EVALUATING THE EUROPEAN SMART CITIES VISIONS OF THE FUTURE

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ABSTRACT

This paper illustrates a novel application of an Analytic Network Process (ANP) in the field of Smart cities with the aim of investigating the interrelations between the components and sectors of Smart cities. Although there is no agreement on the exact definition of a Smart city, a number of main dimensions can be identified through literature review and these include: smart economy, smart mobility, smart environment, smart people, smart living, and smart governance. These six dimensions are used to evaluate four different policy visions of the city of the future as derived from the Joint Programme Initiatives "Urban Europe" (JPI-EU). The results of the evaluation show that *the Entrepreneurial City* is the policy vision with higher priorities in all the sectors considered in the model, i.e. Universities, Government, Industry and Civil Society. Some relevant urban planning and policy implications of this vision are provided in the conclusion.

Keywords: Analytic Network Process, Smart Cities performances, Triple Helix Approach.

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1. Introduction

In the last fifty years the world population has grown exponentially, at an average rate of 1.2% per year, and has recently reached 7 billion people. This is accompanied by an urban explosion, with 1.25 million inhabitants joining urban areas every week. Since 2008 over half the world's population, that is to say 3.3 billion people, is now living in an urban environment. This figure will reach around 5 billion in 2030, and in 2050, 65% of people will live in urban areas. According to United Nations, by 2020 about 60 million people will migrate from sub-Saharan regions to North Africa and Europe, a flow which will increase the current high migration trend. The urban population issue is perhaps the most complex and crucial aspect of the sustainable human development problem. In many regions of the world, the natural increase in population has a greater effect on internal urban growth than the rural exodus.

The future of Europe will be an urbanized future. Urbanization faces the grand challenges our society is confronted with, and simultaneously contributes to their scale and scope. European urban areas have to respond properly and urgently to avoid becoming less attractive to creative talents and firms and degrading in 'liveability'.

This leads to a new '*urban imperative'* and raises the question of long-term strategies for sustainable development. In this context, the European Commission has recently launched the Joint Programme Initiatives "Urban Europe" (JPI-EU) with the goal of developing innovative approaches to adequately address the above mentioned challenges and to create urban places of vitality, liveability and accessibility. To reach these goals JPI-UE provides a systemic long term and strategic approach which takes advantage of emerging technologies, assessing their potential and socio-economic impacts and utilising them in fundamentally new urban policies and design strategies (Nijkamp, and Koutrik, 2011).

The JPI-UE research programme is based on four interlinked cornerstones: economic vitality, smart logistics and sustainable mobility, social participation and social capital, and ecological sustainability. To extract a systematic and coherent research programme from these cornerstones, the JPI-UE has developed four thematic urban images based on stylized appearances of urban agglomerations in the year 2050:

- smart logistics and sustainable mobility – Connected City 2050
- economic vitality – Entrepreneurial City 2050
- ecological sustainability – Liveable City 2050
- social participation and social capital – Pioneer City 2050

All the developed city visions are connected to the concept of "Smart city" which has been quite fashionable in the policy arena in recent years. A Smart city is usually understood as a city with a high urban quality and a capacity to innovate by developing integrated actions regarding all aspects of economy, environment, quality of living, governance, transport and ICT. Therefore, smart urban development is based on a strategic vision and new approaches to policies and urban planning encompassing both efficient management of territorial resources and cultural identity through the use of advanced technologies (Komninos, 2002; Shapiro, 2008; Deakin, 2010).

This paper aims to offer an evaluation of the JPI-EU policy visions on the basis of an analysis of the interrelations between "Smart" cities components and sectors of innovation. It adopts a novel framework for understanding Smart city relationships called the triple helix approach. The triple helix model has emerged as a reference framework for the analysis of knowledge-based innovation systems, and relates the multiple and reciprocal relationships between the three main agencies in the process of knowledge creation and capitalization: university, industry and government (Etzkowitz, 2008).

