LAETITIA MAGNIEZ

4 *Smart Cities: System Thinking Theory and Smart City Concept Applied to Vienna and Fujisawa SST*

Tutor: Tomasz Olejniczak, PhD

Laetitia Magniez – graduated in Management from the Polish Business School of Kozminski University. Rich of her foreign experiences in Poland and Japan, she is currently working in digital marketing. As her article confirms, she is driven by a passion in sustainable solutions.

1. Introduction

Our world is facing important issues: rising number of natural disasters, global warming and climate change, migration and most importantly, urbanization.

In 2008, the equilibrium between rural and urban population switched. We have now far more people living in cities. Within a decade, the number of megalopolis will have extend to 2 to 35 (*Le dessous des cartes*, 2012). All those facts are components of a bigger system, a bigger picture and a bigger status of problems.

One of solutions to these issues is the Smart City initiative. A Smart City is trying to solve multidimensional issues in the mobility field the energy field, the security field and the social community and wellness field.

Because people are moving easily from a city to another, from a country to another or from a continent to another, the migratory flux is increasing. Welcoming and accommodating all these people in cities is a challenge. Furthermore, once they are in the city, they need to circulate, which implies the need of a developed infrastructure network. They need to live there, they will consume energy, fossil or green according to the city's policies. They will also need to feel well, to integrate and to become part of the community. The geographical and decisional centers of all those requirements are the cities. As economical and political centers, they are key to our future. It is then not a surprise to see smart cities flourishing around the world to help or create better cities. Different models are doable depending on multiple factors and conditions.

In this research, we will focus on how Smart Cities work and see if we can establish a pattern behind their organization. The research will therefore attempt to answer the following question: How can system theory be applied to analysis and comparison of the recent phenomena Smart Cities? In order to do so, we will focus on two types of smart cities that we will analyze using comparative case methodology:

- The ones built from the scratch, from an empty land
- The ones built with layouts added to an already existing city

We will analyze their main dimensions and focuses, their model of management and of financing and their current plans for the future.

2. Literature review

Systems have theoretical framework. The System thinking Theory helps understanding the complexity of systems and their retrospectivity taking in

consideration quantitative and qualitative factors (Anderson and Johnson, 1947). It allows the researcher to have a broad picture, being time rational and conscious.

Definition of a system

A system is made of multiple components interacting, interrelating or interdepending form a whole (Anderson and Johnson, 1947; Jackson, 2003; Williams and Hummelbrunner, 2010; Kozminski, 1979; Ramage and Shipp; 2009). Jackson (2003) identified systems such as physical, biological, designed, abstract, social and human activities. Systems are multiple, interacting or interdependent and are usually embedded in bigger systems so called networks (Anderson and Johnson, 1947). Boundaries of systems needs to be defined prior any study related by deciding constraints (Williams and Hummelbrunner, 2010).

According to Williams and Hummelbrunner (2010), systems have the following characteristics:

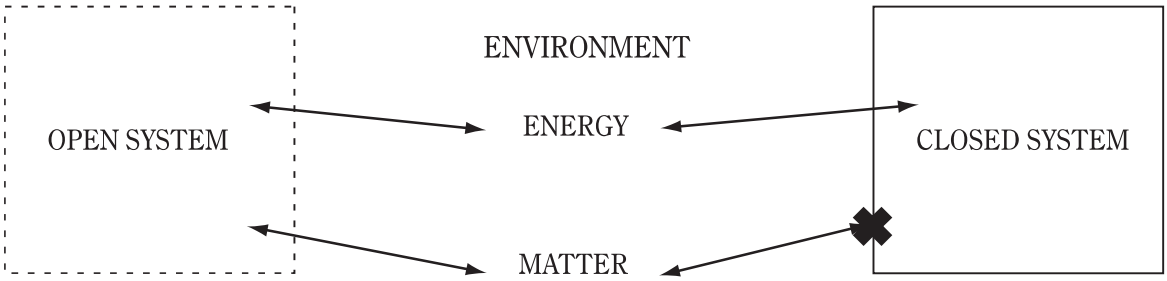
- They only function as a whole: if one element is removed, the system stops working.
- A specific arrangement is required for the system to carry out its purpose.
- Systems have specific purposes within larger systems
- Systems maintain their stability through fluctuations and adjustments.
- Systems have feedback.

In case of complex systems, the literature describes additional characteristics:

– self-stabilizing: thanks to numerous components, the stability is easier to reach but complexes the evolution.
– purposeful: Goal achievement is reinforced by certain flows of actions between components that are required to perform together.
– Feedback (like regular systems): usage to modify their behavior
– Influences their environment: usage of their environment to increase the chances of goal achievement.
– Replication, maintenance, repair and self-reorganization.

