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Smart City, necessary path to sustainable western cities?

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Table of acronyms

ICT	Information and communication technology
Smart City (SC)	Concept of smart city
smart city	A city that is smart
SWOT	Strengths, Weaknesses, Opportunities, Threats
UN	United Nations
w.d.	Without date

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1. Introduction

Over the last few years, there has been significant growth across the world in the phenomenon termed urbanization.

According to the World Health Organization, quoted by Manville *et al*. (2014), the world's urban population is expected to double by 2050. By 2030, 60% of the planet's population will be living in cities, rising to over 70% by 2050, which means an additional 2.5 billion people living in cities (ONU, 2014).

This phenomenon has both positive and negative effects. Population growth in cities could entail the development of services to the population, the development of industry, and transport, but could also bring negative environmental effects, such as an increase in CO_2 and soil degradation. For the record, cities nowadays consume between 60% and 80% of energy worldwide (UN, 2008, quoted by Albino *et al*., 2015). They are responsible for nearly 75% of CO_2 emissions, which were recorded as rising by 45% between 1990 and 2010 as a result of urban growth (Faucheux, 2014).

As the world's population grows increasingly urbanized, cities must meet many new challenges, such as overcrowding, road network congestion, health problems due to pollution, climate change, greater need for security, cyber security and data protection, energy consumption and resource management. Cities need to find new and innovative ways of developing and becoming 'smarter'.

The main task for public authorities is to provide the best living conditions for people who live in cities, i.e. to develop cities in a more sustainable way, while endeavouring to create enough jobs. Cities are also looking to attract and retain the most highly skilled and best-educated people in order to gain a competitive advantage and to achieve the best performance in public value creation (Benevolo, C., Dameri, R.P., D'Auria, B., 2016).

In this context, the Smart City is therefore a winning urban strategy that is growing in acceptance in all four corners of the planet. The main goal of the smart city is to provide inhabitants with a better quality of life and better services, using technology (information and communication technologies or ICTs) to tackle poverty and inequality, unemployment, issues arising from urbanization (the growing urban population as a percentage of the overall population), and energy management and to address environmental issues, such as global warming and climate change.

The target of the Smart City is in fact to reduce global greenhouse gas emissions (in cities) by 15% by 2020 (Faucheux, 2014).

A report entitled 'Mapping Smart Cities in the EU' (2014) gives the following

definition of Smart Cities with a view to gaining a better understanding of the concept: *'the idea of Smart Cities is rooted in the creation and connection of human capital, social capital and information and communication technology (ICT) infrastructure in order to generate greater and more sustainable economic development and a better quality of life.'* (Manville *et al.*, 2014, p.18).

Although smart cities are starting to grow in popularity, a large number of people are still unaware of the concept. Few residents are aware of Smart City goals or smart projects in their home cities, owing to a lack of information and the fact that there is currently no universal definition. Many authors of scientific publications propose their own definitions, which depend on the country they live in (Albino, V., Berardi, U., & Dangelico, R. M., 2015).

We need to bear in mind that this is a worldwide phenomenon and that many cities around the world are taking an interest in the potential for implementing Smart City initiatives as a new approach to the development of urban areas. Obviously, some countries will have a bigger impact than others. Developing countries are right in the middle of the phenomenon of urbanization while developed countries are at the tail end.

India, for example, is spending €66 billion to develop seven cities into smarter cities (Manville *et al.*, 2014). In 2010 South Korea set up a 'Smart Korea IT plan', a strategy to solve the problems caused by overcrowding. In São Paulo, Brazil, the Mayor has unveiled a Smart City plan which includes digitizing the delivery of public services and improving public safety through the use of technology (Mari, 2017). Copenhagen, Denmark, is considered one of the most important smart cities in the world. It has set up many different projects, such as intelligent waste management, smart parking, and a new method for calculating the air quality in the city. Copenhagen's goal is to become the first carbon-neutral metropolis by 2025 (Leleu, 2017).

This paper seeks to understand the phenomenon of smart cities and their environmental impact. It will try to demonstrate whether smart cities are the sustainable cities of the future.

This work will be structured around the following research question: '**To what extent is the Smart City seen as the necessary path to sustainable western cities?'** This paper aims to answer this question and to analyse whether, today, a sustainable city must be intelligent. To do this, this thesis is divided into four parts.

The first part will define sustainable development and its main characteristics in order to gain a better understanding of the concept. We will then develop the concept of sustainable city by establishing the links between the two concepts. The aim here is to analyse the main objectives of the sustainable city.

The second part will analyse in depth the concept of Smart City. We will define the

concept and then talk about its origins and development in the European context. Then we will define the main characteristics that make a city ‘smart’. We will present the various stakeholders of the smart city and outline the new technologies that are available to them. Lastly, we will explain the main similarities between the concepts of the Smart City and of sustainable development.

The third part will focus on a practical case by analysing the city of Copenhagen. The Danish capital intends to become completely carbon neutral by 2025. The aim of this chapter will be to determine whether Copenhagen must be smart in order to become a sustainable city. This will answer the research question through a case study of a particular city.

The final section will focus on the key barriers to smart city development and the possible recommendations for cities to develop in smart ways.

Lastly, we will conclude by presenting what we have learned about the concept of Smart City and more specifically about their environmental impact.

Chapter 1: The concept of sustainable development and sustainable city

Before we begin to define the concept of Smart City, it is important to explain the concept of sustainable development and sustainable cities. This is because the concept of Smart City arose partly thanks to those two concepts.

This chapter focuses on sustainability and is divided into two subchapters dealing with sustainable development and the sustainable city. The aim of this chapter is to understand the differences between these concepts as well as the reasons why cities aspire to greater sustainability. Since smart cities are considered sustainable, it seems important to analyse the concept of sustainability in cities.

1. Sustainable development

1.1. Emergence of the concept

The concept of sustainable development began to emerge in the second half of the 19th century, when Western societies began observing that their economic and industrial activities had an adverse impact on the environment. They therefore sought to increase social awareness of the need to adopt a more sustainable model.

Since then, the world has seen many ecological crises, which have had an impact on the population. The first ecology thinkers (Haeckel and Paul Vidal de la Blache) emerged in the latter half of the 19th century. Between 1850 and 1970, ecology was given a boost by many events, such as the foundation of Yellowstone Park, the first report of the International Union for Conservation of Nature (IUCN) on the environment in the world, and the founding of the Club of Rome. The latter is a think tank that brings together scientists, economists, industrialists and officials from 52 countries to discuss complex issues around the world. Their first report, 'The Limits to Growth', was published in 1972 and broached the main problems facing the world, including the deterioration of the environment (Barbault, w.d.).

International consideration of sustainable development has consistently denounced the misdeeds of industry, the consumer society and the economy. Governments therefore began to take environmental issues into account in their policy agendas. For example, France set up a Ministry of the Environment in 1971, and in 1972 the first Earth Summit took place with a view to determining action to stimulate sustainable development. Since then Earth Summits have taken place every 10 years (E-RSE, w.d.).

1.2. Definition of the concept

In 1987 the UN World Commission on Environment and Development released a report entitled 'Our Common Future', which is better known as the 'Bruntland Report'. It was the first time the term 'sustainable development' was used in a report issued by an international institution, which defined it as *'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'* (ONU, 1987).

The idea behind that definition was to arrive at an economic model that is mindful of the environment and human rights. While the term 'sustainable development' took a long time to take root, it eventually did so, thanks to international conferences on the climate and growing public awareness of ecological problems. Over the years, the concept has developed and incorporated other factors, such as the geographical (sustainable development is not the same locally and globally), political and ethical dimensions.

1.3. Critics of the definition

When we speak of development, we tend to take for granted the idea that there is a kind of universal development that everyone is working to achieve. The term 'developing countries' illustrates that belief in so far as it assumes that they must develop along the path taken by developed (Western) countries, i.e. by moving towards a consumer, industrial and political society. Yet the world has seen other types of society develop, such as those based on the concept of subsistence agriculture or non-state societies.

Gilbert Rist, a professor at the University of Geneva, denounced the assumption behind the term 'sustainable development' in a book entitled 'Development: History of Western Belief' (Rist, 2007). Rist criticizes the concept of development as being, in his opinion, a strictly Western belief which excludes forms of sustainable development other than those established by Western society.

Proponents of zero growth argue that economic growth has a negative impact on humanity and they challenge the concept of sustainable development, which in their view is often associated with economic growth. However, economic growth cannot be linked to the concept of sustainability because infinite, sustainable growth is not possible in a world where resources are becoming increasingly scarce. How can more be produced if resources are limited? (E-RSE, w.d).

These explanations call into question the definition of sustainable development.

1.4. The three pillars of sustainable development

The environmental, social and economic dimensions are the three pillars that ensure that society develops in a sustainable way.

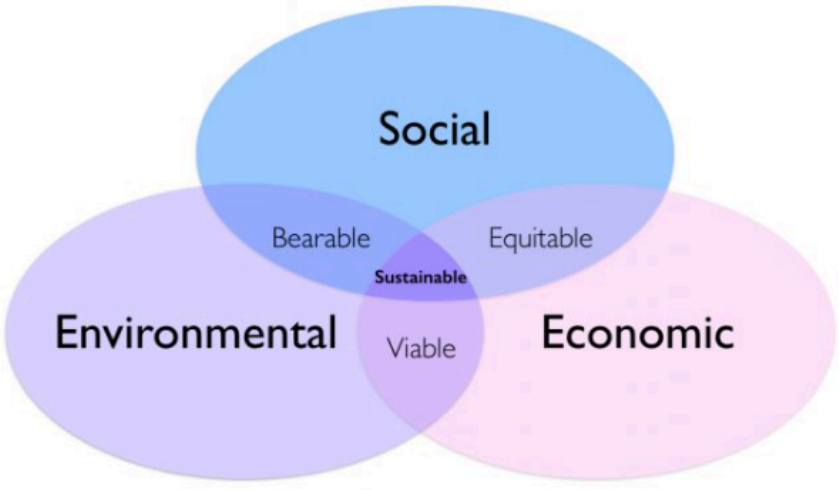
• **Environmental dimension:** This encompasses the main environmental issues, such as conserving natural resources, protecting biodiversity (protecting ecosystems), reducing CO_2 emissions to fight against global warming, and managing and recovering waste.

• **Social dimension:** This refers to the fact that, irrespective of his or her standard of living, every citizen should have access to life's necessities, such as food, housing, healthcare, equal access to work, security, education, human rights, culture and heritage. For example, this means setting up a reintegration assistance policy, selecting fair-trade products, developing social dialogue, and promoting local products.

• **Economic dimension:** This means taking the environmental and social aspects into account when carrying out a project. The price of goods and services must be in line with their environmental and social cost. Examples are fair trade, microcredit, a circular economy and a sharing economy.

The diagram below summarizes the three pillars of sustainable development. They are interdependent, so it is important to strike the right balance between them. For instance, concentrating solely on economic growth to the exclusion of the other two pillars could have major environmental and social consequences (Ivan, 2016).

Figure 1: *The three pillars of sustainable development*



Source: Ivan. (2016). Sustainable Development And The 3 Pillars of Sustainability. Retrieved the 17th of May 2018 from https://weemss.com/blog/sustainable-development-3-pillars-sustainability/

1.5. The five fundamental principles of sustainable development

The five fundamental principles of sustainable development were laid down following the 1992 Earth Summit. They imply that a society develops sustainably if

it takes the following principles into account in its decision-making processes and actions:

- **Horizontal integration:** The three pillars of sustainable development (economic, environmental and social) must be taken into consideration at the same time.

- **Vertical integration:** There must be consistency between policies at different levels of governance as well as international solidarity.

- **Intra-generational equity:** Inequality and discrimination in fundamental rights need to be paid special attention.

- **Intergenerational equity:** The needs of future generations and the capacity of natural resources to regenerate must be borne in mind.

- **Participation:** All stakeholders (public authorities, citizens and civil society) must be mobilized (Service Public de Wallonie, w.d).

1.6. Territorial approaches to sustainable development

'Territorial' approaches to sustainable development involve projects implemented by local, regional or other subnational bodies. Municipalities can approach sustainable development from many angles. The two most important are Local Agenda 21 and the Natural Step. Municipalities need to choose the approach most in line with their outlook.