This analysis of the triple helix is supported and augmented using the Analytic Network Process (ANP) in order to model, cluster and begin measuring the performance of Smart cities. The model obtained allows interactions and feedbacks within and between clusters, providing a process to derive ratio scales priorities from elements (Saaty, 2005). This offers a more truthful and realistic representation on which to support policy making. The model is applied by using a full list of indicators, available at the urban level, and a utilizing a focus group that supported judgments for deriving priorities.

2. Development of a framework for evaluating Smart cities performances

The application of information and communication technology (ICT) in the context of future cities is often indicated by the notion of a Smart City. Compared to the concept of a digital city or an intelligent city (Lombardi et al., 2009), the main focus of a Smart City is not limited to the role of ICT infrastructure, but instead focuses on the role of human capital/education, social and relational capital and environmental issues. These are considered important drivers of urban growth. Although the term "Smart City" is not very widely used yet in spatial planning literature or regional and urban studies, it is still possible to identify various aspects of the concept as a basis for further elaboration. However, it should be noted that, in the literature, the term is not used in a holistic way; rather, it is often related to various aspects of urban life which range from economy to education.

In association with economy, the term Smart City is used to describe a city based on smart jobs or smart industries, i.e. the adoption of a modern business lifestyle and culture in a digital economy. This term recognizes that modern dynamic sectors of the economy, in particular the ICT sector, have the potential to generate high returns. In addition, access to knowledge and information is considered a key entrepreneurial factor for success in an uncertain dynamic urban business environment (Wakelin, 1990; Acs et al., 2002; Giffinger et al., 2007; Fusco Girard et al., 2009; Caragliu et al., 2011). The term Smart City is also used in relation to the training and education of citizens. A Smart City therefore has smart inhabitants in terms of talent, skills and formative level (Benner, C. 2003; Florida, 2002). This concept is also linked to the influence and role that the university can have on local economy by creating living labs and innovation. Such living labs benefit from interactions among companies, universities and research institutes as well as governmental institutions and organisations because these shape the urban innovation system and highlight their role as centres of excellence (Torres, 2005). Furthermore, the term Smart City is used to illustrate the use of modern technology in everyday urban life. This includes both the relationship between the city government administration and its citizens as well as modern transport technologies. On one side, good governance or smart governance, often refers to the usage of new channels of communication for the citizens, e.g. "e-governance" or "e-democracy" (Rosenthal and Strange, 2001; Lombardi et al., 2009). On the other side, logistics as well as new transport systems are "smart" systems which improve urban traffic and the inhabitants' mobility. Various other aspects are mentioned in the literature in connection with the term Smart City like security/safety, green, efficient and sustainable, energy etc. (Benner, 2003, Komninos, 2007; Giffinger et al., 2007; Caragliu et al., 2011). In summary, there are several fields of activity and a number of main dimensions described in literature in relation to a Smart City (Giffinger et al., 2007; Van Soom, 2009; Fusco Girard et al., 2009). These dimensions include smart economy, smart mobility, smart environment, smart people, smart living, and smart governance. These six dimensions connect with traditional regional and neoclassical theories of urban growth and development. In particular, the dimensions are based, respectively, on theories of regional competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and participation of citizens in the governance of cities.

In order to explore the concept of a Smart city, an innovative conceptual framework has been suggested in this paper which is based on the triple helix approach (Etzkowitz, 2008). This model has recently emerged as a reference for the analysis of knowledge-based innovation systems, and relates the multiple and reciprocal relationships between the three main agencies in the process of knowledge creation and capitalization: University, Industry and Government (Leydesdorff and Deakin, 2011). In the Triple Helix innovation model, university-industry-government work together to achieve regional or national innovations in science and technology, forming a mutually beneficial relationship. The triple helix model is composed of three basic elements (1) a more prominent role for the university in innovation, on a par with industry and government in a knowledge –based society; (2) a movement toward collaborative relationships among the three major institutional spheres in which innovation policy is increasingly an outcome of interaction rather than a prescription from government; (3) in addition to fulfilling their traditional functions, each institutional sphere "takes the role of the other" in some regard. For instance, universities, traditional providers of human resources and knowledge, are now critical socio-economic development actors, performing a "Third mission", in addition to research and teaching (Etzkowitz and Leydesdorff, 2000).

