourage citizens or users to develop applications and digital services with the reuse of public data, in order to improve the quality and level of participation of public services. The purpose of this study is to discuss a brief history of the smart cities initiatives worldwide, while trying to sketch the most basic characteristics of a smart city. Also, some techniques are discussed in order to lead successfully to the preservation of the intelligent character of a city. However, someone always has to have in mind that the citizen is the most crucial part of the system that is called smart city and in order to be active participant of this evolution, s/he has to be also one of the recipients of the open data.

Key words: Smart cities, open data, characteristics, success factors, solutions and practices

JEL Classification Codes: O330, O310.

1. INTRODUCTION

The mankind through its existence makes efforts to ease its transactions and to reduce costs without reducing simultaneously the quality of the transaction. Such a need became more intense through the recent years of the economic crisis which affects not only Europe, but the worldwide community. Therefore, the old meaning of the smart city emerged once more within the human aspects of everyday life.

Although there are various definitions on the term smart city, they all tend to characterize it as the city that uses effectively its digital technologies and especially Information and Communication Technologies (ICT), so as to enhance performance and wellbeing, while reducing costs and resource consumption (Economist Intelligence Unit, 2010). Furthermore, the citizens of such cities are actively engage to the sustainability of the smart character of the city (Martin et al., 2010).

However, in order to keep the citizens as active participants, certain information has to be open. Here, the open data come to play a crucial role, which are certain data that are freely

distributed to everyone. They also allow, to the receiver, to use them and republish them as they wish, without any copyright restrictions. Through this active participation, citizens keep alive the meaning of *smart city*, and they feel that they have offered something valuable to the community (Odendaal, 2003).

In this project our target is to identify how a smart city can be developed, and to offer examples of practices from other successful smart cities, which are applicable in different points of the planet, with the epicenter mainly in Europe. The aim of this project is not clearly a research, but investigative, for the methods and the steps which can lead to the smart character of a city. This paper starts with the background theory, which includes smart city characteristics, how can a city be smart, towards an extended governance, common digital city architecture. After background theory, follows the "smartness" success factors and the strategy, which can be used in order a city to be smart. 10 smartest European cities will be reported and the applications, which can be used in a smart city.

The project comes to the end with a general discussion about the overall impact as well as the benefits that the society enjoys by the expansion of smart city projects.

2. BACKGROUND THEORY

2.1 OPEN DATA

Open data is public sector information that is made available to everyone in standard, open, digital formats with a clear structure, so it can be understood. This facilitates access to information and encourages people to reuse it. In this way society — the public, businesses or any institution — can access data easily, to find out information or create new services that add to their social value and may also add to their commercial value (Janssen, 2012).

Open data, or making public information available in open formats so everyone can use it, goes beyond the simple process of allowing it to be reused. It returns public data to society and encourages people to reuse the data in whatever way they want to. In the context of this initiative public data are made available to the public. The Internet portal contains more than 300 categories of data. The five main areas are territory, population, urban services, economy and administration (Janssen et al., 2012).

2.2 SMART CITY

Smart is a city well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens (Giffinger et al., 2007).

A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens (Hall, 2000).

A city "connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city" (Harisson et al., 2010). A city striving to make itself "smarter" (more efficient, sustainable, equitable, and livable) (NRDC, 2015).

A city "combining ICT and Web 2.0 technology with other organizational, design and planning efforts to dematerialize and speed up bureaucratic processes and help to identify new,

innovative solutions to city management complexity, in order to improve sustainability and livability" (Toppeta, 2010)

"The use of Smart Computing technologies to make the critical infrastructure components and services of a city—which include city administration, education, healthcare, public safety, real estate, transportation, and utilities—more intelligent, interconnected, and efficient" (Washburn et al., 2010).

2.3 SMART CITY CHARACTERISTICS

The term "smart city" does not characterize the city itself, but the factors, indicators and actions that can lead to the smartest personality of the city. Major role in this process plays the IT section of the city and its effective use on various human aspects. However, if the public awareness is amiss, it is very difficult for the city to reach its smart character.

The citizens have to be part and basic participants in the creation of the smart personality of the city. The smart character of the city derives, basically, from the educational level of the inhabitants, and from the usage level of the ICT. The attributes of the citizens, indicate, how they are devoted to the promotion of the smart character of the city (Giffinger et al., 2007).