1.6.1. Local Agenda 21

Adopted by 178 countries at the 1992 World Earth Summit in Rio, Agenda 21 is an action plan that describes the areas where it is important for local and regional authorities to implement the concept of sustainable development. Local Agenda 21 forms part of that action plan and will enable any local community to set sustainable development goals and to achieve them as swiftly as possible. It is therefore a participative approach involving many stakeholders, such as municipal administrations, elected representatives, associations, businesses and citizens.

There is no definite plan for developing this approach, but it is important to carry out a territorial diagnosis, which must be accepted by the stakeholders. Once the latter have accepted the diagnosis, the action plan can be implemented. It is usually conducted in consultation and therefore takes up the various proposals put forward during the consultation (Committee 21, w.d.).

In Europe, most medium-sized and large cities have started to design action plans for sustainable development that are comprehensive to a greater or lesser degree. The International Council for Local Environmental Initiatives (ICLEI) conducted a

survey that found that over 6 000 communities in Europe have an Agenda 21 plan (China-Europa Forum, 2007).

1.6.2. The Natural Step

The Natural Step is a non-profit organisation founded by Karl-Henrik Robèrt in Sweden in 1989, following the publication of the 'Brundland Report' in 1987. The aim of the organisation is to step up the pace of work to achieve a more sustainable global society. Today, more than 10 countries represent the organization around the world.

The Natural Step is considered a systemic approach, which means that it is important to consider the community as a system that interacts with its environment. This approach is based on four sustainability principles whereby:

'In a sustainable society, nature is not subject to systematically increasing concentrations of substances extracted from the earth's crust, concentrations of substances produced by society, degradation by physical means and, in that society, people are not subject to conditions that systemically undermine their capacity to meet their needs.' (The Natural Step, 2018, para. 3).

Those sustainable principles form a type of analysis grid that enables local and regional authorities to make strategic decisions. Such organizations can thus project themselves in the future and take the action necessary to achieve their future objectives through a four-step process:

1. Adopt a common language: define what sustainability means for the community.
2. Conduct an assessment: analyse the present situation in the form of a SWOT table.
3. Create a future vision in terms of sustainable development.
4. Set priorities for action.

This type of approach is pursued with a Natural Step coach and calls for the support of the organization, so that the community can declare its affiliation to 'The Natural Step programme' (The Natural Step, 2018).

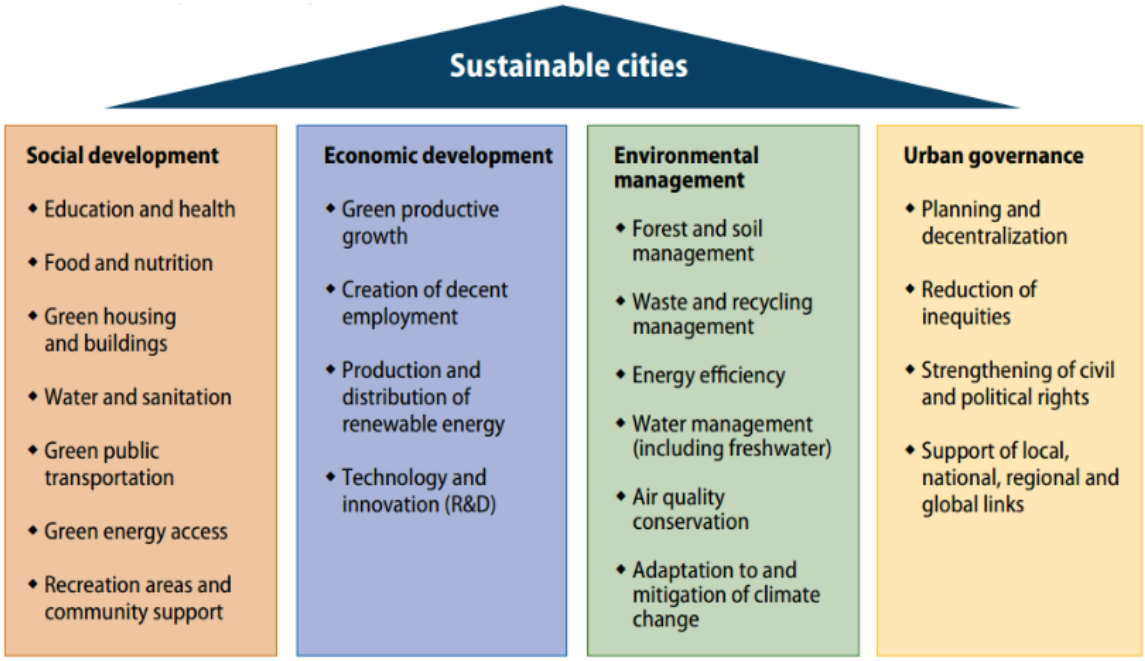
In conclusion, sustainable development is an important concept because it offers the chance to rethink our business models. It is a lever for innovation that will guarantee the sustainability of our cities or our economy. The goal is to fight against global warming, preserve biodiversity (in terms of both environments and resources), safeguard social cohesion and solidarity between generations and between territories, and develop a dynamic based on production methods and responsible consumption.

2. Sustainable city

2.1. From sustainable development to sustainable city

Transforming a city into a sustainable city calls for the implementation of a sustainable development strategy as well as many sustainable projects. There is no universal definition of the concept of a sustainable city, but it must be based on the three pillars of sustainable development, namely the environmental, social and economic dimensions, in addition to a fourth dimension, governance. The table below shows the characteristics of each dimension (Department of Economic and Social Affairs, 2013).

Table 1: *Characteristics of the different pillars of the sustainable city*



Source: Department of Economic and Social Affairs (2013). World Economic Social Survey 2013 : Sustainable Development Challenges. New York : United Nations publication. Retrieved from http://www.un.org/en/development/desa/policy/wess/wess_current/wess2013/WESS2013.pdf

Although there is no universal definition of the concept, some authors give their own. Emelianoff (1999) defines a sustainable city in three stages:

1. First, a sustainable city is a city that is able to maintain itself in time and to preserve its dynamism, collective sense and identity. To advance with its time, the city must project itself into the future without neglecting its past, its heritage, collective memory and cultural diversity, and by carrying out many projects. The term 'sustainable' relates to the sustainability, resilience and innovation capacity of the city.

2. Secondly, a sustainable city must offer a good quality of life throughout to its inhabitants (in connection with the cultural, functional and social mix).

3. Lastly, a sustainable city is one that takes up projects linked to the programme introduced by Agenda 21 and encourages collective participation in urban projects. The goal is to implement projects that are fair in ecological and social terms and reduce social inequality and environmental degradation, taking the impact of urban development into account.

To sum up, the sustainable city is not a reality but rather a project, a goal towards which cities work. A sustainable city is not simply a city with eco-neighbourhoods or green buildings, but one that sets in motion several sustainable development projects. It involves a sea change in urban thinking triggered by a more sustainable vision of public policy, a framework for generating collective projects with a concern to ensure that they do not undermine the prospects of future generations (Emelianoff, 1999; Charlot, 2012).

2.2. Reasons for cities to be more sustainable

There are many reasons for cities to adopt more sustainable behaviour. The five most important are population growth, public health, service administration, the link with economic development and the importance of decentralization phenomena, and the questioning of the role of the state (Hagel, 2014).

2.2.1. Population growth

The increase in the world's urban population is a very worrying phenomenon for cities. As we know, over 70% of the planet's population will be city dwellers in 2050, so cities will face many challenges in terms of public health, the services needed, the space available, wealth distribution, the environment, etc. (UN, 2014).

2.2.2. Public health

There are an ever-increasing number of cities of over a million inhabitants, especially in the 'developing' countries. According to Metzger and Couret (2010), *'Les villes du Sud s'avèrent débordées par la rapidité de leur croissance démographique et de leur extension spatiale ainsi que par l'ampleur de la pauvreté et de l'informalité.'*[1] (quoted by Fagel, 2014, p.44).

Urbanization in poor countries creates many problems, including public health problems. Access to drinking water is becoming scarce and access to care is also more difficult because the population density is increasing and facilitating the spread of pathogens (Hagel, 2014).

[1] [Traduction] Cities in the South are overwhelmed by rapid population growth and spatial expansion as well as the extent of poverty and informality.

2.2.3. Services provided by the administration

The growth of the population poses some problems to administrative authorities. New neighbourhoods unbeknown to the authorities are appearing. According to Eduardo Lopez Moreno (2011), Director of the World Cities Observatory, many cities are hiring officials to take over the new neighbourhoods that have been created overnight. All this demographic growth causes organizational and administrative problems for the structuring and sustainability of services.

2.2.4. Link with economic development

According to Eduardo Lopez Moreno (2011), two thirds of the world economy and 85% of innovation are concentrated in cities. The average GDP per person generated in cities is allegedly three times the national average. Cities are a good way to revive the economy. Most structures are erected in cities, which are places where globalization takes root. Cities host the facilities for the production of goods and services and the creation of wealth, and they are keen to increase their competitiveness (quoted by Fagel, 2014). As a result, Alain Bourdin (2009) goes on to say, *'La ville a donc vocation à se trouver au centre de tout questionnement sur le développement durable'*[2] (Bourdin, 2009, p. 174).

2.2.5. Importance of the decentralization phenomenon and questioning of the role of the state

Other factors triggering sustainable development are decentralization and the questioning of the role of the state. These phenomena are linked to the issue of governance, which began to be raised in the 1980s. The governance issue seeks to reduce state intervention to a minimum by devolving non-strategic functions to private players. Cities and local governments are demanding a say in decision-making (Osmont, 1998).

According to Vincent Beal (2011), following this restructuring of the state and the globalization of the economy, cities have become places where economic competitiveness is growing. The city has turned into an 'entrepreneurial city', where the offer is more and more diversified, and it seeks to attract businesses and households thanks to its competitiveness. It is growing against a background of sustainable development.

To cut a long story short, the city is seen as an issue for sustainability because it encompasses the issue of sustainable development. As a result of urbanization, the vast majority of the world's population, over 70% in fact, will be living in cities in the future. Cities are responsible for generating nearly 75% of greenhouse gases and they consume 60% to 80% of energy in the world. They are focal points for many

[2] [Traduction] The city is therefore destined to be at the center of any questioning about sustainable development.

social problems, such as those relating to health. They are the venue for many production sites, services, etc. Cities therefore lie at the heart of the phenomenon of sustainable development, and if it is possible to make them 'greener', they may have a positive impact on the planet (ONU, 2014; UN, 2008, quoted by Albino *et al*., 2015).

2.3. Principles and goals of the sustainable city

2.3.1. Principles

The sustainable city is based on principles that have existed for several years. Cities must be united in space and time, which means that they must not burden other populations and ecosystems or future generations with their development costs. Solidarity means implementing strategies effectively to manage natural resources (water, energy, space and raw materials), develop strategies to improve social equity (actions against poverty, unemployment, etc.) and apply the precautionary principle, for instance, to avoid irreversible choices and local or global risks, such as the impact of greenhouse gas emissions.

The sustainable city must also determine the decision-making and learning processes needed to improve its basic situation, pursuant to the three pillars of sustainable development, namely the economic, social and environmental dimensions.

Cooperation between the city's stakeholders is vital. Synergy between the various players and strategies for cooperation needs to be harnessed so they can work together to the same end for a better future. Otherwise, it will be difficult for a city to become sustainable (Charlot-Valdieu and Outrequin, 2009).

2.3.2. Goals

To achieve sustainability, cities must set themselves the following strategic goals and make every effort to achieve them:

- Preserve and sustainably manage natural resources, such as water, energy, soil, biodiversity and air.
- Improve the quality of the local environment, i.e. public health, by reducing nuisances and risks.
- Improve social equity by increasing accessibility to jobs, housing, education and health and by fighting against social and ecological inequality, etc.
- Improve equity and cohesiveness between local areas and regions.
- Improve the efficiency and attractiveness of the economic fabric for companies and the workforce.

The last objective is perhaps the hardest to achieve and thus proves that sustainable development remains a distant objective. Economic organizations that dominate the market do not respect the principles of sustainable development. This is true of large

companies that locate and relocate for their own benefit, regardless of the plight of their employees. Such relocation operations represent huge social costs in terms of the dismantling of the economic fabric, unemployment and despair engendered in the local population.