Although the above mentioned model is able to generally explain innovation, it is clearly missing a relevant actor in the discussion of sustainable urban development, alongside the university, the industry and the government. The civil society plays a key role in innovation next to these three institutional spheres This was first highlighted by Etzkowitz and Zhou (2006) who explain, "University–industry–government relations, based on reciprocal principles, focus on the positive aspect of S&T development. When issues arise, the public starts to play a distinct role, directed toward redressing the negative consequences of S&T development or innovation". In the innovative university–industry–government Triple Helix model, three institutional spheres interact to achieve innovation. Thus, the university–industry–government Triple Helix is basically in alignment. However, there may be some conflicts between innovation and application of new ICT solutions in society. Only the inclusion of civil society in the model can guarantee the achievement of innovation in cities. This advanced model presupposes that the four helices operate in a complex urban environment, where civic involvement along with cultural and social capital endowments shape the relationships between the traditional helices of university, industry and government. The interplay between these actors and forces determines the success of a city in moving on a smart development path. The final framework includes both the above mentioned sectors or helices of innovation, i.e. *University*, *Industry*, *Government* and *Civil Society*, and the identified clusters or main components of a Smart city, i.e. *Smart Governance* (related to participation)*; Smart Human Capital* (related to people)*; Smart Environment* (related to natural resources)*; Smart Living* (related to the quality of life) and *Smart Economy* (related to competitiveness).

This framework has been used for classifying a number of Smart city performance indicators, as shown in Table 1. The sources of this data include both a detailed and focused literature review, including EU projects' reports and Urban Audit dataset and indicators selected from statistics of European commission, European green city index, TISSUE, Trends and Indicators for Monitoring the EU Thematic Strategy on Sustainable Development of Urban Environment and Smart cities ranking of European medium-sized cities (Giffinger et al., 2007; Van Soom, 2009; Deakin, 2010; Caragliu et al., 2011) and a focus group with specialists and professionals. The final list includes more than 60 indicators classified in the five clusters mentioned previously. For instance, an indicator such as "Public expenditure on R&D" has been identified as "SMART Economy" and linked to UNIVERSITY. Another example states that the number of lectures or courses which can be downloaded from the Internet is a UNIVERSITY performance indicator belonging to a "SMART Governance" category. This classification has been used for structuring an ANP (Analytic Network Process) exercise (Saaty, 2005) with the aim of investigating the relations between Smart cities components, actors and strategies. This exercise was conducted within a focus group, involving a number of experts in different disciplines as described in the next section.

Table 1
Smart Cities' components, revised triple helix sectors and performance indicators