The greater the level of devotion, the best the services they are offered, in the organization of e-governance, smart transport systems, efficient and sustainable energy and various other aspects of human life that promote the typical attributes of a smart city.

Generally six *characteristics* can be found in a smart city, such as *Smart People, Smart Governance, Smart Mobility, Smart Environment, Smart Living* and *Smart Economy* (see Figure 1). Smart People are not only described by the level of the qualification or education of the citizens, but also by the social and ethnic plurality, the flexibility, the creativity and the participation in public life.

Smart Governance contains aspects of political participation, services for inhabitants - such as functioning of administration, transparent governance - by using open data. Local and international accessibility are very important aspects of Smart Mobility, as well as availability of ICT and sustainable, modern and safe transport systems (Giffinger et al., 2007).

By Smart Environment, citizens can discover methods to reduce the pollution, to make natural conditions viable, so as to protect the environment. Smart Living, can be described by cultural and educational facilities, health conditions, housing quality, touristic attractivity, etc.

Finally, the character of Smart Economy can be promoted by innovative spirit, which is necessary for a sustainable and evolving economy, productivity and flexibility of the labour market, as well as the integration in the international market.
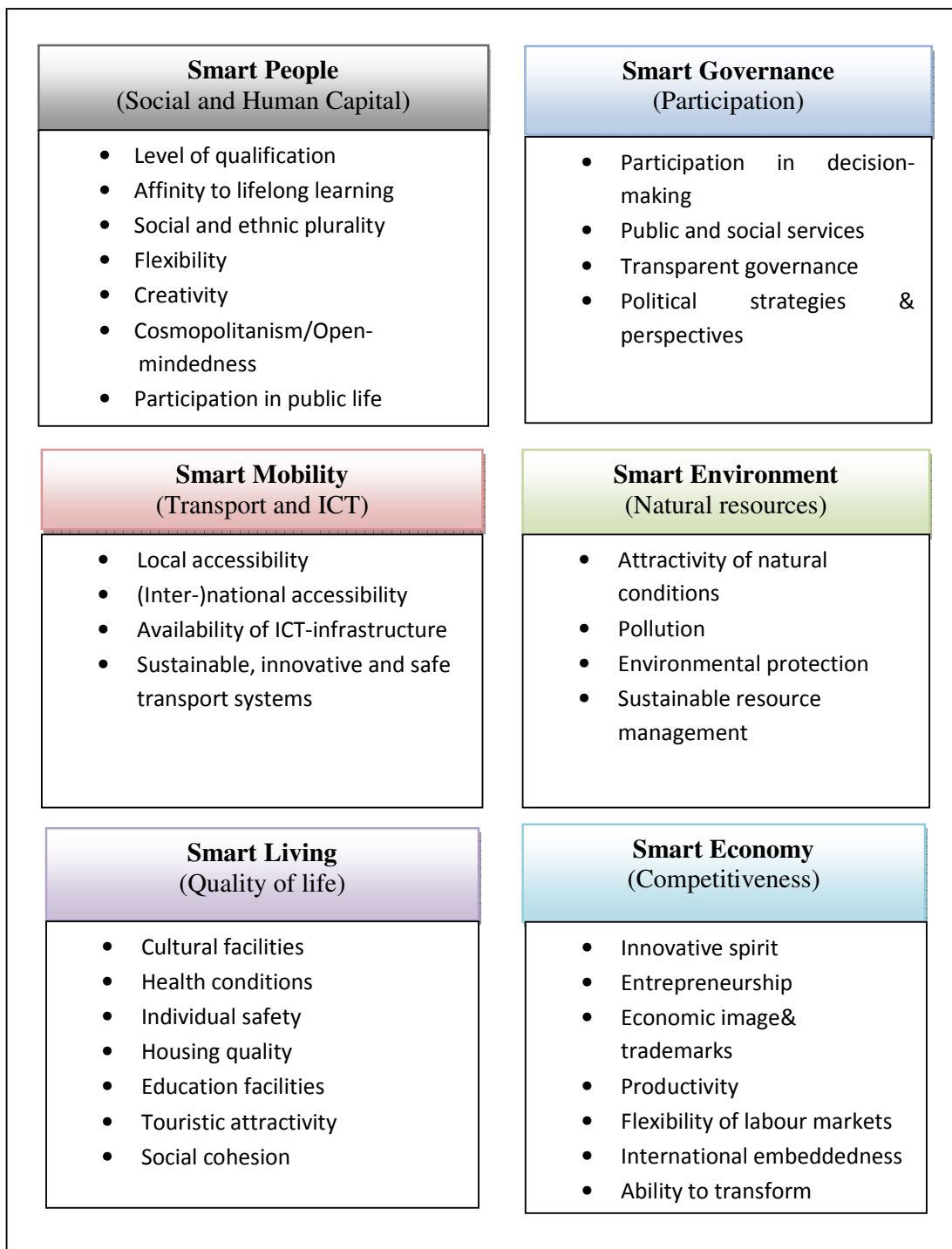
Smart People
(Social and Human Capital)