The attractiveness of the area remains an important aspect of the location and development of businesses, and cities need businesses to generate wealth, even if they do not adopt a sustainable approach to do so. This is a huge paradox facing sustainable cities, bearing in mind that they must promote the emergence of sustainable businesses. Companies will therefore have to find solutions in conjunction with the socio-economic players in the local area in order to continue their activities, but in a more sustainable way (Charlot-Valdieu and Outrequin, 2009).

2.3.3. Examples of actions undertaken by a sustainable city

When we speak of the sustainable city, we often think of environmental issues, such as reducing our ecological footprint. Cities must identify sound projects to reduce their ecological footprint and have a positive impact on their inhabitants to ensure they have a better future. Various areas where cities can take action to achieve greater sustainability are discussed below.

As we explained above, cities alone account for almost 75% of CO_2 emissions (Faucheux, 2014) and urban air is increasingly polluted. Greenhouse gas emissions, which originate in various sectors, are harmful to people and ecosystems. A large percentage of such atmospheric emissions (around 25%) comes from buildings and dwellings. Sustainable cities therefore need to support the introduction of green buildings to recover the energy they emit and reduce the energy they use. A good opportunity for cities to take action on the environment involves developing new green technologies for buildings.

Cities also need to focus on green areas (parks, natural environment, etc.), which have several positive effects on global warming. Green areas filter air and retain CO_2, which is essential to maintaining air quality and preventing its contamination (Bouzou & Marques, 2016).

Cities must also implement many initiatives to bring about a change of mentality in terms of mobility and transport. The goal is to promote sustainable modes of transport in place of the motor car.

3. Conclusion

One of the main problems that sustainable development has encountered in this century is tackling the many challenges currently facing cities. Cities must increasingly move to models of development that differ from those currently in use and which have been around for more than sixty years.

The world population has been increasing since the 1950s and people are increasingly settling in urban areas. In 2008, it was the first time that more than 50% of the population lived in urban areas. It is estimated that by 2050 more than 70% of the population will live in cities.

The main environmental problems identified in the city are the increase in air pollution, falling water tables and increasingly polluted rivers. However, the most important problem is that of climate change and the problems it brings, such as coastal flooding, difficulties in access to water, and more frequent and intense weather events, such as hurricanes. To counter these problems, cities need to significantly reduce their CO_2 consumption and thus use fewer fossil fuels and more renewable energy, such as solar and wind energy.

Cities need to find new solutions to address the challenges of climate change, the scarcity of resources, rapid urbanization, and so on. They must manage their urban environment in a more sustainable way. This is one of the most important and perhaps the most difficult challenge cities will face for decades to come. There is currently no universal strategy that every city could follow, but the following chapter explains a concept that is becoming more and more popular in the world: the ‘Smart City’. This relatively novel concept aims to reduce the CO_2 emissions emitted by cities, manage the city’s resources he more efficiently and improve the quality of life of citizens using the new information and communication technologies.

Chapter 2: The concept of the Smart City

After defining the concepts of sustainable development and sustainable cities, this chapter focuses on the concept of the Smart City. As the previous chapter noted, current urban development models are no longer adapted to the many challenges facing cities. This concept has therefore been developed as a possible solution to the problems facing cities in economic, technological and environmental terms.

This chapter is divided into several sub-chapters that explain the origin of the concept, its definition, development and characteristics, the role of the stakeholders, and the role that communication and information technologies can play in these cities. Lastly, it outlines the main factors that make a city 'smart' and the strengths and weaknesses of smart cities, before presenting examples of some smart cities.

This chapter was drafted by referring to many scientific articles and information gathered at conferences. In particular, on 19 October 2017 we attended *Digital First*[3], an event that gave us first-hand knowledge of the many technologies that could be used in smart cities. We also attended the *Brussels Smart City for Economy*[4] conference on 13 November 2017 and the *Smart Cities Forum*[5] conference on 1 March 2018. These conferences and events extended our knowledge of the subject and allowed me to meet people working in this area.

1. Origin of the concept

Many phenomena have been identified to explain the origin and popularity of the concept of Smart City that emerged in the 1990s.

First, the expression was popularized by private firms. During a recession, IBM launched a strategy to reclaim its market and return to profitability. The strategy sought to identify cities as a large potential market and to link ICT to it. IBM then 'sold' the concept to cities, popularizing and giving it momentum. Thus the term 'Smart City' was the result of an advertising campaign by a firm seeking to make profits.

The term 'smart' was not chosen by chance. Although there are many names for the cities of the future, such as 'future cities', 'eco-cities', 'innovative cities', 'green cities', 'smart cities' and 'digital cities', the expression 'smart cities" has been the most successful (Mair *et al.*, 2014).

According to Albino *et al.* (2015), the word 'smart' was a marketing choice. It is

[3] https://www.digitalfirst.be/index.php.
[4] https://event.smartcity.brussels/economy.
[5] http://www.smartcitiesforum.be.

more user-friendly than ‘intelligent’ in the language of marketing. The connotations of the latter are more elitist, and it tends to be confined to fast-response aspects, while the term ‘smart’ could include systems for communicating with one other and adapting to the needs of people using the system.

The expression ‘Smart City’ has developed recently through the history of town planning and considerations / reflections on the city of tomorrow in which technology should play a big role.

Cities face four major challenges:

- Increasing urbanization
- Climate change and scarcity of resources
- Tighter budgets
- Competition between cities

These phenomena all call for the implementation of various actions that the Smart City could remedy (Mair *et al*., 2014).

2. Definition of the concept

For some years now, the emerging concept of ‘Smart City’ has been increasingly recognised around the world, though no single unequivocal, clear or precise definition of the concept exists. The definitions vary from country to country and author to author. Although many experts are trying to define the Smart City in more precise terms, no universal definition of the concept has been developed to date, given the many areas to which it applies (Cocchia, 2014).

The definitions of various authors are discussed in the following section.

1.1. Definition of authors

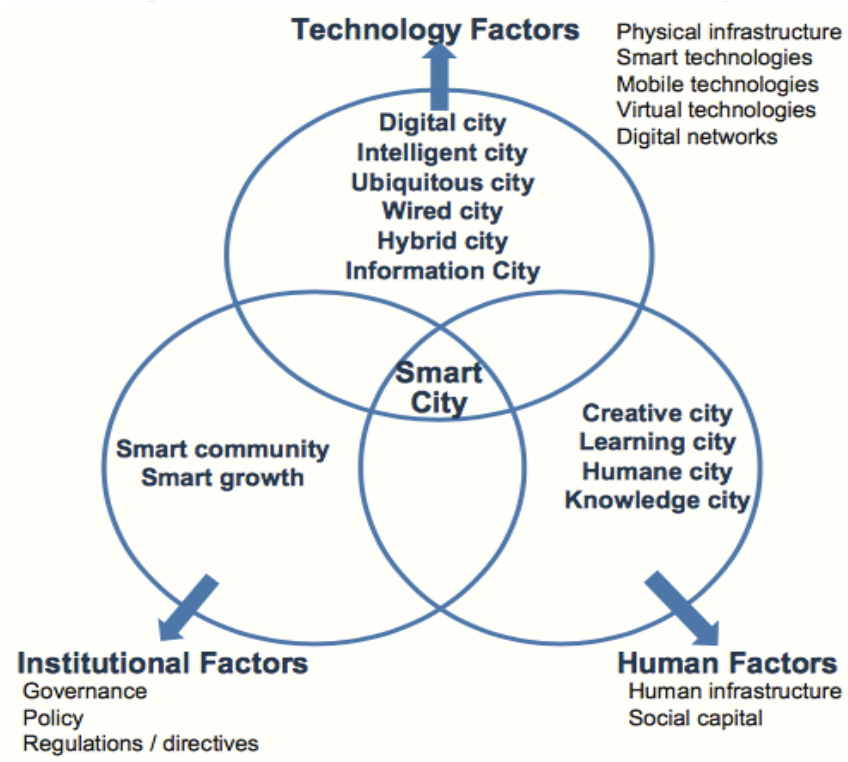
‘Cities [should be seen as] systems of systems, and that there are emerging opportunities to introduce digital nervous systems, intelligent responsiveness, and optimization at every level of system integration.’	MIT, 2013
‘Smart Cities combine diverse technologies to reduce their environmental impact and offer citizens better lives. This is not, however, simply a technical challenge. Organizational change in governments – and indeed society at large – is just as essential. Making a city smart is therefore a very multi-disciplinary challenge, bringing together city officials, innovative suppliers, national and EU policymakers, academics and civil society.’	Smart Cities and Communities, 2013

'The use of ICT [makes] 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 and Sindhu, 2009
'A city is smart when investments in human and social capital and traditional and modern communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.'	Caragliu, Del Bo and Nijkamp (2009)
'In a Smart City, networks are linked together, supporting and positively feeding off each other, so that the technology and data gathering should: be able to constantly gather, analyse and distribute data about the city to optimise efficiency and effectiveness in the pursuit of competitiveness and sustainability; be able to communicate and share such data and information around the city using common definitions and standards so it can be easily re-used; be able to act multi-functionally, which means they should provide solutions to multiple problems from a holistic city perspective.'	Copenhagen Cleantech Cluster (2012)
'A "smart city" is a multi-stakeholders' ecosystem – composed with local governments, citizens' associations, multinational and local businesses, universities, international institutions… – engaged in a sustainability strategy/transition (mobility, environment, economy, people, governance & living) using technologies (ICT mainly) as an enabler in order to become more sustainable (economic prosperity, social well-being & conservation of our natural resources).'	Desdemoustier and Crutzen (2015)

The concept is still rather vague and complex, as those definitions show. Some approach it from the viewpoint of new ICTs, others from that of an ecosystem of stakeholders, while still others focus mainly on human and social capital, infrastructure, etc.

According to Nam and Pardo (2011), the Smart City concept is a mixture of three main categories of factors: technological (new technologies, use of ICTs), human (human infrastructure, human capital and education) and institutional (government and governance policy are important for the implementation of Smart City initiatives

Figure 2: *Fundamental Components of Smart City*



Source : Nam, T., & Pardo, T. A. (2011). *Smart city as urban innovation: Focusing on management, policy, and context*. Retrieved the 25th of March 2018 from https://www.ctg.albany.edu/publications/journals/icegov_2011_smartcity/icegov_2011_smartcity.pdf

Accordingly, the definition best suited to the remainder of this study is that put forward by the Smart City Institute, namely *'an academic institute dedicated to the thematic of smart cities. It is founded on an original partnership between four private companies (Belfius, Proximus, Schréder and Strategy&), a University and its Management School (HEC Liège) and Wallonia.'*(Smart City Institute, 2018).

'A "smart city" is a multi-stakeholders' ecosystem – composed with local governments, citizens' associations, multinational and local businesses, universities, international institutions… – engaged in a sustainability strategy/transition (mobility, environment, economy, people, governance & living) using technologies (ICT mainly) as an enabler in order to become more sustainable (economic prosperity, social well-being & conservation of our natural resources).' (Desdemoustier and Crutzen, 2015, p.7).

3. Evolution of the concept

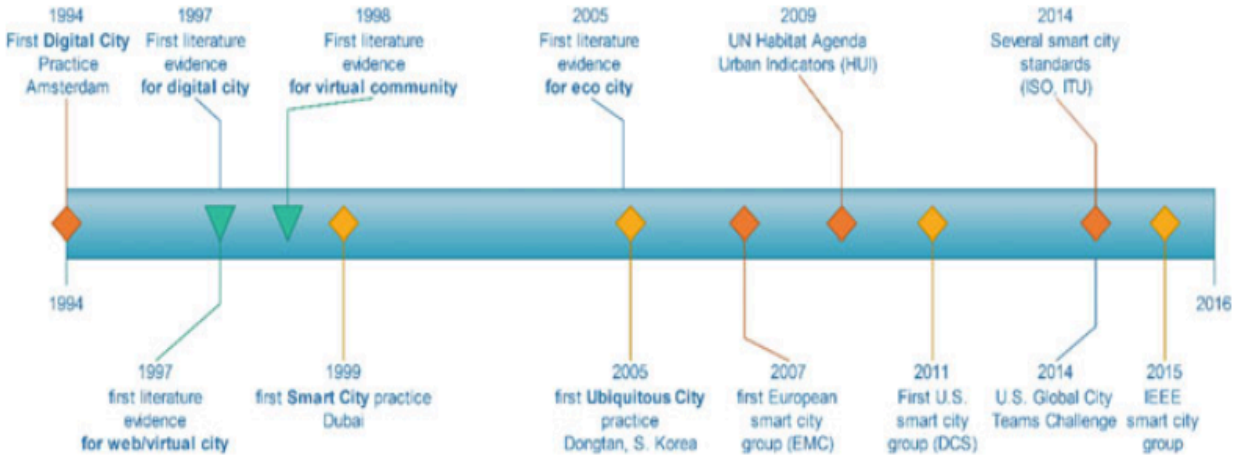
While the concept started appearing for the purposes of defining urban technological evolution, scholars did not initially use the term 'Smart City'.