Additionally, Ludwig von Bertalanffy applied thermodynamics concepts to describe a distinction within systems: openness and closeness. "An open system has a clear boundary, and thus a distinction between the inside of the system and the outside (its environment), but it is possible for both matter and energy to cross the boundary; by contrast, in a closed system it is only possible for energy to cross the boundary" (Bertalanffy, 1950), see Figure 1.

Figure 1. Open system vs. Closed System based on Bertalanffy's description



Source: own elaboration.

To determine the essence of Smart Cities, we will focus here on their context and their definitions in the contemporary literature.

The International Panel on Climate Change stated in its Fifth Assessment Report (later on referred as AR5, 2014) that the deterioration of our climate stability was caused by human influences and mostly driven by our development. The OECD experts came with findings that the city-scale vulnerability is subjective to location, economy, and size. They emphasized the need of early actions (such as system planning) against awareness raising.

Cities are more subjective to suffer from climate change due to their interconnectedness between inhabitants, the immediate hinterland and the macro economic and social environment (Weitzman, 2009, IBM 2010).

A global solution to face Climate Change is the development of Smart Cities – a model of urbanization based on "the utilization of human, collective, and technological capital for the development of urban agglomerations" (Angelidou, 2014, p. S3). The concept of intelligent city has been developed since many decades (Ford, 1913; Schultz and McShane, 1978; Fairfield, 1994). It usually includes strategic planning to fulfill a vision for a long-term aspiration (Russell, 2015).

Ben Letaifa (2015) indicates the most common indicators to build a Smart City: smart people, smart governance, smart mobility, smart environment, and smart living and smart economy (Giffinger et al., 2007). They are also referred as Smart Urbanism by Russels (2015) and by the European Commission (2012). Additional ones can be found in the literature such as national. local, hard/soft infrastructure, economic. geography based (Angelidou, 2015). A distinctive characteristics made is between cities created from the scratch and the ones adding a layer of Smart City (Shelton, Zook and Wiig, 2014).

- Smart people – This indicator is linked with the social capital and equality in the society based on education, gender parity, social diversity, tolerance, creativity and engagement.

- Smart governance – This indicator is linked with services offered by the government such as e-services. It also includes transparency in strategy, decision-making process and actions from the government.
- Smart mobility – Smart mobility is linked with urban planning and consequently with modes of transportation (public, shared or private, electric or motorized).
- Smart environment – This dimension is linked with energy creation, management and consumption as well with green house gases emissions and enhancement and preservation of natural environment in cities.
- Smart living – Smart living concerns the quality of life of residents and visitors in terms of services, social cohesion and safety. Smart living includes cultural facilities, e-health, social services, and public safety tools, such as surveillance systems and inter-emergency service networks (Toppeta, 2010).

Angelidou (2015) acknowledge criticisms about management of Smart City: "complex ecosystems of people, institutions and stakeholders are significantly harder to organize and discipline (Bélissent, 2010; Ratti and Townsend, 2011) and special attention should be given to issues of accessibility for all, avoiding digital disparities and spatial polarization" (Angelidou, 2015, p. 103). Shelton, Zook and Wiig (2014) raised concerns on the possible technocratic governance and the potential for mass surveillance (also mentioned by Hollands, 2008; Sennett, 2012; Greenfield, 2013; Halpern et al., 2013; Kitchin 2014; Vanolo 2014; Luque-Ayala and Marvin, 2015). Harisson and Townsdend (2013) emphasized the idea that "looking smart, even more than being smart, was the real force driving mayors into the arms of engineers" (p. 68).

The amount of characteristics, elements and stakeholders involved in the development of Smart Cities make the organization system hard to clarify. A multiplication of models can be found in the literature, and it seems difficult to identify a pattern. Answers to conceptual questions remain vague. There is a need to identify a theoretical grounding fitting the definition of a system: multiple components (tangible or intangible) interacting, interrelating or interdepending form a whole, with constraints, boundaries and exchange (full or limited) with the environment (Anderson and Johnson, 1947; Williams and Hummelbrunner, 2010; Kozminski, 1979; Ramage and Shipp, 2009).

3. Methodology

From the research in the literature review, we identified the gap present on Smart Cities. For this reason, we would like to discuss two Smart Cities to

determine if they match the same theoretical framework and in which proportions. Consequently, the research question of this study is:

How can system theory be applied to analysis and comparison of the recent phenomena Smart Cities?

The chosen methodology here is the case study. It is a traditional research tool used by scientist such as Yin (2003) and Woodside (2010) in many fields. Its purpose is to help understanding current circumstances and phenomenon. It is adequate to test proposition.

According to Yin (2003), a case study is "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident". In other words, a case study concerns a real phenomenon that can be studied in depth. He also identified a "logic of design": the scope of a case study and its inquiry.