	SMART Governance	**SMART Economy**	**SMART Human Capital**	**SMART Living**	**SMART Environment**
UNIVERSITY	N. of universities, research centres in the city	Public expenditure on R&D - % of GDP per head of city	% of population aged 15-64 with secondary level education (Urban Audit)	% of professors & researchers involved in international projects and exchange	An assessment of the ambitiousness of CO2 emissions reduction strategy
	N. courses entirely downloadable from the internet / Total No. Courses	Public expenditure on education - % of GDP per head of city	% of population aged 15-64 with high education (Urban Audit)	Number of grants for international mobility per year	An assessment the extensiveness of city energy efficiency standards for buildings
		Number of research grants funded by international projects	% of inhabitants working in education and in research & development sector	% of accessible courses	
GOVERNEMENT	E-government on-line availability (% of the 20 basic services which are fully available online)	Gross Domestic Product per head	Voter turnout in national and EU parliamentary elections	Proportion of the area in recreational sports and leisure use	Total annual energy consumption, in gigajoules per head
		Debt of municipal authority per inhabitant	Share of female city representatives	Green space (m2) to which the public has access, per capita	Efficient use of electricity (use per GDP)
	Percentage of households with computers	Median or average disposable annual household income	City representatives per resident	Number of public libraries	Total annual water consumption, in cubic metres per head
		Unemployment rate		Number of theatres & cinemas	Efficient use of water (use per GDP)
	Percentage of households with Internet access at home	Energy intensity of the economy - Gross inland consumption of energy divided by GDP		Health care expenditure - % of GDP per head of city	Area in green space (m2)
					Greenhouse gas emissions intensity of energy consumption
				Tourist overnight stays in registered accommodation in per year per resident	An assessment of the comprehensiveness of policies to contain the urban sprawl and to improve and monitor environmental performance
					Urban population exposure to air pollution by particulate matter - micrograms per cubic metre
CIVIL SOCIETY	E-government usage by individuals (% individuals aged 16 to 74 who have used the Internet, in the last 3 months, for interaction with public authorities)	% of projects funded by civil society	Foreign language skills	Total book loans and other media per resident	The total percentage of the working population travelling to work on public transport, by bicycle and by foot
			Participation in Life-long learning (%)	Museums visits per inhabitant	An assessment of the extent to which citizens may participate in environmental decision-making
			Individuals' level of computer skills	Theatre & cinema attendance per inhabitant	An assessment of the extensiveness of efforts to increase the use of cleaner transport
			Individuals' level of internet skills		% of citizens engaged in environmental and sustainability oriented activity

Table 1 (Cont'd)
Smart Cities' components, revised triple helix sectors and performance indicators

	SMART Governance	SMART Economy	SMART Human Capital	SMART Living	SMART
INDUSTRY	Number of research grants funded by companies, foundations, institutes / No annual scholarships	Employment rate in: - High Tech & creative industries - Renewable energy & energy efficiency systems - Financial intermediation and business activities - culture & entertainment industry - commercial services - transport and communication - hotels and restaurants	Patent applications per inhabitant	Number of enterprises adopting ISO 14000 standards	The percentage of total energy derived from renewable sources, as a share of the city's total energy consumption
					Combined heat and power generation - % of gross electricity generation
		All companies (total n.)	Employment rate in knowledge-intensive sectors	Rate of people undertaking industry based training	Rate of recycled waste per total kg of waste produced
		Number of local units manufacturing High Tech & ICT products			
		Companies with HQ in the city quoted on national stock market			Total CO2 emissions, in tonnes per head (2)
		Components of domestic material consumption			% of new buildings and renovation, sustainability certification

3. Assessing the Smart city's visions of the future

In order to adequately address urban challenges and to create urban places of vitality, liveability and accessibility, the JPI-UE research programme has identified the following four interconnected urban images:

The Connected City (smart logistic and sustainable mobility): The image of a connected city refers to the fact that in an interlinked (from local to global) world, cities can no longer be economic islands ('no fortresses'), but have to seek their development opportunities in the development of advanced transportation infrastructures, smart logistic systems and accessible communication systems through which cities become nodes or hubs in polycentric networks (including knowledge and innovation networks).

The Entrepreneurial City (economic vitality)*:* This image assumes that in the current and future global and local competition, Europe can survive only if it is able to maximize its innovative and creative potential in order to gain access to emerging markets outside Europe. Cities are then spearheads of Europe's globalization policy.

The Liveable City (ecological sustainability): This vision addresses the view that cites are not only energy consumers (and hence environmental polluters), but may through smart environmental and energy initiatives (e.g., recycling, waste recuperation) act as engines for ecologically-benign strategies This allows cities to act as climate-neutral agents in a future space-economy, and cities in Europe are then attractive places to live and work.