- Level of qualification
- Affinity to lifelong learning
- Social and ethnic plurality
- Flexibility
- Creativity
- Cosmopolitanism/Open-mindedness
- Participation in public life

Smart Governance
(Participation)

- Participation in decision-making
- Public and social services
- Transparent governance
- Political strategies & perspectives

Smart Mobility
(Transport and ICT)

- Local accessibility
- (Inter-)national accessibility
- Availability of ICT-infrastructure
- Sustainable, innovative and safe transport systems

Smart Environment
(Natural resources)

- Attractivity of natural conditions
- Pollution
- Environmental protection
- Sustainable resource management

Smart Living
(Quality of life)

- Cultural facilities
- Health conditions
- Individual safety
- Housing quality
- Education facilities
- Touristic attractivity
- Social cohesion

Smart Economy
(Competitiveness)

- Innovative spirit
- Entrepreneurship
- Economic image& trademarks
- Productivity
- Flexibility of labour markets
- International embeddedness
- Ability to transform

Figure 1. Characteristics and factors of a smart city (Batty et. al., 2012)

2.4 HOW CAN A CITY BE SMART?

A city can reach its smart character by taking simple actions in various everyday aspects that the city faces. For example, in the business sector and integrated ICT network will assist in achieving a sustainable business environment leading this way to a general smart economy – Figure 2.
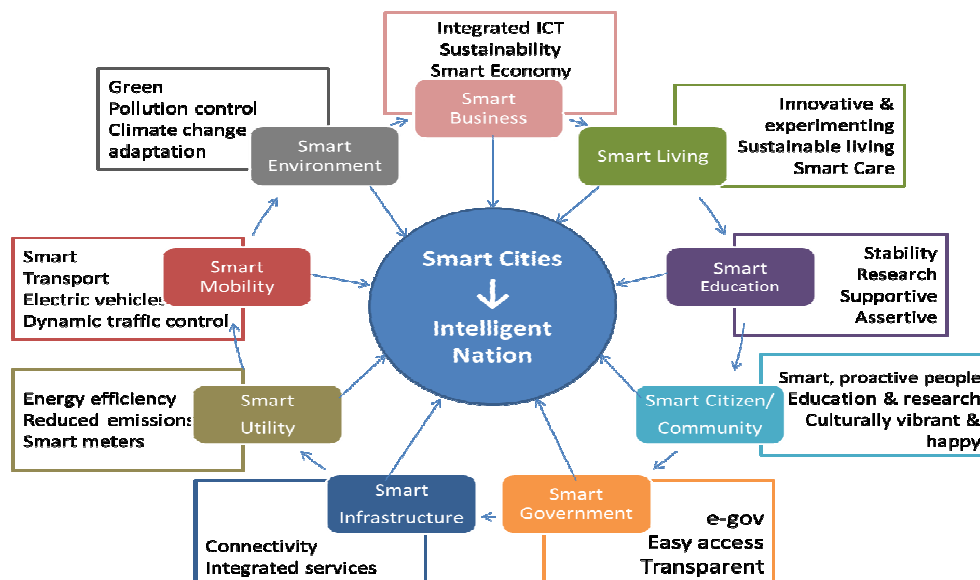
Figure 2: How can a city be smart (Kolokythas, 2015)

The new digital environments that are being implemented within the education facilities should offer stability and opportunities for research. In addition the educational environment should be supportive and assertive of any new effort of research.