Case study methodology suffers however numerous criticisms. The most global one concerns the lack of rigor used in case study methodology: it is difficult for a researcher to stay in the systematic procedures and to keep resources and findings unbiased. The second critic discuss the utilization of the case study methodology, for instance as focused teaching tool or as objective research method. An important critic is about the establishment of generalizations from cases, especially over time. Kennedy (1976) and Yin (2003) answered here that "case studies, like experiments, are generalizable to theoretical propositions and not to population or universes" and that they should be conducted on sufficient period of time.

The case study methodology presents advantages such as its flexibility in terms of number of cases included, the type of data (quantitative and/or qualitative).

This methodology can be used in four cases according to Yin (2003):

- explanation of real-life phenomenon difficult to explain by surveys or experiments.
- description of an intervention of its context.
- illustration of certain topics within an evaluation, joining the descriptive application.
- enlightenment of unclear outcomes of interventions in context.

The multiple case study (used here as a comparative study) brings more evidence as it combines more info and build robustness (Herriott and Firestone, 1983). Each case will bring something to the study, but they have to use the same patterns. In this study, we collected evidence from the field, from interviewees and their offices as well as from various documents they provided and from

Internet for two cases Smart Cities Fujisawa Sustainable Smart Town and Vienna (with two bodies: the Smart City Wien Agency and the ASCR).

During the study, the data was collected in the following manner (see Table 1).

Table 1. Data collection procedure

Research	Fujisawa SST	Vienna
Field study	Yes – June 2015	Yes – January 2016
Interviews	1	2 Smart City Wien Agency ASCR
Languages spoken by the interviewees	Japanese, English	Austrain, German, English
Data collected	Yes Documentation in Japanese, few in English	Yes Full documentation in English
Barriers encountered	language	none

Source: own elaboration.

Protocols were established for data collections and interviews, with a certain list of topics. They form the structure of the inquiry.

Data analysis was performed in the following way: establishment of a list of key elements and problems encountered during the readings, interviews and observations; broadening of the perspective and grouping elements into bigger categories; structuring.

The study encountered limitations in terms of lack of transparency and complexity of the local authority structure (especially in Vienna) and communication issues/ protectionism behaviors and cultural differences (especially in Fujisawa SST).

4. Results

4.1. Case 1: Fujisawa Sustainable Smart Town – Japan

The Japanese economy, population and overall situation suffered tremendously from climate changes impact. Consequently, the country had to think fast and hard to establish possible solutions in order to adapt. With global resources depletion and overpopulation in the megalopolis Tokyo, the state needed a strong governance and the development of more resistant infrastructures as well as a switch from precarious fossil energies.

Before the Fukushima incident, Japan was almost fully relying on fossil resources: 13% on nuclear power, 22% on coal, 18% on natural gas and 42% on oil. Hydrogen was only 3% and renewable energy for 1%[1]. Different actors had strong interests (financial and notorious) in the establishment of Smart City Initiatives in Japan, including various central agencies, governmental bodies and multinational enterprises. As Smart Cities were developing over the country, Panasonic Corporation launched its own project: Fujisawa SST located in Fujisawa city, Kanagaya Prefecture[2].

Fujisawa SST intended to build 1000 households with a timeline of 100 years. The quality of life will be there achieved by a focus on 5 dimensions: advanced technology-based infrastructure, community design, energy management and renewable energy, actual lifestyle-based on innovative systems and security. The full completion of the project should be done a decade after its start – 2018. The motto of this vast action is "Bringing Energy to Life[3]". Targets were established in the three following areas: environment, energy and security; in other words, a reduction of 70% of CO_2 emissions (compared with 1990 levels), 30% of energy from renewable energy and a security target of 3 Days of Lifeline maintenance to face natural disaster.

3 poles energy: energy-saving technologies, energy-creation and energy-storage

To create energy, houses and public spaces are equipped with solar panels that can generate roughly 3 MW from solar modules. Energy-storage is managed by powerful storage batteries on each house. In case of natural disaster, this energy can be used and shared to keep the town powered. Energy saving is possible thanks to a house management system called SMARTHEMS: SMART Home Energy Management System. It allows residents to be advised, control, understand and adapt the energy consumption of their habitation on usage such as lightening, home appliances and air conditioners[4]. Undoubtedly, houses are also equipped with energy-saving technologies. Based on their overall behavior, inhabitants are also receiving guidance on how to enhance eco-friendly consumption and budget-pleasing support.

Fujisawa SST is a virtual gated town: streets are monitored by camera and few concierge making patrols. High level security is a standard that has to be

[1] Energy & Capital – American research firm, http://www.energyandcapital.com/articles/panasonics-japanese-smart-town/3485 (25.01.2016).