The Pioneer City (social participation and social capital): This image refers to the innovative 'melting pot' character of urban areas in the future, which will show unprecedented cultural diversity and fragmentation of lifestyles in European cities. This will prompt not only big challenges, but also great opportunities for smart and

creative initiatives in future cities, through which Europe can become a global pioneer.
These four thematic urban images on stylized appearances of urban agglomerations in the year 2050 are evaluated using the framework described in Section 2 with the support of the ANP model. This consists of five clusters of Smart cities components, the cluster of the four urban visions, and the sixty selected indicators. A structured ANP model has been developed which involves the clusters of a Smart city, i.e. Smart Governance (related to participation), Smart Human Capital (related to people), Smart Environment (related to natural resources), Smart Living (related to the quality of life) and Smart Economy (related to competitiveness). The relationships between indicators (and clusters) has been identified by using a "control hierarchy", composed of the four axes of the adopted Triple Helix, i.e. University, Industry, Government, Civil Society, as shown in Figure 1.

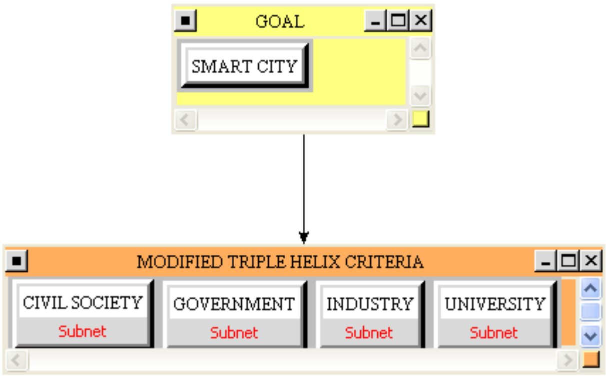

Figure 1The main network

Each axis is organised by a sub-network consisting of:

- The five clusters representing the above mentioned Smart cities component/activities including the relative selected indicators;
- A cluster of alternatives composed of four policy visions (or prototypes) of Smart cities in 2050, as derived from the "Urban Europe" Joint Programme Initiatives (P. Nijkamp, K. Kourtik, 2011): *Connected City*, *Entrepreneurial City*, *Liveable City* and the *Pioneer City*.

Figure 2 shows an example of the Civil Society sub-network. Bidirectional relationships have been recognized between "Smart Human Capital" and "Smart Living" by means of indicators such as "Museums visit per inhabitant", "Theatre and cinema attendance per inhabitant", and "Total book loans and other media per resident". "Smart Economy" and "Smart Environment" have a bidirectional relationship by means of indicators such as "Percentage of projects funded by civil society" and "Relationship to percentage of citizens engaged in environmental and sustainability oriented activities". In addition, a number of mono-directional relations are recognized between: "Smart Governance" and "Smart Human Capital", "Smart Economy" and "Smart Human Capital", and "Smart Human Capital" and "Smart Environment".