At the end of the 1990s, scholars used various perspectives and terms to describe the arrival of ICT in urban space. It was only in 1997 that the first data on smart cities appear. At the time there existed more than 2 000 virtual cities and urban webpages using the term 'web' or 'virtual city' to describe all local initiatives involving ICT networks which enabled local virtual communities to develop (Graham and Aurigi, 1997).

The aim of those virtual cities was to develop new interactive 'public arenas' in cities where there was lack of public space or an increase in violence, etc. Such cities were the first to use the Internet to enhance the quality of life of the inhabitants. However, there was a problem: the residents needed to be involved for there to be feedback, but none were involved.

'Digital city' is a broader term than 'virtual city' because it does not focus on a specific urban area only, but involves a larger infrastructure. Amsterdam was the first to try out such a digital city in 1994 with the aim of facilitating dialogue between the community and politicians.

Table 2: *Evolution of the Smart City*



Source: Anthopoulos, L.G. (2017). *Understanding Smart Cities: A tool for Smart Government or an Industrial Trick?*. New York : Christophe G. doi : 10.1007/978-3-319-57015-0_2

What this tells us is that both virtual and digital cities were an attempt to tackle very similar challenges with the same technologies in order to create communities, using ICT to socialize citizens, democratize local government and utilize virtual space

where there was a lack of public space.

Many synonyms of digital city began to appear, such as ‘information city’, which was understood to be an environment where ICTs play an important role in delivering innovative online services (Lee *et al*., 2014).

The term ‘information city’ evolved subsequently into ‘ubiquitous city’, a term coined by the South Korean Government (Lee *et al*., 2014) and which focuses on data that are available everywhere (ubiquitously). For instance, data are available through equipment embedded in streets, such as sensors (Anthopoulos and Fitsilis 2014).

All these cities have been evolving over the years into more complex ecosystems, which aim to provide more intelligent services with the help of technology. An ecosystem can be understood to be ‘an inter-dependent social system of actors, organizations, material infrastructures, and symbolic resources’ (Maheshwari and Janssen, 2014).

4. Smart City in Europe

The European Union also plays a role in transforming our cities into smarter cities. It develops and funds many projects, using its expertise in various fields such as research, the economy and the environment.

In 2012 the European Commission set up a European partnership called the ‘Smart City and Community’ to implement smart innovations in Europe. This partnership brings together industry leaders, European cities and citizens to improve urban living conditions through many smart projects (European Commission, 2013).

At present there are nearly 370 commitments to finance and develop smart projects in Europe, mainly in the fields of transport, energy and ICT. Among those commitments which represent 3 000 partners, six clusters have been identified (Desdemoustier and Crutzen, 2015):

- Business models, finance and procurement
- Citizen focus
- Integrated infrastructure and processes (including open data)
- Policy and regulations / integrated planning
- Sustainable districts and built environment
- Sustainable urban mobility

The partners are working together to find intelligent solutions covering each.

This all forms part of Horizon 2020, a European Commission research and development programme. Today, the Commission is doing everything possible to arrive at a maximum of smart cities by 2020. Its website has an entire section

dedicated to the Smart City. The European Parliament has also published a white paper entitled 'Smart City Mapping in the EU' that maps today's situation regarding smart cities in Europe.

5. The 6 features of the Smart City

According to Rathod and Zaveri (2015), the concept Smart City breaks down into more than six dimensions. They comprise several features, namely smart infrastructure, smart mobility, smart energy, smart heritage, smart health, smart governance, smart education, smart environment, smart living, smart tourism, smart economy, etc. Unfortunately, this approach is too complex for cities to apply.

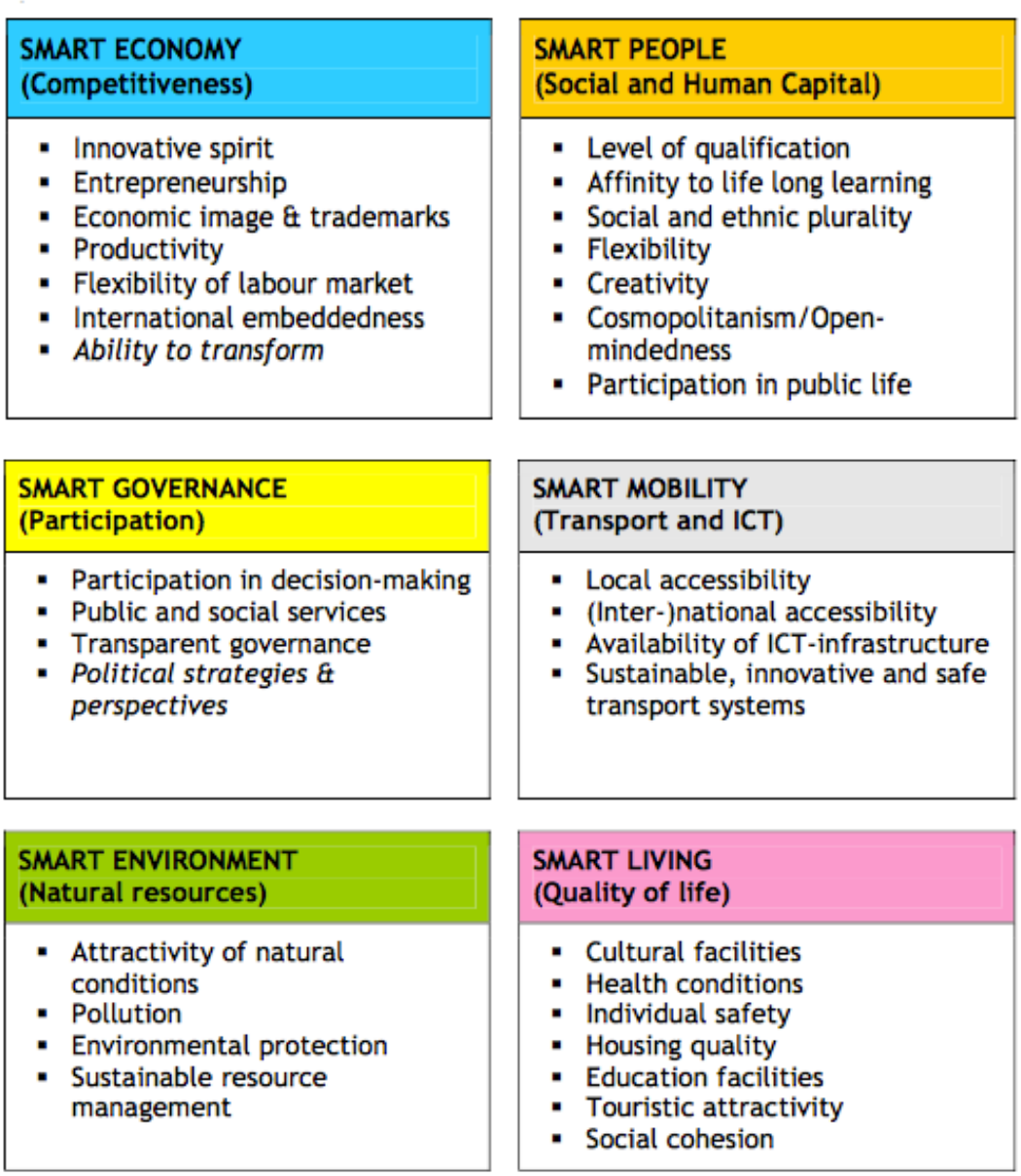
The model developed by Giffinger *et al*. (2007), a team of researchers from the University of Vienna, is simpler and comprises only six characteristics pertaining to various aspects of urban life, namely the economy, the environment, governance, citizens, mobility and quality of life.

Giffinger *et al*. introduced the model with a view to assessing European smart cities. The idea is to classify 'smart' European cities in terms of those characteristics. They are also interested in making cities aware of what they are putting or have put in place and what they need to do to become 'smarter' (Giffinger *et al*., 2007).

These characteristics are non-hierarchical, which means that we can start with any dimension. A certain rationale, developed by Joëlle Simar (2015), can be applied. Governance and the citizen are perhaps the most important aspects to start with when seeking to achieve smart status. Before a city is developed and qualifies as 'smart', it needs to be smart in terms of governance. Governance is the connection with the other dimensions (Zubizarreta et al., 2015). The government manages many aspects, such as house-building, public transport and water supply. It is therefore essential to take the city's inhabitants into account so the various projects can be tailored to them, or the undertaking could fail.

The following table exemplifies the six characteristics and their main factors.

Tables 3: *The six characteristics of Smart City*



Source : Giffinger, R. and al. (2007). *Smart cities: Ranking of European medium-sized cities*. Vienna : Centre of Regional Science. Retrieved from http://www.smart-cities.eu/download/smart_cities_final_report.pdf

5.1. Smart Economy

The 'Smart Economy' characteristic is a key factor based on competitiveness in terms of productivity, innovation, entrepreneurship, sustainable job creation for the city, and flexibility of the labour market. This characteristic also corresponds to e-commerce, and manufacturing goods and services using ICTs (Giffinger *et al.*, 2007).

It also implies the economy's ability to transform itself and to involve the international market, because it serves as an interconnection between the local and

global markets. This interconnection is characterized by the exchange of goods and services and by physical and virtual links.

In addition to a desire to develop economically, a city may also be attractive from an international point of view thanks to its intelligence (Harrison and Donnelly, 2011).

5.2. Smart Governance

According to Wilke (2007), the society we live in has been transformed. Everyone has wide access to knowledge now, and as society develops, the need for a new form of governance becomes apparent.

Any type of public or private service or administration can use the principle of 'Smart Governance' to improve the quality of a city. As technology permeates our daily lives and our cities ever more intimately, governments need to rethink the way in which they could interact with citizens. The aim of this concept is to connect the stakeholders, such as the city residents, government and business, in a new and collaborative way.

Smart governance refers to a progressive approach which focuses on the future and on the quality of life and is sustainability-oriented by using ICTs at its very core (Scholl and AlAwadhi, 2016). The aim is to make public services more accessible to people, improve the way such services function internally and make communication between administrators and users easier.

Another aspect of smart governance means involving the public in order to incorporate their knowledge into the decision-making process and thus produce services that are directly adapted to them and their environment. If this form of governance is applied, more transparency is vital for building trust among people, which is very important for government.

5.3. Smart People

The inhabitants play a key role in the Smart City. The degree to which the latter is 'smart' depends on its human and social capital in terms of qualifications, access to education, open-mindedness, flexibility, and creativity, and the population's social diversity (Giffinger *et al*, 2007).

It is worth bearing in mind that new ICT tools operate a shift in power from government to the people, who are thus more involved. 'Smart' citizens will play a bigger part in public life and public debate, they will have greater decision-making powers, etc. 'Smart' residents are thus closely involved in the city and in the development of a smarter city.

5.4. Smart Environment

A concern to protect the environment and take steps to reduce the negative impact of human activities on the planet are a feature of our time. Global warming, pollution, resource management (water, energy, waste), etc. are becoming increasingly important for cities. For the record, cities are responsible for nearly 75% of CO_2 emissions worldwide (Belfius, 2014). 'Smart Environment' involves a concern to reduce to a minimum the ecological and energy footprint of cities.

New technologies are available for cities to use their resources more intelligently. For example, smart grids are tools for controlling energy resources according to demand and thus saving energy (e.g. smart street lights).