[2] http://fujisawasst.com (05.02.2016).

[3] http://news.panasonic.com/global/topics/2012/13633.html (5.02.2016).

[4] http://panasonic.net/es/solution-works/HouseEnergy/ (5.02.2016)

reached as, in Japan, respect and safety are part of the communities and of the protectionist culture. The "passive design" of the city was made in such way that it optimizes the circulation of natural light and fresh air from winds.

Mobility is enhanced in the city by the provision of electrical cars, electric scooters and electric assisted bicycles that can be booked online via the town's application for residents. Regular vehicles can be inspected in order to optimize their gas consumption and reduce their pollution. Fujisawa SST put a strong emphasis on the construction of community and wellness of inhabitants. The goal is to create a lifestyle adapted to current energy policies and re-establish a strong community with shared knowledge (common places of discussions, cafes and library). By enhancing social interactions and a tight network, a strong sense of community will raise. To guarantee a high level of wellness for residents, the town is equipped with care facilities, assisted residences, clinics, nursery centers and cram schools.

Management

The city is managed through a council made of 17 companies[5]. Those actors are from the public and the private sector. Panasonic Corporation, being leader of the joint project, is using the city as a showcase of its newly developed products. The Fujisawa SST Management Company (founded in 2013 – capital of 260 million yen[6]) is in charge of the operational activities within the development of the Smart City. The board of directors is composed of representatives of the major actors of the project. The Fujisawa SST Council is responsible for in-house and external management and partnerships in terms of city energy, ICT, housing and real estate, business relations, care of inhabitants (services, entertainment, wellbeing).

Finances

There is a lack of available information about Fujisawa SST financials. Due to protectionist measures, the only information revealed by Panasonic is the overall

[5] Mitsui Fudosan Co.,Ltd., Mitsui Fudosan Residential Co.,Ltd., Culture Convenience Club/ SO-TWO.INC, Dentsu Inc., Tokyo Gas Co.,Ltd, PanaHome Corporation, Sumitomo Mitsui Trust Bank, Limited, Telegraph and Telephone East Corp., Mitsui & Co.,Ltd, Ain Pharmaciez Inc., Accenture Japan Ltd, Yamato Transport Co.,Ltd., Gakken Holdings Co.,Ltd., Sunautas Co.,Ltd., Sohgo Security Services Co., Ltd., NihonSekkei, Inc., Keio Research Institute at SFC, Tokyo Electric Power Company, Incorporated (TEPCO), Fujisawa SST Management Company, Fujisawa City.

[6] As of May 2013, from Panasonic Corporation manifest.

cost of the project of 60 billion yens (0.5 billion euros)[7]. The company Audi gave in its blog the following opinion: "The costs of energy solutions and infrastructure are to amount to only 10% more than those arising in a conventional construction project of this size. The plan is to amortize these additional costs within 10 to 20 years through energy savings in normal operation and state subsidies. The ecological benefit, by contrast, is incalculably great"[8].

Problems

During the field study, one could notice the presence of empty spaces or abandoned sites under construction despite active works on house construction. The activity observed in the city's streets was surprisingly quiet for an early morning. Few persons were present in the public spaces such as coffee shops and library. The access to the monitoring system was restricted, limiting visitors and their time in the room, no pictures allowed. This makes it difficult to identify what ICT were used and in which proportions. The only possible observations concern the important quantity of data collected. Additionally, the closed behavior of the town's representative could also be sensed. Those elements could convey in the restriction of foreign attraction of funds and/or of residents who could sense a lack of transparency.

Conclusion: A detailed oriented project

Thinking through such dimensional project in terms of utilities and spaces' utilization shows a high commitment from the founding company to adapt to climate change. However, there might be mistaken provisions in terms of appeal for potential residents and for human development. Some criticisms arose in the popular opinion that such city would become a "town of privilege[9]", a town were purchasing power would insure more resources and security to privileged families The no-disclosure of financial information (price of housing, landscapes investment etc.) is a significant obstacle in terms of future predictions concerning the project, despite the long term plan established by Fujisawa SST Council.

---

[7] http://rethink-iot.com/2014/12/05/panasonic-led-fujisawa-smart-town-project-enjoys-grand-opening-japan/ (7.02.2016).

[8] http://audi-urban-future-initiative.com/blog/smart-city-reloaded (7.02.2016).

[9] http://rethink-iot.com/2014/12/05/panasonic-led-fujisawa-smart-town-project-enjoys-grand-opening-japan/ (25.04.2016).

4.3. Case 2: Vienna – Austria

Vienna is one of the most livable city worldwide. This recognition has been developed over the time by strong investments in infrastructures, energy supply and overall quality of life from the city political figures. In the last decade, the city initiated the "Smart" trend in Europe, by self-developing an applied strategy.