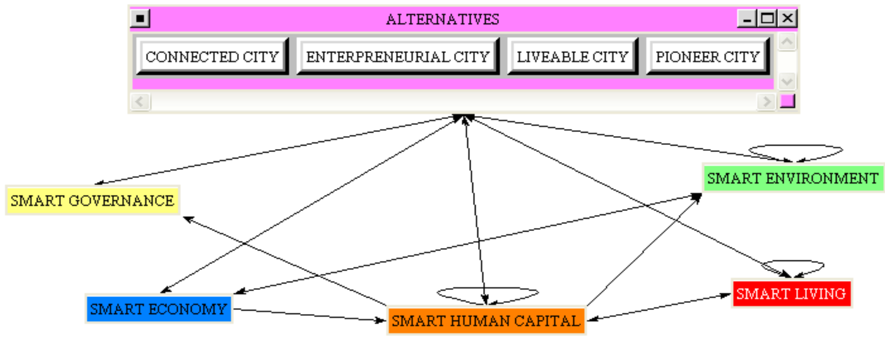

Figure 2 The Civil Society sub-network

The subsequent step of the ANP application requires the development of pair wise comparisons of both elements (or nodes) and clusters. This assessment exercise was conducted within a focus group composed of a group of stakeholders belonging to all the identified sectors: university, industry, government, and civil society. Focus group members had heterogeneous backgrounds and expertise in the following areas: environmental engineering, evaluation of the built environment sustainability, design, planning and micro-economy.

Although all the performance indicators included in the ANP model are quantitative and measurable, this assessment exercise was conducted through judgment attribution not by using statistical data. The reason for this is that quantitative data were not available for the investigated areas, i.e. the four city visions. This was a pilot assessment exercise with the goal of comparing different urban images of the future. However, a quantitative evaluation is possible and feasible if one wishes to evaluate and rank different cities on the basis of their performance in the present.

During the exercise a pair wise comparison was carried out both between clusters and nodes (indicators). In each pair wise comparison matrix a ratio scale of 1-9 was used. Figure 3 shows one of the several pair matrices used to derive weighted priority vectors of elements (Saaty, 2001). In particular, the figure shows the cluster comparison matrix for the alternatives.

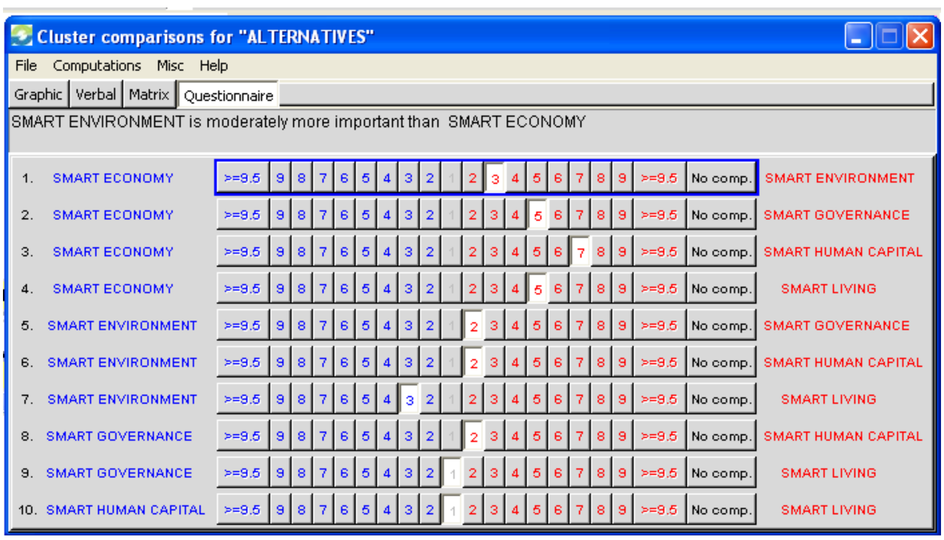

Figure 3 Pair wise cluster comparison using Saaty's fundamental scale

Judgments/assessments have been done for the performance indicators in each sub-network. The performance indicators (children nodes) are connected from the same cluster of Smart City components (parent node), and are assessed with respect to how they influence that node, or how that node influences them. For instance, in the Civil Society sub-network, it was asked whether the “Percentage of projects funded by civil society” is more influential than the “Relationship to percentage of citizens engaged in environmental and sustainability oriented activities” in relation to Smart Economy. As recommended by Adams and Saaty (2003), influence has been treated consistently (how the parent influences the children, or vice versa) but the flow direction has been kept the same throughout the network and the model. The software used for making comparisons and for deriving priorities allows one to know in real time the comparisons coherence level. Inconsistent answers were re-submitted to the participants until an acceptable compromise was found. Nonsense questions, such as “With respect to the Alternatives, which is more important (or is more influencing)?, the Alternative cluster or the Smart Economy cluster?”, were left unanswered; in this case, the system, by default, assigns a 1 point judgment score to them.