Another example can derive from the mobility sector and especially the methods of transport. It is a general truth that the extensive use of cars led to the increase of the pollution levels. Therefore the search for more friendly environmental means of transport has begun. The new transportation targets can be achieved by the implementation of a smart transport system, which uses electric vehicles and in combination with a dynamic traffic control, the mobility needs of a modern city can be successfully served (Mitchell, 2007).

2.5 TOWARDS EXTENDED GOVERNANCE

The modern time we live in demand a more flexible and not so stereotype kind of governance. Local governments can achieve this flexibility through the use of ICT and other modern technologies that facilitate a better performance level. In addition, the implementation of real time governing applications, as well as tools of better data procession can aid to a more efficient governmental approach (Ferro et al., 2013).

To be more specific ICT affects the following governmental actions:

Budgeting: Combining social media with simulation tools can be useful approach in increasing the participation levels of all the stakeholders, like citizens. This approach can help citizens understand basic budgetary matters and have a better opinion about the process of their investment on the smart city project.

Emergency management: Aiding applications that can lead faster to the emergency exits of central buildings in cases of emergency will impact in the increase of safety level within these buildings.

Urban planning and management: The use of real-life data mining techniques can assist to the better organization of the public transportation routes in order to serve better the citizens and at the same time reduce the mobility costs (Ferro et al., 2013).

Environment and energy: The proper utilization of consumption data can stimulate more friendly behaviors for the environment and can produce reliable energy results that increase the environmental sensitivity of the citizens.

Healthcare: The implementation of real-time data techniques can bring as a result the reduction of the impact of aging populations, as well as can lead to the better management and control of contagious illnesses.

2.6 COMMON DIGITAL CITY ARCHITECTURE

Every smart city initiative as a project has to have a design that will arrange its operation facility. Based on real-life cases a proper organization chart containing all the levels that contribute to the successful operation of a digital city has been set. This schedule includes five operational layers, which are:

The *stakeholders' layer* embraces all the user groups of the digital city services from citizens and businesses to civil servants and public agencies.

The *service layer* includes software applications offering public information and services to the basic stakeholders.

The *business layer* is actually a set of rules and policies that define the proper enterprise architecture within the digital city (Anthopoulos & Filitsis, 2010).

The *infrastructure layer* contains all the available accessibility networks, as well as an efficient transport system and public access points in major public buildings.

The *information layer* is the information and data that derives as an outcome of the infrastructure layer.

3. CORE COMPONENTS OF SMART CITY

In order to identify the core components that characterize a city as smart, we have to take under consideration that all the implementing features, identified by literature, are re-categorized into three major classes, namely *technological*, *human* and *institutional* factors (Figure 3).
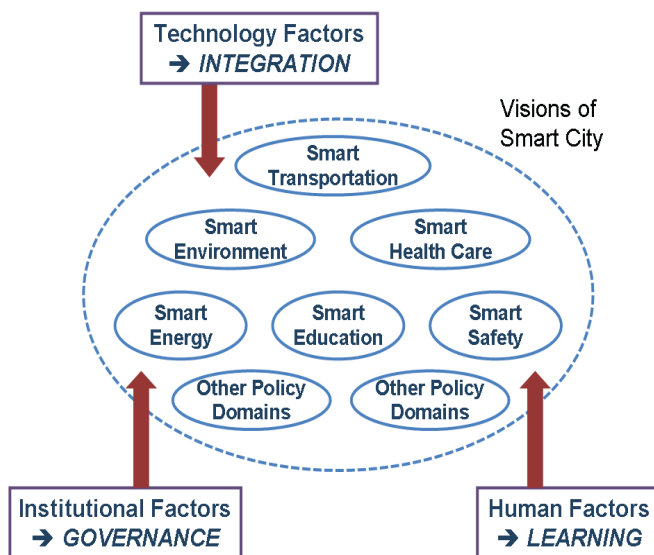

Figure 3. Core components of a smart city (Nam et. al., 2012)

3.1 TECHNOLOGY FACTORS

It is beyond any doubt that technology plays crucial role in a smart city and especially ICT infrastructures, which enable the sharing of ideas and information on various city development matters (Hollands, 2008). A city can achieve a sustainable competitive advantage through the use of the current available technology combined with some upgraded technological tools. However, it should be made clear that without the usage of technological factors by the citizens and all involving institutions, there will be no feedback on high importance information regarding city development features. Everyone should play their role in sharing innovative ideas, so as to sustain the smart character of the city. Especially businesses can produce and promote necessary applications, which can aid to the flow of information. The key meaning of implanted technological factors is to achieve flexibility, something that can be generated through the proper built infrastructure like that installation of fiber optic networks and expansion of wifi connectivity (Anthopoulos, Filitsis, 2010).