This study was conducted with two bodies: Tina Vienna and the ASCR. Both are strong actors of the Smart City Initiative of Vienna and closely evolve with the Viennese government. The first is a company of Wien Holding Gmbh. For the Smart City Initiative, the Smart City Wien Agency established a Framework Strategy[10]. This document emphasizes the importance of citizens' work-life balance and the relation with it and infrastructure, energy (consumption and saving) and mobility in urban development. The ASCR is a joint-venture company, composed by 5 entities: Siemens, Wien Energy, Wiener Netze, Wien3420 and Vienna Business Agency. It is an official partner of the former and is dedicated to a specific geographic area: the Seestadt Aspern district. It is a rehabilitated district which should be completed by 2028 and should attract 20 000 residents. This is one of the largest expansion projects in Europe, focused on sustaining the energy transition and its decentralized process.

Goals

The Smart City Wien Agency is focused on three dimensions: Ressource, Innovation and Quality of Living, all connected by the social dimension and by an emphasis on energy.

The Framework Strategy document is detailing each objective and plan of action on short and long term. Powerfull and legitimate (approved by the government), the document gives guidance and compulsory actions to all actions realized in the city.

Each dimension detalied in sub-objectives: the highest resource preservation possible, including energy efficiency and renewables, energy savings in mobility and the use of Information and Communication Technologies (ICT); the position of being an innovation leader enhanced by research, education and economy; and the top quality of living for citizens, incorporating social inclusion, healthcare and environment.

The ultimate goals of the ASCR are the reduction of CO2 emission and ensuring a failure free supply of energy. Those aims will be attained by two focus: (i) the optimization of urban energy production and consumption by the integration

[10] https://smartcity.wien.gv.at/site/en/initiative/rahmenstrategie (1.03.2016).

of residents and (ii) extended research on energy production, prosumers, storage technologies and locations of all the mentioned above.

The ASCR concentrates on innovative approaches on"building automation systems, using the energy flexibilities of buildings and the energy market in ways that enable residents to cooperate and accept the new systems"[11]. Those developments are possible due to the use of ICT, big data collection and analysis.

Management

The Smart City Wien Agency has numerous stakeholders which can be gathered in three groups: a leading steering Group (15 persons), a Smart City expert advisory board (5 persons) and a thematic process monitoring – working group (17 persons). Additionally, a project leader, two persons monitoring processes and 96 interview partners and process contributors are involved. Each unit works separately and answer to a hierarchical system.

The ASCR has for stakeholders: Siemens (energy transmission solutions and infrastructure services), Wien Energy (energy supplier), Wiener Netze (power and energies grids operator), Vienna Business Agency and Vienna 3420 (business developers). All participated in the elaboration of the ASCR financially or politically. The management structure is typical of business (MDs, Finance, Infrastructure, Operations and Grants). The core team is composed of stakeholders' representatives defending their own interests. To reach a decision approval, at least two of them have to be interested in the project. For conflict resolution, a case by case method is used and discussions are externalized in the involved companies.

Finance

Since the Smart City Wien Agency is partially public, numerous funds originate from the city management and the national government. Nevertheless, budgets are not released publically.

The ASCR finances are provided by its stakeholders: Siemens (44% of the total investment), Vienna Energy (30%), Wien Netze (20%), Vienna Business Agency (5%), Wien3420 (1%). A budget of 40 million euros is committed by the partners with a business plan of 5 years.

[11] ASCR folder, p. 15, available at http://www.ascr.at (7.02.2016).

Problems

Problems appear at two different level: the city management and its political inferences and the bodies working on the Smart City Initiative.

Political implications influence every decision made in the city hall, and they directly impact the operational decisions of the bodies. Plus, the complexity of the governemental system makes them numerous anf interrelated.

Consequently, bodies concerned by those decisions have difficulty to reach full cooperation. External ones, such as the ASCR, will also tend to get involved politically in order to obtain a certain support.

The second most important issue face at both level is timing. Long term perspective are necessary to achieve goals of project such as Smart Initiative. For instance, it took few years to build the Framework Strategy and the ASCR is using a learming by doing approach, meaning that experimental phase last long.

A "Big Brother" issue appeared among citizens about the data collected in public spaces and mobiles. A monitoring system was problemactic to be accepted at the beginning, but the recent terrorist events happening in Europe made it more acceptable for inhabitants.

Future

The continuity of the Smart City Initiative will be ensured by the work of many bodies in Vienna.

As for the Smart City Wien Agency, it plans a renewal of its financial contracts; in different measures since variations can appear in purveyor, budget and interests.

As for the ASCR, at the time of the research the company had just closed Q4 2015. The preparatory phase being over, the entity was about to start a baseline phase. Concrete results were not yet to be seen as the research may extend till 2018. The company is also exploring other possibilities such as entering the consulting sector for cities developing Smart City initiatives.