The final priorities have been derived from each sub-network. Table 2 shows the final priorities (%) of the four urban visions in each sub-network. I In all the four rankings the preferred alternative is the Entrepreneurial City. The second position is different only in the Civil Society sub-network. Here, the Pioneer City assumes a high priority while, in all the other sub-networks, the Livable City is the second preferred vision. The ‘worst’ alternative is the Connected City for both University and Civil Society while it is the Pioneer City for both Government and Industry.

Table 2
Final priorities (%) assigned to the alternatives related to each sub-network

	UNIVERSITY	**GOVERNMENT**	**CIVIL SOCIETY**	**INDUSTRY**
Connected City	14	16	16	16
Entrepreneurial City	47	47	36	48
Livable City	21	23	18	22
Pioneer City	18	14	30	14

In addition to ranking the alternatives, a synthesis of the priorities for each node (performance indicator) has been derived in each sub-network. For instance, Figure 4 shows the performance indicators with the highest priorities in the Civil Society. Both “the e-government usage by individuals” and “the percentages of projects funded by civil society” are the two performance indicators with the highest priorities. These indicators belong respectively to the “Smart Governance” cluster and “Smart Economy” cluster. This sufficiently explains why the Entrepreneurial City and the Pioneer City are the two preferred alternatives. Figure 4 illustrates the most preferred indicators in each sub-network.

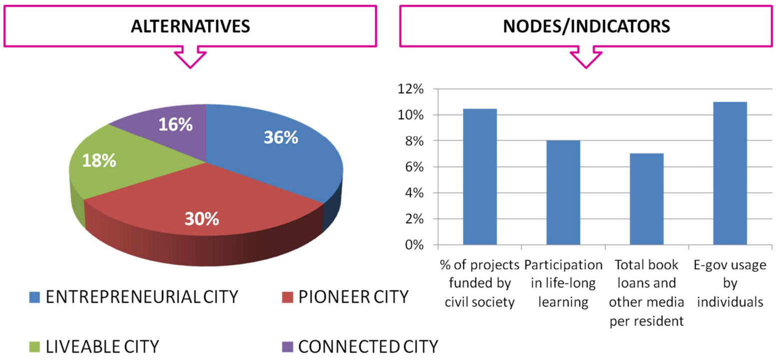

Figure 4 Final priorities of both alternatives and nodes (indicators) in the Civil Society sub-network

The results obtained in each sub-network are useful information for a decision-maker as they highlight the most preferred performance indicators, identifying a short-list of key performance indicators, as it is shown in Table 3.

Table 3
The Smart Cities' key performance indicators

	SMART Governance	**SMART Economy**	**SMART Human Capital**	**SMART Living**	**SMART Environment**
UNIVER SITY	N. of universities, research centres in the city	Public expenditure on education - % of GDP per head of city	% of inhabitants working in education and in research & development sector		An assessment the extensiveness of city energy efficiency standards for buildings
GOVERNEMENT	Percentage of households with Internet access at home				
CIVIL SOCIETY	E-government usage by individuals (% individuals aged 16 to 74 who have used the Internet, in the last 3 months, for interaction with public authorities)	% of projects funded by civil society	Participation in Life-long learning (%)	Total books and other media loan per resident	
INDUSTRY	Number of research grants funded by companies, foundations, institutes / No annual scholarships	Employment rate in: - High Tech & creative industries	Patent applications per inhabitant Employment rate in knowledge-intensive sectors		

Finally, a ranking of the four urban visions has been obtained by synthesizing the priorities of the alternatives from all the sub networks. In order to derive the final priorities, the following combining formula has been used: $NormalNet(Civil Society) * $SmartAlt (Civil Society) + $NormalNet (Government) * $SmartAlt (Government) + $NormalNet (Industry) * $SmartAlt (Industry) + $NormalNet (University) *$SmartAlt (University).