Sensors can also detect water leaks and measure the quality of the air, manage waste, etc.

Renovating buildings and equipment and designing green buildings (capable of generating energy through photovoltaic solar panels, wind turbines, etc.) are also an integral part of this dimension.

All these technologies could enable cities to reduce their CO_2 emissions and use their resources more efficiently.

5.5. Smart Living

The 'Smart Living' dimension covers aspects involving living in a healthy and fulfilling environment and enjoying a good quality of life. According to Giffinger *et al*. (2007), the main aspects relate to services, such as tourist attractions, health, culture, access to education, security and the quality of housing.

According to Joëlle Simard (2015), smart living can also cover ecological and environmental dwellings that generate their own (renewable) energy.

5.6. Smart Mobility

The characteristics of 'Smart Mobility' correspond to a new mobility model which differs from the previous model in so far as it takes account of flexibility, reactivity and the use of new technologies, such as smartphones, GPS, social networks, digital platforms and charging points. It encourages the use of public transport, such as trams, underground trains and buses, and non-motorised private transport, such as bicycles and travel on foot, because one of the goals of the Smart City is to reduce CO_2 emissions.

Smart mobility also takes account of the entire connected infrastructure, intelligent vehicles (shared or autonomous cars and bicycle sharing) and the use of certain types of data (open data). Real-time access to data can save people time as well as

providing some data in real time to help to determine traffic flows. Such data relate to the transport network and play a part in improving mobility there.

According to Giffinger *et al*. (2007), the concept of smart mobility involves four elements, namely local accessibility, the availability of ICT infrastructure, international accessibility, and a sustainable, innovative and safe transport system.

All these projects aim to enhance travel efficiency and reduce cost and CO_2 emissions through technology.

6. Stakeholders

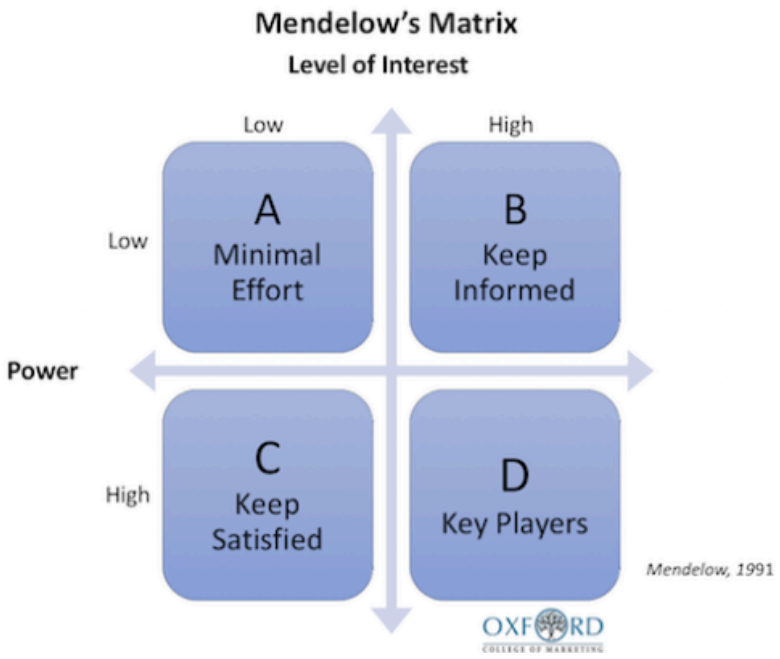
Before listing the smart city's stakeholders, let us briefly consider a definition given by Freeman (1984): *'A stakeholder in an organization is by definition any group or individual who can affect or is affected by the achievement of the organization's objectives'* (quoted by Ruwet, 2017).

The stakeholders will help a city to become smarter by working together. This section will cover the stakeholders involved in the Smart City project.

Taking into account the stakeholders has become very important for the development of a business or for the development of a smart city. Indeed, if a city wants to become intelligent, it must create value for each actor that relies on it, namely the citizens, public authorities, companies (technological, computer or transport), research centres and universities, etc. We must take into account the interests of each stakeholder because the interests of one are based on the interests of the other. Each group therefore has its role to play and its efforts must be linked to the strategy of the city.

Given that each stakeholder has his or her own expectations, it is important for the city to know the importance of the various actors in terms of interests and power related to the decision process. We must therefore use a specific strategy for the various groups so that they work in the same direction and with the same vision as that of the city. The Mendelow matrix is a very specific tool for measuring the stakeholders of the Smart City and gauging their importance.

Figure 3: *Mendelow's Matrix*



Source: Eriksen-Coats, F. (w.d.). What Is Mendelow's Matrix And How Is It Useful ? Retrieved the 26th of July 2018 from https://blog.oxfordcollegeofmarketing.com/2018/04/23/what-is-mendelows-matrix-and-how-is-it-useful/

All stakeholders do not have the same impact on the city: they all have a different influence on the city. This is why it is important to measure their influence with a suitable management tool so that the city can adapt its communication to the various players.

Mendelow's matrix is a matrix that identifies the stakeholders according to their power (their ability to influence the city's strategy or the resources of smart projects) and their interest (groups with an interest in the city's projects). This allows the relationship of a city with its main players to be determined.

For example, if a stakeholder has slight interest and slight power in the city, the city need not focus on it but will need to keep an eye on it to check if there is a change in its degree of interest and power. On the other hand, if a player has a high degree of interest and great power, the city will have to make a lot of effort to ensure that it is satisfied.

In the smart city, there are many stakeholders such as inhabitants, local business owners, research centres and universities, public interest groups, government, public authorities, urban planners, utility and public services providers, telecommunication

providers, industries, cantonal and national agencies, financial organisations, specialized consulting firms, technology and transportation companies.

The following table is the Mendelow's matrix and it identifies the different stakeholders in function of the power and the interest that they have in a smart city.

Table 4: *Mendelow's matrix of Smart City's stakeholders*[6]

Minimal effort	**Keep informed**
	Research Centers and University Specialized consulting firms Telecommunication providers Industries
Keep satisfied	**Key player**
Public interest groups Local Business owner Cantonal and national agencies Financial organisations	Inhabitants Public authorities Urban planners Utility and public services providers

<u>Key player</u> (high level of power and high level of interest)

Inhabitants play a major role in smart cities. Smart cities enable their inhabitants to enjoy better living conditions through the various services offered and they can also have a say on the issues that affect their daily lives. Inhabitants need to be involved actively in projects, as passive participation can cause them to collapse. The city's inhabitants should be viewed as customers who deserve satisfaction, as a source of innovation and as project partners (Desdemoustier and Crutzen, 2015).

Public authorities are also key player and aim to meet all the necessary conditions to ensure that projects are run smoothly. They are considered a source of inspiration for others, such as stakeholders who put forward projects and ideas.

Urban planners (City manager, City Planner, Engineer, Architec, etc.) are important stakeholder as they are responsible for the conservation, use and planning of the city. It is important to have their expertise available to understand how to include ICTs into city planning.

[6] Horizontal axis: Level of interest (from low to high) / Vertical axis: Level of power (from high to low)

Utility and public services providers (Electricity, Water, Gas, Public Transportation, Hospital, etc.) are also key player because their roles are to provide services to the occupants of the cities and therefore to implement intelligent solutions to improve their services.

Keep satisfied (high level of power and low level of interest)

The stakeholders that have a high level of power and a low level of interest need to be satisfied. This is the case of the financial organisations, their interests for the smart city are low, they mostly have financial interest. Nevertheless, they have a high level of power as they decided to loan money for smart city projects.

Another stakeholder that a smart city needs to keep satisfied are local business owners even if they have a middle level of interest and a high level of power. Indeed, the level of interest is a bit higher because the smart city can bring a better visibility and better opportunities to them as they could bring their expertise and products among all smart cities. They also have high level of power as they create economic growth, competitive growth and they create jobs and innovations.

Keep informed (low level of power and high level of interest)

The stakeholders with low level of power and high level of interest need to be informed. The city needs to talk with them in order to ensure that no major issue are arising. These stakeholders can also help the city to point out areas that it needs to improve or that have been overlooked. It is the case of Research centres and Universities, telecommunication providers and specialized consulting firms**.** They can provide innovations, new technologies or new methodologies that will improve the quality of live of people.

Unlike the local business owner, the industries have less power than them but a greater interest. Indeed, they can provide people with good services or products that will improve their daily life.

7. Role of new information and communications technologies (ICTs)

ICTs are technologies born of the merger of computer science and telecommunications. They process, transform and store information and communication using an electronic process. The ICT field brings together many companies that produce devices (telephones, television sets, computers, etc.), distribute it (shops selling computer equipment, etc.) or offer services (telecommunications companies) enabling citizens or organizations to use these technologies.

ICT tools comprise mobile phones and applications, computers, the Internet (websites, blogs, social networks, etc.), digital cameras, smart sensors, live broadcast

devices (television, radio, etc.) and many more. In short, they involve all means of electronic communication (Yolin, 2009).

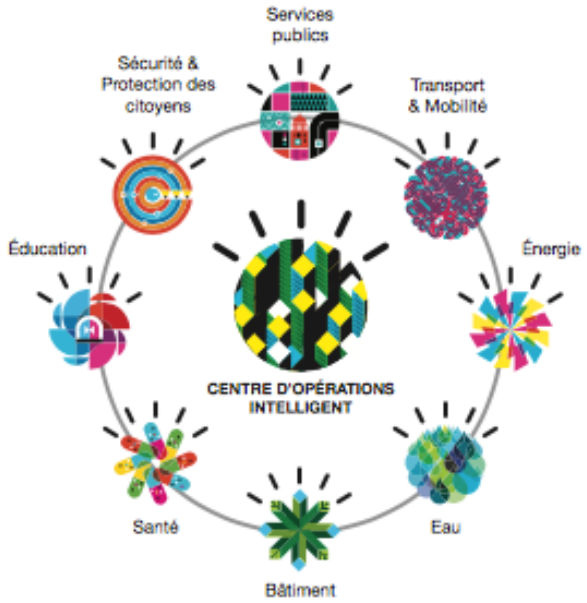
Recent years have seen an increase in the power of ICTs following the huge development of smartphones, the Internet, etc. This affects many areas, such as the workplace, leisure, health systems, education, transport and many others.

But what about the Smart City? According to Eger (2009), *'The smart city concept reflects a particular idea of local community, one where city governments, enterprises and residents use ICTs to reinvent and reinforce the community's role in the new service economy, create jobs locally and improve the quality of community life'* (Eger, 2009, p.48).

Smart cities and ICTs are highly interconnected. A city cannot be smart if it involves no new technologies such as ICTs, which lie at the heart of the Smart City's development. These technologies will increase productivity and efficiency, improve the quality of life and create jobs. They will also enable people to handle and store information and use a lot of information and data in real time. They aim to meet the Smart City's challenges in such areas as the environment and the economy (Hub Smart City, 2017).

ICTs will play an important role in various aspects of a smart city. The following diagram shows the various sectors concerned, i.e. public services, transport, energy, water, buildings, health, education and public security (IBM, 2011).

Figure 4: *Different Sectors concerned by ICTs*



Source: IBM. (2011). *Des villes plus intelligentes. Innover pour construire un futur durable.* Retrieved the 4th of May 2017 from https://www.ibm.com/smarterplanet/global/files/ibm_broch_smartercity_web.pdf

Let us now look at some examples of ICTs in a smart city. One of the challenges facing the Smart City is the environment. The aim is to reduce the global footprint, preserve green areas (and therefore biodiversity), and monitor such resources as energy and water. ICTs also make this possible. Some cities have smart streetlights with motion sensors to adjust streetlight power in line with the degree of use, to reduce energy consumption and achieve a positive impact on the planet. This also has an economic impact by reducing energy costs, as in the case of San Diego (Hub Smart City, 2017).

Another example is mobility. By using certain smartphone applications, people are now able to access certain data in real time to plan their journeys and take the fastest route. Such information helps users to make the best decision. This has all been made possible by ICTs, including smart sensors, cameras and mobile-phone applications. (IBM, 2011).

ICTs also play an important role in facilitating communication between citizens and the public authorities, which brings real exchange of collective intelligence within the city. Furthermore, this exchange occurs in real time. For example, the city of Nice has decided to install urban sensors in car parks in order to improve the flow of traffic. A simple mobile application can geolocate and guide a user to an available parking space close by in real time. This system was introduced because the city observed that it took more than 30 minutes for motorists to find a parking space (Hub Smart City, 2017).