Conclusion

Since Vienna is strongly involved in the Smart City Initiative, we studied here two entities developing frameworks, research and concrete actions within the city. However, many multiple bodies are working towards one initiative is unique in terms of governance in this field. The city hall maintains a certain grip over those entities by partially financing them. Vienna intend to be a major

European actor in the Smart city field with its ecosystem being a model for Smart Cities worldwide.

5. Discussion

In order to compare the two Smart Cities, we established a list of criteria from the theories of Angelidou (2009 and 2015) and of Shelton, Zook and Wiig (2014) mentioned in the literature review. We add some other points of comparison such as the image, the main reason of implementation, the transparency, the recognition of the quality of life, the security dimension, the order of priorities, the eternal influences, the possible replication of the model, the undeclared intentions and the inhabitants housing access. Many differences are present, especially in terms of management, financing, transparency and intentions (see Table 2).

Table 2. Points of comparison of Smart Cities

Criteria	Fujisawa SST	Vienna
National/Local	Local	Local
New/existing	New	Existing
Hard/soft focus	Hard + soft	Soft (+hard)
Economic sector/ geographically based	Geographically based	Geographically based
Funding origins	Mostly form private funds	From public institutions
Management	Close, Japanese with a leading organization	Open as an external agency working closely with governmental bodies
Shareholders	Private	Public + private
Transparency	Very opaque	Transparency
Image	Good reputation in Japan, small worldwide reach. Perceived as a showcase of Panasonic	Known worldwide for certain dimensions such as quality of life
Reason of implementation	Climate change and natural disasters, historical influencers	Reputation and care of inhabitants, cultural influence
Quality of life	No information	Highly recognize worldwide
Security	One of the first priority	Included in the dimensions
Priorities order	According to the environment, regulated by the conglomerate	Organized by the framework strategy, guided by the European requirements and advises
External influences	Olympic games 2020: Strong influence factor of development	Maintain reputation and staying a model for European cities

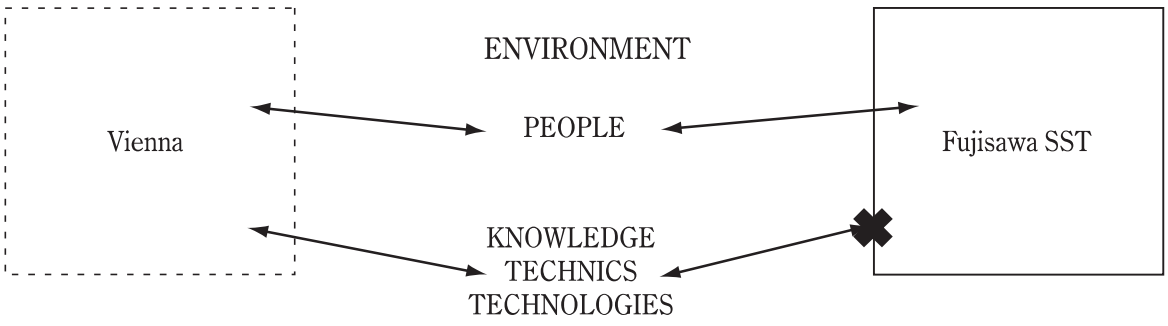
Criteria	Fujisawa SST	Vienna
Replication	In japan and in Denver	No direct replica, more being like a model
Undeclared intentions	Revitalize local and commercialize global the technology	Attract best minds and investors in Austria
Inhabitants housing	Pay for the house and the services. Might be perceived as a town of privilege	Pay regular cost of living like in any city and benefit of public actions

Source: own elaboration.

By analogy, we wish to determine the nature of the two Smart City following on the open /close dichotomy discussed by Bertalanffy (1950).

In a Smart City system, the Energy may be associated with people and the Matter with people knowledge, technic and technologies. As one can see in the Figure 2, for Vienna, the flow is present between both people knowledge, technic, technologies and people and the environment. Therefore, Vienna is an open system. However, Fujisawa SST has a flow of people but knowledge, technics and technologies are not coming in since they are provided inside the system. Consequently, the Japanese Smart City can be qualified as a closed system. Their boundaries are mostly geographical: the limits of the two cities.

Figure 2. Vienna and Fujisawa SST analogy based on the Open system vs. Closed System from Bertalanffy's description



Source: own elaboration.

In the following table, we analyze if the Smart City studied can be considered as systems (see Table 3).