3.2 HUMAN FACTORS

Without the investment and active involvement of the human capital, the project of the smart city is terminated due to the lack of generation of ideas and spreading information. Nowadays people are characterized as smart enhanced with subjects of social and ethnic plurality, flexibility, open-mindedness and participation in public life. Furthermore the ability of the human to learn through social activity enforces them with the necessary skills for creative generation of constructive ideas (Nam, et al., 2012).

3.3 INSTITUTIONAL FACTORS

The government of the city is responsible for combining all the above mentioned factors and facilitating their proper use for the promotion of the smart city initiative. Both supportive policies, like the enhancement of relationship between governmental and non-governmental parties, and regulatory authorities, like the setting of the legal framework of a smart city initiative, should co-exist and interrelate. Furthermore smart governance should be characterized by transparency and accountability, effective resources management and enlarging public access to information about decisions that affect the lives of the citizens.

4. SUCCESS FACTORS OF SMART CITY

Smart city initiatives can sometimes increase the jealousness of some cities and therefore promote the competition among them for the more successful strategy. However, conceiving the essence of such projects as means of competition and not as ways of improving wellbeing, guarantees the unsuccessful effort in carrying out such project. Comparing the smart city project to a business will help us understand better the factors that affect the success of this kind of initiatives.
So the *factors* which consist the criteria of a successful smart city implementation are (Figure 4):
Management and organization: It is considered the spine of the project that takes care to ensure that the ICTs are going to be efficiently and effectively used for the improvement of citizens' wellbeing.
Technology: ICTs are considered the key component of such projects and if all the parameters are taken under consideration, like resource availability, capacity and institutional willingness, the route to success is obtained.
Governance: It involves the well-established cooperation of the various stakeholders of the smart city project, an action that is enhanced by the proper use of the ICTs.

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Policy context: It is actually a set of rules and directions for the proper use of ICTs in order to assist to the development of the smart character of the city.

People and communities: A critical point of understanding how projects like these should work is not only the individual citizen with his needs, but also the organized community they participate in.

Economy: The better the economy of a city is organized, the best way it will serve to the purpose of development of the smart character of the city.

Built infrastructure: The availability of proper network infrastructure is considered crucial to the successful implementation of ICTs and thus the successful way of the smart city initiative.

Natural environment: The better exploitation of the natural resources of the city, as well as their sustainability, ensure the improvement of wellbeing and therefore the success of the project (Nam et al., 2012).
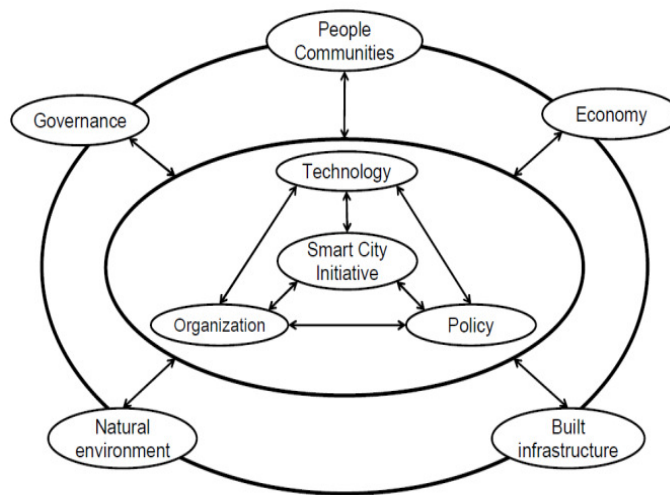