ICTs make it possible to manage energy expenses better. They can therefore help to develop cities in a smarter way by boosting people's participation and helping to make the city more economical and ecological.

8. Key factors of a smart city

There are various factors that enable us to determine what makes a city smart and how to measure its smartness. According to Dameri and Rosenthal-Sabroux (2014), making a city smart involves looking at the following basic components:

- **Territory:** the city's geographical area
- **Infrastructure:** the buildings, streets, transport facilities, and so on
- **People:** all inhabitants, including residents, students, commuters who work in the city but live outside, and visitors
- **Government:** the local authorities that govern the city

To become smarter, the city's core components must take three other factors into account (Casalino *et al*., 2013; quoted by Dameri & RosenthalNSabroux, 2014, p. 6).

1. **Effectiveness:** This represents a city's ability to provide effective public and private services to the various players in the city, such as companies, citizens

(students, workers, elderly, etc.) and non-profit organizations. Thus, when a city seeks to become smart, it will not do so only in its own interest, but also in order to bring public value to the various players.

2. **Environmental considerations:** These relate to the harmful impact generated by big cities on the environment. In fact, one of the main objectives of the Smart City is to reduce those aspects to a minimum in order to preserve the quality of the environment, and in particular energy consumption, air and water pollution, road traffic and land use.

3. **Innovation:** New technologies constitute a very important aspect of smart cities because they improve the quality of life there. Smart cities must use all the technologies available to improve the quality of the main components. They can also improve services and reduce their environmental footprint through those technologies.

To be smarter, a city should therefore improve its core components by making them more efficient, ecological and innovative. This means that a smarter territory is cleaner, with clean water and fresh air. Smarter infrastructure will use new technologies (ICTs) to achieve greater efficiency and serve people better. Smarter people means people who are aware of their city's smart initiatives and who are better informed because they have better access to the Internet and new technologies. A smarter government is a government that uses all new technologies available to improve the quality of its services (Dameri and Rosenthal-Sabroux, 2014).

9. Measuring the performance of smart cities

Measuring the performance of a city is an important consideration. It is not merely a matter of measuring the smartness of a city. According to Merli and Bonollo (2014), the issue is far more complex: it covers all the progress that a city makes in order to provide stakeholders with better quality of life. The concept of the Smart City not only is related to new technologies that the city can use but must also take due account of the role of human, social and relational capital. The stakeholders must therefore be induced to play an active part. To that end, they must be informed of the activities, objectives and results achieved.

9.1. Performance measurement models

It is difficult to measure the performance of a smart city but many measurement models, index and methods have emerged in recent years. These models are increasingly used by city leaders, which allows them to determine with greater ease the areas on which they must spend more time. These measurement models will enable them to provide more transparent information to the city players (inhabitants, companies, and so on) by communicating the results obtained. In addition, it will

enable them to compare one smart city with another (Albino *et al*., 2015).

The Giffinger model (Vienna University of Technology)

Giffinger and his team set up an evaluation system to classify medium-sized European smart cities. Their measurement system is based on the six dimensions of the Smart City (economy, living, governance, environment, people, mobility) and on these various factors (see Table p. 22). In addition to identifying those factors, they also determine indicators to study the performance of each. The indicators are based on free, available public data obtained from several databases, such as Urban Audit and Eurostat.

Once the indicators are determined, they are combined to provide a measurable result by characteristic and then a result for each city. The result is then divided by the total number of indicators, which allows them to measure cities of different sizes in a reliable manner. For example, if we take the smart governance dimension, the degree of participation in decision-making, public and social services, transparent governance and political strategies and perspectives will be analysed to measure the performance of this dimension (Giffinger *et al*., 2007).

Intelligent Community Forum

Another system is a programme that rewards smart cities, developed by a non-profit organization called 'Intelligent Community Forum' (ICF). Each year the organization announces the cities awarded the status of Smart Communities on the basis of five factors, namely broadband connectivity, knowledge of the workforce, digital inclusion, innovation and marketing, and advocacy. This reward programme aims to allow cities to make progress every year in their smart projects. The Top 7 Intelligent Communities in 2018 were Chiayi City (Taiwan), Espoo (Finland), Hamilton (Canada), Ipswich (Australia), Tainan (Taiwan) and Winnipeg (Canada) (Intelligent Community, 2018).

The Lombardi et al. model

Lombardi *et al*. (2012) also proposed a model to measure the smartness of a city. Their model is based on the triple propeller developed in the early 21st century by Henry Etzkowitz and Loet Leydesdorff. Their triple helix is the union of government, business and university, which form the centre of any innovation system. The three 'propellers' are considered the main institution of knowledge creation.

The Lombardi model is based on the latter model but includes a fourth helix (civil society) (Etzowitz and Zhou, 2006), which assumes that citizen participation interacts with the other three propellers in a complex urban environment. The interaction between the propellers characterizes the successful approach of a city in the process of becoming smart. This new version of the model includes potential indicators of the Smart City for each of the four propellers (60 indicators). The

indicators were determined on the basis of reviews of the literature and fall into five categories, namely smart governance, smart economy, smart people, smart environment and smart living. The authors did not take the smart mobility dimension into account (Lombardi *et al.*,2012).

There are many other models for measuring the performance of smart cities, such as the *Smart City Index*, a tool based on 18 indicators from such fields as the economy, energy, the environment, mobility and administration (Lazaroiu and Roscia), the *IBM Smart City* and the *McKinsey Global Institute*, which classifies cities according to urban areas (IBM, 2018; McKinsey Global Institute, 2018).

It is worth pointing out that many indicators for measuring sustainable cities can also be used for evaluating smart cities. Smart cities are increasingly more sustainable, so it seems logical that these sustainable development indicators can be used to gauge the performance of smart cities too (Häkkinen, 2007; Sharifi and Murayama, 2013).

10. Strengths and limitations of the Smart City

10.1. Strengths:

According to the INRS report (2017), the Smart City holds out three great possibilities for meeting many of the challenges facing cities today.

The first is that cities could become more efficient thanks to the data available, which make it possible to monitor and control the city and make it more responsive.

According to Michael Flowers (2016), a data-driven city is one that will use such data in an intelligent way to provide better-quality services, such as better resource allocation and better information sharing. In his view, a data-driven city is a challenge of organizational leadership rather than of technology (Beyond transparency, 2016).

The second possibility is that cities could become more stimulating places where life is pleasant. This means that the city needs to improve the inhabitants' quality of life as well as governance, urban policy, etc. In addition, the new ICTs will enable citizens to be smarter and to behave accordingly (Florida, 2002). For others, such new technologies could offer a new way to innovate and administer the city in a transparent and responsible way. This could also help reduce social inequality (Townsend, 2013; Kitchin, 2014).

The third possibility is that cities could become more sustainable. The aim is to reduce their energy consumption and therefore their impact in terms of CO_2 because they are responsible for nearly 75% greenhouse gas emissions, as we explained at the beginning of this study. The city will therefore use new technologies to become more sustainable (INRS, 2017).

10.2. Weaknesses

An analysis of the literature shows that the Smart City's weaknesses outnumber its strengths, although the latter can be summarised under a small number of points.

First, one of the smart city's main advantages is also one of its biggest drawbacks. The Smart City produces and has access to an exponentially growing quantity of data, which the city can process and sell. This may result in the covert surveillance of individuals. In addition, management of the smart city is fully digital, which can lay it open to potential cyber attacks, hacking or technical outages. To counter such attacks or breakdowns, the digital system must be updated constantly, which generates regular costs.

Some authors argue that cities often claim to be smart without providing any tangible evidence (Douay and Henriot, 2016).

Another problem is the fact that the term 'Smart City' has been popularized by firms seeking to make a profit. Cities have become a market for such firms, and this may result in private players taking control of a city's future. According to Baraud-Serfaty, *'L'intervention des acteurs privés dans la ville [...] prend désormais des formes inédites: accélération de la privatisation classique, nouvelles portes d'entrée dans la ville, rôle central de l'usager/habitant, financiarisation de la fabrique urbaine'*[7] (Baraud-Serfaty, 2011, p.166).

Some authors see the development of the Smart City as reinforcing social and territorial inequality. For instance, in such cities as Singapore and Boston, certain neighbourhoods are smarter than others, which increases territorial inequality. In this respect, the increase in 'smart' services attracts more people to a given area. This drives rents up and poorer people away (Felli, 2015).

Another form of inequality is the digital divide. In cities where everything is digital, all inhabitants are expected to know how to use ICTs, but this is not necessarily the case. There will always be a big gap between those who have access to the Internet and know how to use it, and those who do not. The latter are thus excluded from yet another dimension of society.

11. Example of Smart City projects around the world

Many cities around the world have started to grow smarter and have begun experimenting with the Smart City concept, which emerged mainly in Europe before expanding internationally. Recent years have seen the advent of many Smart City projects, which fall into two types: smart cities created from scratch and cities that

[7] [Traduction] The intervention of private actors in the city [...] now takes unprecedented forms: acceleration of the classic privatization, new doors of entry in the city, central role of the user / inhabitant, financialization of the urban factory.

have become smart.

Many cities or neighbourhoods have been created from scratch and are therefore 100% smart. Some examples are set out below.

The city of Masdar in the United Arab Emirates is one of the world's best-known sustainable and smart cities. The main idea was to create a sustainable, carbon-neutral, waste-free city through the installation of wind turbines, solar panels on buildings and a water recycling system. Many critics have since wondered whether Masdar could really achieve its goal. According to *Time*, Masdar is not a carbon-neutral city but rather a low-emission one (Walsh, 2011). According to Steve Severance, the head of Programme Management and Strategy at Masdar City, 'The goals were very ambitious for schedule, size and sustainability. Building something that is too expensive for anyone to live in is not sustainable.' (quoted by Iren Quaille, 2013).

Another city built from scratch is PlanIT Valley near Porto in Portugal, which was designed as a testing ground for data-sensor technology. It has more than 100 million real-time sensors to make life on the site as easy and efficient as possible. For example, sensors can alert fire-fighters in the event of an emergency and air conditioners are turned on when you enter a room (Jaffe, 2013).

Another well-known example is the city of Songdo in South Korea. Built in the last decade, it is home to nearly 75 000 people. Many smart projects have been undertaken there, such as an underground train system that produces no CO_2 emissions and control panels installed in each house / apartment to allow residents to control their energy consumption, safety, etc. (Jaffe, 2013).

These new cities are the subject of much criticism. Optimists regard them as potentially offering a new urban model to address today's challenges, such as population growth and global warming. In addition, they attract investors and workers, which will foster strong economic growth (Vanolo, 2013). Others criticise these cities for claiming to be smart simply because they use new ICTs (Albino *et al.*, 2015).

To become smart, however, a city does not have to be created from scratch. Many cities that have existed for centuries are attracted by the concept, which offers them an opportunity to develop using the new technologies available. The following are examples of smart city projects and initiatives drawn from the literature.

In Europe, one of the first cities to achieve 'smart' status is Southampton in the UK. It has introduced a multifunctional 'Smartcities card' for accessing many services available in the city, such as paying for public transport, a library card and a leisure card (Southampton City Council, 2018).

In the transport field, the city of Barcelona has introduced a data-gathering system to

improve user journeys. The data gathered gives the city a knowledge of the daily journeys of its inhabitants, which has allowed it to rethink its bus system entirely. Today, the people of Barcelona can carry out 95% of their journeys with just a single connection (Malone, 2015). Stockholm has also decided to implement an intelligent tool, which has led to a significant reduction in road traffic (18%) and air pollution in the city (Bordage, 2009).

Not all cities are smart in the same way, of course. Some cities (such as Barcelona and Stockholm) focus mainly on transport, while others are taking action in other sectors. Oslo, for instance, is concentrating mainly on intelligent street lighting with the aim of reducing electricity consumption by 70%. In San Francisco, municipal data available to the inhabitants have enabled them to design nearly 60 applications to improve their quality of life.

There are many examples of smart city projects, so it is important for cities to choose which industry to focus on. The cities in the examples given concentrate on a single or only a few of the dimensions listed by Giffinger *et al*. In the latters' opinion, however, a city is smart when it takes account of all six dimensions.