First we look at the characteristics and their specific arrangement. Both Smart Cities contain the necessary elements to be described as such and align with the system conditions of specific arrangement. They both have purposes in larger perspectives and are able to adjust and fluctuate over time. Both also

include systems of feedbacks. In terms of complex system specificities and thanks to feedbacks, the two Smart Cities stabilize themselves overtime. Additionally, they fit inner and larger purposes by partially influencing their inner and outer environments. Ultimately, both have replicas: Fujisawa SST is replicated in Japan and in Denver; but Vienna has indirect replicas since the city serve more as a model.

Conclusively, Smart Cities fit the characteristics of systems and can therefore be analyzed with System Thinking Theory.

Table 3. Comparison of System and Smart City Characteristics

System Characteristics	Smart City characteristics	Fujisawa SST	Vienna
All components present to have a working system	Important dimensions are present (energy, mobility, community, wellness) as well as key stakeholders. Global and local environment to interact with	Presence of dimensions: community, wellness, security, energy, resources; various stakeholders and environments	Presence of dimensions: community, wellness, mobility, resources; and various stakeholders and environments
Specific arrangement	Arrangement to influence positively one or more dimensions, carefully planned and executed with specific purposes	Clear organization of the goal	Framework strategy established to organize goals
Purpose in the larger system	Intended to help solving worldwide issues, by local actions. Non-addable and indivisible since each and every Smart City has its own characteristics and specificities.	Intended to adapt to climate change and risks of natural disaster in a more sustainable environment. Non-addable and indivisible	Intended to create a high quality environment for citizens and to be a model in Europe. Non-addable and indivisible
Fluctuate and adjust	Smart Cities need to be flexible, to evolve over time to its environment and to the new innovative technics and ideas that are developed, it is a “learning by doing” process	Used as a showcase for new technologies; evolving with time and has plans for the future	Framework strategy includes short term planning and long term planning to allow a maximal flexibility
Feedback	A Smart City needs the feedback of its citizens but also the feedback from its environment, from its philosophy and so on. Feedback and flow of information is another key feature of a functioning Smart City. It has internal and external feedback process, which can come from various sources and influence plenty of other components.	Focus groups within inhabitants, information from other districts nearby and from shareholders	Forums and workshops arranged for citizens and worldwide professionals to earn feedback. Exchange of information with other cities in Europe.

System Characteristics	Smart City characteristics	Fujisawa SST	Vienna
Self-stabilizing	the number of components is extremely high and the main idea will be reached even if some of those components (projects or dimensions) do not perform.	Seems to be stabilized despite the stopped construction on the land	Learning by doing process in the whole initiatives which stabilized over time
Purposeful	the achievement of the goal of a complex system is reinforced by certain flows of actions between components. Paths or consequences can be opposite but overtime will balance themselves. Smart Cities have some process to reinforce their course of actions and effects. Incentives are given to cities hosting the projects for example.	Has a clear purpose and established goals in short and long terms. The objective is to avoid conflict and draw a global direction. Supported by the government, with a loop of information and actions	Clear and separated goals stated in the framework strategy. Constant implementation of new goals and evolution of the structure.
Influence over environment	Smart Cities are not only interacting with their environment but are actually changing it in tangible and intangible manners (actions on the ground and change of mindsets).	Had transformed its environment and will supply neighborhoods in case of climate crisis. Is trying to achieve a pollution reduction and a decrease of energy consumption at its scale	As a capital, the footprint on the environment of the city is high. A reduction in energy consumption and an increase of green energy production and consumption is having a beneficial on the close environment
Capable of replicating, maintaining, repairing and reorganizing themselves	The initiative is worldwide but requires local adaptation in every case. This adaptation can be minimal or radically different	Is already replicating in Japan and in Denver. No information can be found yet regarding its maintenance and capacity of reorganization	By its sharing information process, Vienna is replicating since the city exchange its experience and knowledge with other cities in Europe

Source: own elaboration.

It is important to highlight some of the criticisms and concerns about Smart Cities in general.

The first concern regards the level of monitoring and data collection. Hollis (2013) warns: "Like Google, they'll have enough data not to have to ask you what you want." It is therefore necessary to educate and discuss this ethical point with inhabitants. Due to the lack of precedent and theoretical background, it remains difficult to fully see interdisciplinary relations and to build priorities without being biased by previous city management ways. The possible conflicts of interests and political interferences in the development of a Smart City is the last criticism raised. This brings controversy to the fundamental idea of establishing Smart

City and might harm public's opinion. Vienna is an example of such challenging situation.

6. Conclusion

Facing the challenge of our evolution, we need to develop practical solutions concerning urbanized areas. Those zones are the most subjected to suffer from fast urbanization and climate change.

This study showed that some cities worldwide acknowledge the current situation issues and decided to dedicate parts of their agenda to counter negative impacts and enhance green growth: Smart Cities.