Figure 4. Success factors of smart city initiatives

5. A SMART CITY STRATEGY EXAMPLE

Referring to the smart city strategy our example comes from Greece and especially from Thessaloniki area. A project called intelligent Thessaloniki proposes the implementation of ICTs in five major districts of innovation and entrepreneurship, namely the port of Thessaloniki, the central business district, the university campus, the eastern Thessaloniki technology district and the airport area. The implemented digital applications have the sole purpose of sustainable innovation and entrepreneurship. In order for such target to be achieved, intelligent environments had been installed, with the use of sensors for producing real time information and alerts. More specifically the implemented ICTs in the port area aim to enhance competitiveness in various harbor operations. In the central area, business district smart environments facilitate accessibility, mobility and environmental practices. Within the university campus such environments promote the research, as well as encourage the collaboration with the private sector. Finally, in the eastern area, technology district and the airport online applications purpose to the better area allocation and handling of general matters (Komninos & Tsarchopoulos, 2013).

6. CLASSIFICATION OF SMART CITIES

Before we refer to any kind of classification of smart cities, we should point out that there is no ultimate classification, as all the cities do not fulfil all the criteria which characterize a city

as smart. For example, a city may be ranking high on usage of renewable sources of energy, another may have a better organized mobility system, while there may be a combination of the above mentioned characteristics in a third city. At this point we are going to mention a classification made by Boyd Cohen (2015), who categorizes the cities in 4 world regions, namely Europe, Latin America, Asia/Pacific and North America. In order to end up with this classification Boyd Cohen presented initially the circle of attributes, a set of concentric circles, categorizing the attributes to the six characteristics of smart city (Figure 5).
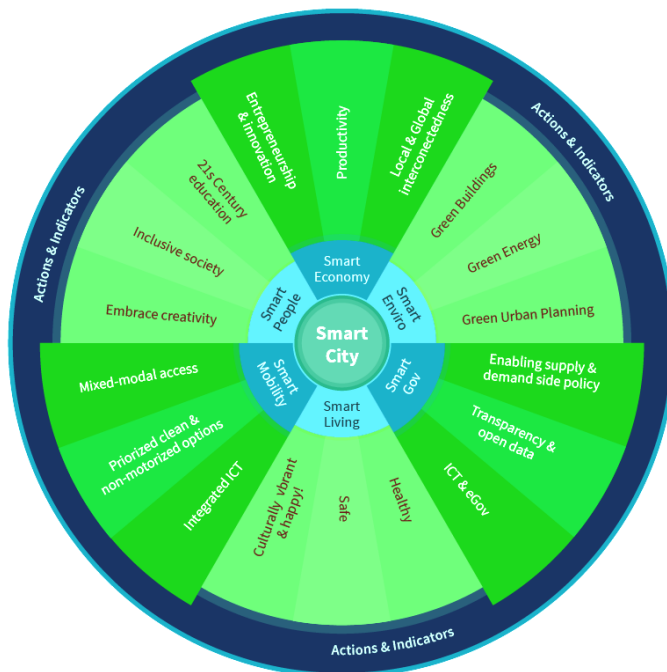

Figure 5. Wheel of attributes, made by Boyd Cohen (2015)

However, the wheel of attributes does not described the whole idea of how these attributes correlate, so he ended up with a table where the 28 indicators of the Smart Cities Wheel are analyzed into 62 general attributes that form the character of the city.

We are going to simply refer to the classification regarding the regions of Latin America, Asia/Pacific and North America (Figure 6) and we are going to analyze more the classification concerning Europe.

The 8 smartest cities in Latin America: Santiago, Mexico city, Bogota, Buenos Aires, Rio De Janeiro, Curitiba, Medellin, Montevideo.

The 10 smartest Asia/Pacific cities: Seoul, Singapore, Tokyo, Hong Kong, Auckland, Sydney, Melbourne, Osaka, Kobe, Perth

The 10 smartest cities in North America: Seattle, Boston, San Francisco, Washington D.C., New York, Toronto, Vancouver, Portland, Oregon, Chicago, Montreal

The 10 smartest cities in Europe (10-smartest-cities-in-europe, 2015):
Copenhagen: The capital of Denmark has been awarded as European Green Capital for the year 2014, due to its lowest carbon footprint per capita achieved through energy efficiency and renewable sources projects combined with the impressive cycling rates at the approximate percentage of 40%.

Amsterdam: This city does not only have amazing cycling rates with more than 10.000 bicycles moving daily around the city, but it also has developed the Amsterdam Smart City collaboration that has supported more than 40 smart city projects until now.