The overall priorities of the alternatives obtained are as follows:
1. Entrepreneurial City (48%)
2. Pioneer City (20%)
3. Livable City (17%)
4. Connected City (13%)

4. Conclusions and further steps

This paper has illustrated a study in the field of Smart cities' evaluation. The analysis began with a revised notion of the Triple Helix approach. This revision is based on the consideration that Civil Society usually plays a prominent role toward the realization of sustainable development in cities (Etzkowitz and Zhou, 2006). In order to assess the connections between Smart city development and this institutionalization of the Triple Helix approach, an ANP model has been developed. The development of this model, as well as the assessment exercise, is the result of a participative process, involving a number of people with urban expertise such as, urban planning, sustainable development evaluation, urban sociology and urban economy. This model has been used to investigate the relationship between smart cities components, actors and visions, or strategies.

The ANP model that was developed is not only able to underline the complexity of an urban system, but it also shows the relationships and the inter-connections between all the constituting elements of a Smart cities vision. The main innovative features of the model are:

- The introduction of the Civil Society as a crucial stakeholder that empowers the classical Triple Helix model composed by University-Government-Industry.
- A more truthful and realistic city model representation based on a network system with the expression of relationships between elements.
- The use of the four helices, representing the main stakeholders operating in a smart urban development, as control criteria for modelling the decision making problem.
- A measurement of a "Smart city" policy vision, considered as an holistic, interrelated, multi- stakeholders concept, which requires both quantitative indicators as well as experts' opinions.

This interrelated model has been used for both assessing four urban images as derived from the Joint Programme Initiatives "Urban Europe" (JPI-EU) and selecting the key-performance indicators for a Smart city.

The most relevant indicators are related to "Smart Governance" and include the following:

- Number of universities, research centres in the city
- Percentage of households with Internet access at home

- E-government usage by individuals (% of individuals aged 16 to 74 who have used the Internet, in the last 3 months, for interaction with public authorities)
- Number of research grants funded by companies, foundations, institutes / number of annual scholarships

The most relevant indicators belonging to "Smart Economy" are:

- Public expenditure on education - % of GDP per head of city
- % of projects funded by civil society
- Employment rate in high-tech and creative industries

Finally, "Smart Environment" and "Smart Living" include, respectively, "An assessment of the extensiveness of city energy efficiency standards for buildings" and "Total books and other media loan per resident".

A second relevant result of this exercise is the ranking of the urban visions. The final results show that *the Entrepreneurial City* is the policy vision with higher priorities in all the sectors considered in the model, i.e. Universities, Government, Industry and Civil Society. Some relevant urban planning and policy implications of this vision are as follows:

- A high degree of entrepreneurial activities and a constant flow of new firm creation is a prerequisite for finding a role within the new global economic landscape. Innovation and creativity are thus the necessary ingredients for entrepreneurial cities in Europe.
- Special emphasis has to be given to new architectures, building technologies, intra-urban mobility solutions, public space management, e.g. for lighting or citizen information management, integrated urban energy planning and management and ICT-based solutions that offer various opportunities for new urban design and management.
- New requirements for efficient, effective and reliable infrastructures (such as energy, ICT, water, waste treatment and management etc) may occur. Since an appropriate infrastructure is essential for a cities´ attractiveness to companies and people and therefore to their economic development, emphasis has to be given to the determination of these requirements within the scope of cities as complex systems.

In conclusion, the results obtained from this exercise are interesting, but clearly the model requires further implementation and improvement. This assessment exercise is a pilot study, and still requires the development of a testing exercise with the participation of main city stakeholders, offering a reflexive learning opportunity for the cities to measure what options exist to improve their performances. The author's plan is to develop this in the future.

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