12. Conclusion

It has been noted that the concept of Smart City is still fairly new but is developing more and more around the world. To date, there is still no universal definition of what constitutes a smart city, but all agree that new technologies are at the centre of the concept.

One thing this chapter has taught us is that to be smart, a city must have convincing results in the six areas developed by Giffinger (smart governance, smart mobility, smart people, smart economy, smart environment and the smart living). If the city has launched or plans to launch smart projects in the six areas, then we can say that the city is smart.

Another important aspect of this chapter is the role of the stakeholders, who can play an important role in the development of smart cities. It is therefore important for the city to identify them in order to create value for each stakeholder.

The role of ICTs goes to the heart of the Smart City. Without them, the Smart City cannot exist. These technologies aim to increase productivity and efficiency and improve the quality of life of the inhabitants. They play an important role in many areas, such as transport, public services, health, education, public safety and buildings.

Some models are useful for measuring the performance of smart cities. They measure the progress made by a smart city since the start of smart project launches.

Lastly, the smart city will offer the inhabitants better services to improve their

quality of life. Thanks to new technologies, the city will be more efficient and more responsive. The data that the city will gather can help it to offer services that are more closely adapted to the needs of the inhabitants. These technologies will also enable cities to be greener and reduce their CO_2 emissions. It is therefore a new development model that can inspire cities to respond to the many challenges they face.

Chapter 3: The smart city and sustainable development

Now that we have explained the two concepts of sustainable development and the Smart City, this section covers the links between them. The Smart City is seen as a new model of development for cities and the aim of this chapter is to understand the ways in which the Smart City can promote sustainable development. It outlines various points, such as the similarity and difference between the two concepts, the combining of the Smart City and sustainable development, and some examples of the use of ICTs in sustainable development.

1. From sustainable development to smart city

The smart city will therefore use modern tools (ICTs) to improve the inhabitants' quality of life and the environment for companies. Unlike the smart city, which is based on territorial marketing, sustainable development aims to protect our planet from harmful human activities (pollution, etc.) in order to preserve the well-being of future generations. Many sustainable development initiatives have been carried out in various areas, including cities, as the section entitled 'Sustainable city' shows (cf. p. 9).

Today, smart cities play an increasingly important role in sustainable development. Owing to urbanization, cities face significant challenges that are inducing them to rethink their approach to development. The sustainable city of tomorrow will therefore need to be smart if it is to solve its many social and environmental problems. This concept is growing in importance in many countries around the world and can provide a tool for promoting sustainable development in cities.

In 2015 the International Telecommunication Union (ITU), a United Nations agency working in the field of ICTs, defined the smart sustainable city as follows:

'A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects' (ITU, 2015, para. 7).

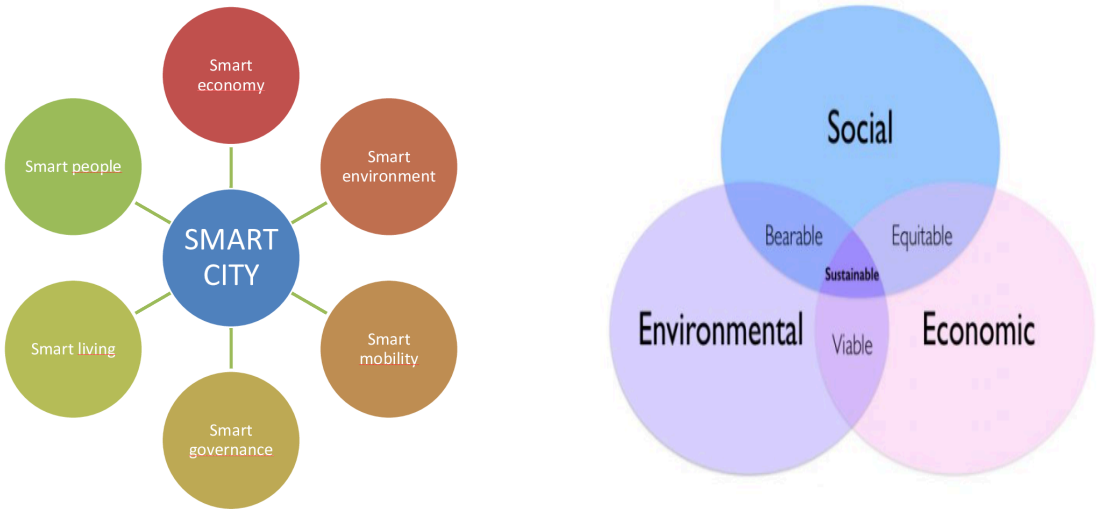
2. Similarities and differences between sustainable development and the Smart City

The table below sets out the various points used in comparing the two concepts (the Smart City and sustainable development) and summarizes the content of this study. Their comparison highlights their differences and similarities.

	Smart City	Sustainable development
Definition	A "smart city" is a multi-stakeholders' ecosystem – composed with local governments, citizens' associations, multinational and local businesses, universities, international institutions… – engaged in a sustainability strategy/transition (mobility, environment, economy, people, governance & living) using technologies (ICT mainly) as an enabler in order to become more sustainable (economic propsperity, social well-being & conservation of our natural resources).	Development that meets present needs without jeopardizing the ability of future generations to meet their own needs.
Dimensions	6 dimensions: - Smart Environment - Smart Living - Smart People - Smart Mobility - Smart Governance - Smart Economy	3 dimensions: - Social dimension - Environmental Dimension - Economic dimension
Goals	The main goal of such a city is to provide a better quality of life and services to citizens by using technology (ICTs) to tackle poverty and inequality, unemployment, urbanization issues (growing share of urban population) and energy management and to contribute to sustainable development.	The goal is to fight against global warming, preserve biodiversity (in terms of both environments and resources), preserve social cohesion and solidarity between generations and between territories, ensure the health and safety of citizens, develop a dynamic based on production methods and responsible consumption.
Type of approach	Participative approach: citizen, companies and organization are involved in the process of carrying out projects.	Collaborative approach: work in collaboration with companies and public or private organization.

The table offers an indication of similarities and differences. Some similarities are apparent in the section on the various dimensions, with some dimensions of sustainable development being included in the Smart City. Both concepts address economic, social and environmental concerns.

Figure 5: *Characteristics of Smart City and sustainable development*



Source : Ivan. (2016). *Sustainable Development And The 3 Pillars of Sustainability*. Retrieved the 17th of May 2018 from https://weemss.com/blog/sustainable-development-3-pillars-sustainability/
Sikora Fernandez, D. (2016). *The concept of smart city in the theory and practice of urban development management*. Retrieved the 27th of May 2018 from https://www.researchgate.net/publication/304570582_THE_CONCEPT_OF_SMART_CITY_IN_THE_THEORY_AND_PRACTICE_OF_URBAN_DEVELOPMENT_MANAGEMENT/figures?lo=1

Taking this further may involve comparing a dimension of sustainable development with several other characteristics of the smart city. For example, the environmental dimension is related to the smart environment, smart mobility and smart living characteristics because these characteristics have the same aim: to reduce CO_2 emissions. This proves that the Smart City plays an important role in sustainable development.

The most important difference between the two concepts may well be the type of approach. On the one hand, we have a more participative approach where the city needs to base itself on citizens and the various companies and organizations with their participation. Citizens play a key role and the city needs to incorporate them into its administration because no projects can be carried out without them (Bathie, 2017).

On the other hand, the concept of sustainable development is more collaborative, because the various players (companies, public and private sector, etc.) need to work

together if they are to meet its objectives.

3. Combining the Smart City and sustainable development

As we have seen, the Smart City plays a major role in sustainable development. The diagram below shows that the Smart City can be analysed in terms of the three pillars of sustainable development, namely the social, environmental and economic pillars. The Institute of Information Technologies and Society of Laval University has produced a model describing the three main functions of a Smart City and linking it with the role of ICT. The model is based on the work of Rudolf Giffinger (cf. p. 21) and the three components of sustainable development (Doran, 2014).

Figure 6: *The integration of the three components of sustainable development with the smart city*

Source: Doran, M-A. (2014). Qu'est-ce qu'une ville intelligente? Le Sablier, Votre ville est-elle SMART ? Volume 21, no1. p. 20-29

3.1. The smart city and the economy

This section concentrates on the public administration and economic players. The administration of the Smart City aims to implement and plan infrastructure and to provide services to the inhabitants on sustainable economic development conditions, while being responsive to their needs. In conjunction with businesses and the various economic players (universities, colleges, technology parks), the Smart City seeks to support innovation and ensure urban development is bolstered by promoting prosperity and sustainable development.

This component covers models for economic growth as well as urban planning, open data and metadata, bandwidth and wireless networks, mobility and all infrastructure using ICTs, such as intelligent transport, security services, smart electricity networks and water management (Doran, 2014).

3.2. The smart city and the environment

The environment in the smart city brings together its management infrastructure and natural resources. This means everything relating to air, energy, water, waste management, alternative or collective transport, green buildings, eco-neighbourhoods, green areas, smart growth, climate change analysis, and so on. To offer citizens a good quality of life, this component needs to be taken into account because it is closely linked to their health (Doran, 2014).

3.3. The smart city and the social component

The citizen is at the centre of this component, which entails participation and interactions by and between the inhabitants and the public administration. This is a very important dimension in this context, because a smart city must be built around and with the citizen. The latter is a key stakeholder and the city must take his or her needs and concerns into account. Human development is therefore as important as urban development. This component brings together all the services offered to citizens, including community life, participatory democracy, the digital divide, health, education, social innovation, citizen participation, the promotion of culture and heritage, shared urban space, neighbourhood life, urban regeneration, and so on.

To sum up, it is important to maintain a balance between the three components, because this will enable a smart city to be geared to innovation, prosperity, the citizen, and of course, sustainable development. This is the way to ensure the Smart City's success, bearing in mind that none of this would be possible without the elements of governance, citizen participation, stakeholder input, management and economic development with a view to sustainability and open data access (Doran, 2014).

4. ICTs for sustainable development

As the foregoing chapters and this study as a whole show, the concept of the Smart City has grown in importance and is being implemented to a greater extent around the world. Smart cities have developed thanks to ICTs, which are used in many fields and especially at municipal level, which is related to the three components of sustainable development, namely the environment, the economy and the social component. The sustainable city clearly also features a change in citizens' behaviour that can be fostered by new technologies. Some examples of new tools that the Smart City can use to change the behaviour of citizens and users to promote a more sustainable city are presented below.

4.1. Smart grids

Smart electricity grids use new technologies to adjust the flow of electricity between suppliers and consumers. The aim is to optimize energy generation, consumption and storage. This technology manages energy consumption intelligently and combines it with renewable energies. Smart grids bring both economic and environmental benefits. The challenge is to inform consumers in real time of their electricity consumption, so they can subsequently adapt to conserve energy and cut costs (Association des entreprises électriques suisses, 2018).

4.2. Smartphone mobile applications

There are numerous mobile apps that may have a positive impact on the environment, e.g. for mobility, to access traffic and travel information in real time depending on the mode of transport. This could induce users to leave their cars at home and opt for public transport, which would in turn promote sustainable travel. There are applications for sorting waste and determining what can be recycled, resold or disposed of. Other applications compare various products in terms of their environmental impact and allow consumers to choose the most environmentally friendly products, and so on (IDNEXT, 2014).

4.3. Tools to measure air pollution

Air pollution in cities can be measured today using cameras and sensors. In New York City, for instance, they can detect clouds of pollution invisible to the naked eye, which makes it easier to detect the source. As cities are the main emitters of CO_2, this technology could help them reduce air pollution in severely affected city areas (Cloutier, 2015).

4.4. Green buildings

ICTs can also make city buildings smarter using systems for managing their energy consumption better (smart grids) and measuring their energy efficiency with infrared cameras. Heat losses from buildings can be detected and prevented through energy efficiency measures (Cloutier, 2015).

4.5. Smart parking

Smart parking is not only a matter of finding a parking place more easily in city centres, but it also helps to reduce traffic, pollution and noise generated by vehicles. 25% of traffic in city centres is allegedly due to drivers looking for a parking space (Walter, w.d.).