Vienna: Vienna is well known as a provider of high quality of life for many years mainly through some innovative projects as the "Citizen Solar Power Plant", as well as the testing of a range of electric mobility solutions and the forbiddance of residents of specific areas to own a personal vehicle. But the most impressive project is the renovation of a former slaughterhouse district into an innovation district focused on media science and technology.

Barcelona: Barcelona is a respectively newly-constructed city which combines modern architecture with lively streets and it is supporting not only its own initiatives but also international ones, like the Smart Cities Expo World Congress held in its premises. Furthermore it was the first city exploiting e-mobility in a huge innovation district consisting a mixture of smart urban planning and entrepreneurial innovation.

Paris: The city has invested a lot on shared mobility with the Velib bikesharing network that extends throughout the whole city leading to a 5% decrease of vehicle congestion. In addition the Autolib car sharing project is an example to be followed by other cities as well. Also Paris's entrepreneurial ecosystem was characterized as the 11th best in the world.

Stockholm: With the 40% of its land mass dedicated to green space, Stockholm was rated second in Siemens Green City Index and it was awarded in 2010 as EU Green Capital. The city's extensive metro network figures the highest per capita users, leading to air pollution decrease and meeting the viable levels of air quality being set by the World Health Organization.

London: The British capital holds the 7th best position in the world in entrepreneurial ecosystems, while with its congestion zone gains income and less traffic. Also the Olympic Games was the perfect opportunity for London to dedicate more to the greener character, with the characteristic example of the Royal Docks one of the greenest and smartest buildings in Europe.

Hamburg: Besides the award as a European Green Capital in 2011, the city has undertaken the largest urban regeneration project of Europe Hafen City.

Berlin: The city attracts and retains the creative class leading to urban renewal and economic growth through innovation and entrepreneurship and by supporting a vibrant cultural scene.

Helsinki: An exceptional position among the cities thriving in the Smart Government arena is Helsinki with its more than 1.000 open datasets enabling active citizens' engagement through hackathons. Besides hosting Open Knowledge Festival in 2012, the city also employs its own smart city project Forum Virium Smart City Project hopping to improve quality of life.
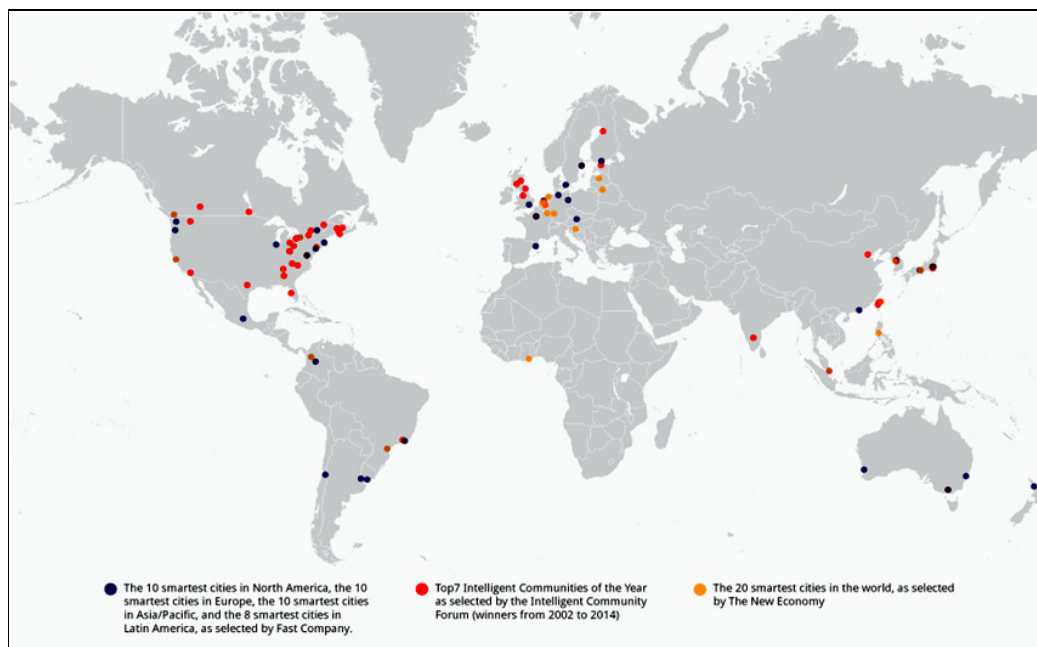
Figure 6. Smart cities in the world