Smart Cities are complex systems which require a certain amount of elements such as time, financing and clear organization. Those components are necessary to develop functioning systems such as Fujisawa SST or Vienna. These two cities are distinctive examples of the Smart City Initiative progress happening this decade. Despite being developed in very different geopolitical environment and culture, they regroup all the necessary characteristics of a system but differ in structure and organization. However, they evolve toward the same goal building an urban area that is adapted to our current environment, flexible and scalable, habitants friendly and green.

Further, one would be able to identify Smart Cities as Systems using System Thinking Theory, therefore developing a pattern of categorization.

Bibliography

Anderson, V. and Johnson, L. (1997). *Systems thinking basics*. Cambridge, Mass.: Pegasus Communications.

Angelidou, M. (2015), Smart Cities: A conjuncture of four forces. *Cities*, *47*: 95–106.

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): 331–350.

Bélissent, J. (2010). *Getting clever about Smart Cities: New opportunities require new business models*. Forrester for Vendor Strategy Professionals: Forrester.

Ben Letaifa, S. (2015). How to strategize Smart Cities: Revealing the SMART model. *Journal of Business Research*, *68*(7): 1414–1419.

Bertalanffy, L. von (1969). *General System Theory*. New York: George Braziller

Bertalanffy, L. (1955). General Systems Theory. *Main Currents in Modern Thought*, *11*: 75–83.

Fairfield, J.D. (1994). The Scientific Management of Urban Space: Professional City Planning and the Legacy of Progressive Reform. *Journal of Urban History*, *20*(2): 179–204.
Ford, G. (1913). The City Scientific. *Engineering Record*, *67*: 551–552.
Glaeser, E.L. (2011). *Triumph of the City: How Our Greatest Invention Makes Us Richer, Smarter, Greener, Healthier, and Happier*. Penguin Press.
Herriott, R.E. i Firestone, W.A. (1983). Multisite qualitative policy research: Optimizing description and generalizability. *Educational Researcher*, *12*: 14–19.
Hollands, R.G. (2008). Will the real Smart City please stand up? *City*, *12*(3): 303–320, http://dx.doi.org/10.1080/13604810802479126.
Hollis, L. (2013). *Cities are good for you*. Bloomsbury Press.
Hummelbrunner, R. (2007). *Process Monitoring of Impacts: Applied study for the European Territorial Cooperation Programs*. Vienna: INTERACT, http://www.interact-eu.net/interact_studies/63
Kozminski, A.K. (1979). *Analiza systemowa organizacji*. Warszawa: PWE.
Jackson, M. (2003). *Systems thinking*. Chichester, West Sussex, England: Wiley.
Le dessous des cartes (2012). Géographie Des Transports Mondiaux.
Luque-Ayala, A. and Marvin, S. (2015). Developing a critical understanding of smart urbanism? *Urban Studies*, *52*(12): 2105–2116.
Ramage, M. and Shipp, K. (2009). *Systems thinkers*. Dordrecht: Springer.
Ratti, C. and Townsend, A. (2011). Harnessing residents' electronic devices will yield truly Smart Cities. *Scientific American*, 16 August 2011, http:// www.scientificamerican.com/article.cfm?id=the-social-nexus
Schultz, S.K. and McShane, C. (1978). To Engineer the Metropolis: Sewers, Sanitation, and City Planning in Late-Nineteenth-Century America. *The Journal of American History*, *65*(2): 389–411.
Shelton, T., Zook, M. and Wiig, A. (2014). The 'actually existing Smart City. *Cambridge Journal of Regions, Economy and Society*, *8*(1): 13–25.
Vanolo, A. (2013). Smartmentality: The Smart City as Disciplinary Strategy. *Urban Studies*, *51*(5): 883–898.
Weitzman, M. (2009). On Modeling and Interpreting the Economics of Catastrophic Climate Change. *Review of Economics and Statistics*, *91*(1): 1–19.
Williams, B. and Hummelbrunner, R. (2010). *Systems Concepts in Action*. Palo Alto: Stanford University Press.
Woodside, A. (2010). *Case study research*. Bingley: Emerald Group Pub.
Yin, R. (2003). *Case study research*. Thousand Oaks, Calif.: Sage Publications.

Websites

http://audi-urban-future-initiative.com/blog/smart-city-reloaded
http://www.ascr.at
http://www.energyandcapital.com/articles/panasonics-japanese-smart-town/3485
http://fujisawasst.com
http://www.ibm.com/smarterplanet/us/en/smarter_cities/overview/

http://news.panasonic.com/global/topics/2012/13633.html
http://panasonic.net/es/solution-works/HouseEnergy/
http://rethink-iot.com/2014/12/05/panasonic-led-fujisawa-smart-town-project-enjoys-grand-opening-japan/
https://smartcity.wien.gv.at/site/en/initiative/rahmenstrategie
www.tinnavienna.at
http://www.wien.gv.at