7. EUROPEAN ACT AND APPLICATIONS

7.1 DIGITAL AGENDA IN THE EUROPE 2020 STRATEGY

Europe 2020 is an act presented by the European Commission targeting to achieve sustainable growth levels within the European Union by the year 2020. The act contains 7 pillars, the successful implementation of which is going to lead to the desired results. These pillars can be described as following (Digital-agenda-europe, 2015):

1. Establishing a simple digital market in order to eliminate any physical barriers set by the national borders.
2. Ensure the interoperability of electronic devises within the European Region.
3. Increase trust on the online transactions and promotion of the security futures in the online economy.
4. Enhance Internet connection to every single European household ensuring fast download rates.
5. Invest more on research and innovation, turning the best research ideas into marketable products and services.
6. Spread the Internet skills even to those people who are presented to be digitally illiterate people.
7. Focus on ICTs capabilities in order to reduce energy consumption, revolutionize health services and ensure better delivery of public services.

7.2 AIDING APPLICATIONS

Synchronized with the directorate of the European initiative on smart cities, the European Agenda contains a digital platform able to support any initiative that is generated within European Union. It is actually an application that offers policies and projects for the proper

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utilization of ICTs for the environment, mobility, health, public services, trust and reliance. In reality, it works as an aiding tool for smart cities initiatives around Europe.

Another characteristic application of a European city, which actually is providing the open data to its stakeholders, is "Amsterdam Smart City" that operates as an innovation platform and it motivates businesses, residents, the municipality and knowledge institutions to suggest and apply innovative ideas and solutions for urban issues (Amsterdam smart city, 2015).

Also from the other side of the Atlantic Ocean, a leading company in the computing technology sector, IBM, has introduced a series of applications that can be used as guiding tools for various actions that enhance the smart character of a city, with the most characteristic ones being IBM water management center, energy optimization and IBM transportation management center (Smart-cities-urban-planning, 2015).

All these applications aim to transform the attributes that promote the smartness of a city to open data, in order to be shared among the major stakeholders of such initiatives, so as for the project of smart city development to be successful. In this way public awareness is achieved and makes the citizens main contributors and components of this development process, something that makes these applications a constant source of ideas and innovation.

8. CONCLUSIONS

Smart City initiatives and their successful implementation is essential for the sustainable growth of the societies nowadays, especially through the improvement of wellbeing. Governments and leading businesses should enforce the technological environments necessary for the fulfillment of the Smart City projects. However, we should not forget that the most crucial part is considered to be the active engagement of the citizens, who provide feedback and generate ideas for the achievement of competitive advantage.

Each of these initiatives has a series of expected impacts, spreading to three major directions:

Impacts on Science: New scientific fields emerge, with the expansion of e-science, which engulfs shards form social science and digital science and how they relate. Furthermore urban economics and economic geography advance to a whole new level, especially through the new approaches to mobility and communication.

Impacts on Technology and Competitiveness: The constant generation of ideas is a powerful source for development of new technology, in order to enhance the smart character of a city. This act increases the competitive character of the smart cities, which race to prove themselves better in various fields, like fast resource allocation, more efficient energy consumption plan, improved transportation system and other actions that promote the smart character of the city.

Impacts on Society: Smart cities are based on citizens' equity and the best exploitation of citizens' way of thinking, in order to keep up with the continuous improvement. Very important feedback derives from how the citizens cooperate on common targets, like the promotion of smart city projects. (Batty et al., 2012)

Finally we should point out that such initiatives produce serious benefits to the society, few of which are:

- Successful installation of smart grids increases energy efficiency and broadens the acceptance of renewable forms of energy.
- Adoption of smart police services leads to serious crime reduction.

- · Smart environment systems can be used to fight air pollution and provide better natural resources management.
- · The Smart Traffic System in Stockholm improved air quality, reduced traffic jams and increased the use of public transport.
- · Availability of smart governance and smart living services improves residents' community participation and quality of life (powerhousegrowers, 2015).

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