4.6. Water consumption

New technologies will also affect the water consumption of the city's inhabitants / companies. Smart water meters enable water companies to track residents' water consumption and they can be charged to prevent waste. Consumers can thus monitor their water consumption in real time and see when it starts to rise excessively, which is when the price will go up.

Another positive point is the fact that these technologies can be used to detect water leaks immediately whereas it once took several hours or even days and a lot of water was wasted. Nearly 50% of purified water in developing countries is lost because of leaks in the distribution system or theft (ITU, 2011).

These examples show what ICTs can do from a sustainable development perspective. There are many technological tools other than those mentioned above, of course, but these are the most practical examples for smart cities. They can enable the inhabitants to adapt their behaviour and help cities to follow a more sustainable path.

5. Conclusion

In the 1990s, the concept of sustainable development was seen as a concept to meet the various needs of a growing population while aiming to preserve resources to ensure the well-being of future generations. Many sustainable development initiatives and projects have sprung up in cities, especially in urban planning.

At present, we are talking more and more about the smart city as a possible vector for sustainable development. Information and communication technologies are the main tools guiding this concept. The impact of this phenomenon is growing bigger and bigger around the world. As the next chapter and the example of Copenhagen in particular will show, these technologies are helping cities to become more sustainable.

This chapter has illustrated the similarities between the two concepts. The most important point is the fact that both concepts take economic, social and environmental concepts into account. This is very clear in the concept of sustainable development, whereas it is a little more subtle in the Smart City.

To sum up, sustainable development, on the one hand, is a very broad concept that does not require a lot of tools to implement. It tends to be seen in terms of long-term projects undertaken by the players to meet the objectives set at the start (for example, to fight against global warming, preserve biodiversity, and achieve social cohesion). The Smart City, on the other hand, will use many tools (ICTs) to achieve its goals.

As we have seen, there are many links between the two concepts. The Smart City is not an extension of sustainable development but should be seen as a vector thereof. It is true that the Smart City will use new technologies to improve the quality of life of its inhabitants, both now and in the future.

This has induced us to analyse in greater depth the city of Copenhagen in order to answer our research question: '**To what extent is the Smart City seen as the necessary path to sustainable western cities**'. Through this case study, we wish to determine whether the Danish capital's smart strategy is used as a vector for sustainable development. The analysis will therefore take into account the current situation of the two concepts within the city.

Chapter 4: Practical Case on the city of Copenhagen

Now that we have analysed the concepts of sustainable development and the Smart City, the final section of this work consists of a case study of the two concepts as they relate to the city of Copenhagen. The aim is to determine whether a city that seeks to grow in a sustainable way nowadays must be smart. This chapter therefore analyses the case of Copenhagen and answers the following research question: '**To what extent is the Smart City seen as the necessary path to sustainable western cities**'

To answer that question, this chapter describes the situation in the city of Copenhagen today from the viewpoint of sustainable development and the Smart City. First, some key figures on Denmark will be presented to put the country into perspective. Secondly, a brief description will be given of the Danish capital, the challenges it faces and the opportunities before it. This will be followed by an outline of Copenhagen's plan to achieve sustainability and its Smart City strategy. By way of a conclusion, we shall seek to determine whether Copenhagen is indeed a smart city.

To write this chapter, we have used documents kindly provided by the Danish Embassy, such as the Capital Sustainability Document *CPH 2025 Climate Plan* and a document on the city's smart project initiatives entitled *Smart City Solutions: A stronghold in the Copenhagen region*.

1. Key figures on Denmark

Before focusing on the city of Copenhagen, let us look at some key figures on Denmark to put the country's capital in context.

Table 5: *Key figures on Denmark*

Population	Approximately 5.75 million inhabitants (2018)
Area	42 931 km^2
GDP	US$324.87 billion (2017)
GDP per inhabitants	US$56.335 (2017)
Capital	Copenhagen – Approximately 600 000 inhabitants (2017)
Unemployment rate	3.9% (June 2018)[8]
Employment rate	65.3% (April 2018)
R&D expenditure	Enterprise: 2.08% of GDP (2016) Public sector: 1.12% of GDP (2016)[9]

[8] cf. Appendix 4
[9] cf. Appendix 3

Entrepreneurship	Ranked first in the ranking of Europe's leading entrepreneurial economy (2016).[10]
Information technology	Most digital Country in Europe (2016). [11]
Denmark's ranking in four international studies	No 1 Global Business Environment, Economist Intelligence Unit 2006. No 5 World Competitiveness Yearbook 2006 (IMD). No 4 Cruise Competitiveness Index 2005 (World Economic Forum). No 7 Globalization Index, Foreign Policy 2005.

Source: Inspired by the website http://denmark.dk/fr/en-bref/le-danemark-en-chiffres

2. The city of Copenhagen

Copenhagen is Denmark's capital and largest city with more than a million inhabitants (Copenhagen urban area). In recent years, Copenhagen has emerged as one of the few internationally recognized green and sustainable cities. The city's initiatives in this area have been recognized by many awards and quality labels. In 2013 the city was ranked first in the *Siemens European Green City Index*. In that year, the city also won the *City Climate Leadership Award* in the category 'Planning the Carbon City'. In 2014 Copenhagen was declared the 'Green Capital of Europe'.

Achieving that status took several decades. A major effort was needed to revitalize the city, which had been severely affected by deindustrialization, the dismantling of its port activities, massive debt, etc. Despite these problems, the city managed to achieve the status of a smart and sustainable city.

Since 1990 Copenhagen has been transformed as a result of municipal intervention and proactive policies. It has improved its public accounts, which has enabled it to apply a determined urban renewal policy based on the housing and real estate market and on the knowledge economy. The city works in cooperation with various local economic players (university and research institutes, the public sector, etc.) to renovate the city centre and develop vacant space for infrastructure projects to improve mobility and energy efficiency. Many projects, such as the introduction of

[10] https://investindk.com/en/insights/denmark-is-the-best-country-in-europe-for-entrepreneurs
[11] https://www.visitdenmark.com/denmark/denmark-most-digital-country-european-union

eco-neighbourhoods and the city's zero-carbon economy for 2025, have raised international awareness of Copenhagen's urban strategy.

The role of the Danish state has also been very important in the city's development. Numerous state-run projects, such as the airport expansion, the construction of the bridge linking Denmark and Sweden and the Baltic tunnel project, have raised the Danish city's profile internationally (Halpern *et al*., 2014).

3. Copenhagen's challenges and opportunities

The growth of Denmark's urban population has generated various social issues associated with city development. These mainly concern improving the quality of the living environment through the provision of new social housing for households.

Denmark has managed to return to economic growth thanks to reforms and a bespoke economic model. Openness to immigration is a major issue in the country. With unemployment standing at 3.9%, Denmark seeks to expand its labour market, and one option involves hiring more foreign workers.

The city of Copenhagen faces many challenges:

- Population growth: population is expected to increase by 20% by 2025.
- Economic growth is weaker than in Sweden.
- All modes of transport are congested.
- Health and the quality of life: this calls for a reduction in atmospheric pollution.

Against that background, the city has introduced a green mobility strategy, which encompasses most of the city's initiatives in terms of improving the quality of life and green growth. Achieving more sustainable mobility is one of the ecological challenges facing Copenhagen, which intends to reduce its ecological footprint significantly by 2025.

As part of its efforts to resolve social issues, the city hopes to facilitate mobility for the inhabitants by offering sustainable transport accessible to all. For the time being, the city's transport networks are fairly limited and people living in more remote suburbs have difficulty in accessing the centre of Copenhagen. The city regards solving this to be a priority, because most people live far from the centre and if they cannot come in the city by public transport, it means that there will be a potential loss of manpower (City of Copenhagen, 2016).

4. Copenhagen's Sustainable Development Plan

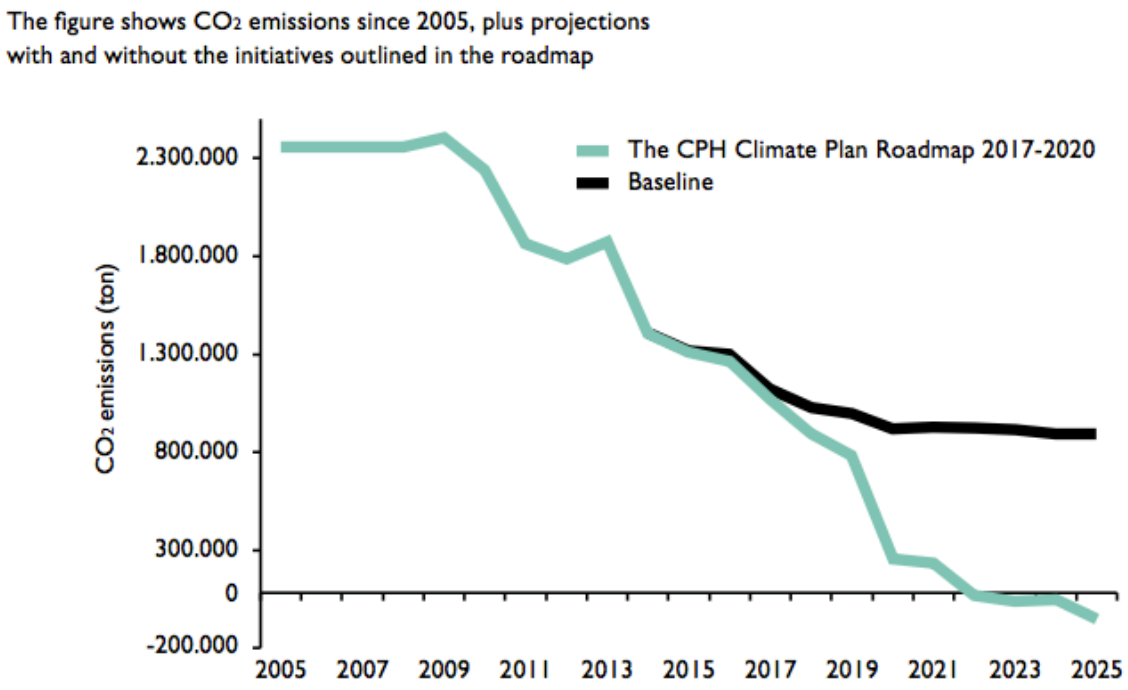
With a view to sustainability and in order to meet its main objective (achieving carbon-neutral status by 2025), the city of Copenhagen has decided to develop a sustainable development approach called the 'CPH 2025 Climate Plan'. The capital

wants to show that it is possible for a city to grow and reduce its CO_2 emissions at the same time. The initiatives put in place under that Plan are financed by budgetary agreements or alternative financing decisions.

Nonetheless, the CPH 2025 Climate Plan is not just a plan for climate-oriented action but also an indicative plan for businesses, the authorities and universities on how they can work together. The Plan also allows Copenhagen residents to learn how to reduce their own ecological footprint. It sets out ways in which energy companies of the future can help cities to manage their resources better. It also highlights the fact that the municipality, the country's largest employer, has a big role to play (City of Copenhagen, 2016).

Hereunder is a graph depicting the city's CO_2 emissions since 2005 and forecasts for the coming years.

Figure 7: *City's CO_2 emissions since 2005 and projections for the coming years*



Source: City of Copenhagen. (2016). *CPH 2025 Climate Plan*. Copenhagen : Technical and Environmental Administration. Retrieved from http://kk.sites.itera.dk/apps/kk_pub2/index.asp?mode=detalje&id=1586

4.1. Origin of CPH 2025 Climate Plan

In 2005 Ritt Bjerregaard, the former European Commissioner for the Environment, was elected Mayoress of Copenhagen with a programme focusing on sustainable development. Four years after her election, the UN Climate Change Conference took place in Copenhagen. In August 2012 the city's first carbon-neutral climate plan was adopted by the City Council. The following year saw the start of some 60 projects, including the construction of wind turbines in Copenhagen and the surrounding area,

work to ensure that all cogeneration plants would be powered solely by biomass by 2020, and the extension of the underground railway network.

According to Copenhagen City Hall, many jobs have been created in the green economy thanks to those projects. The target is to create between 28 000 and 35 000 jobs by 2025 (Hivert, 2016).

4.2. CPH 2025 Climate Plan: the road to carbon neutrality for 2025

The aim of the Danish capital is to become carbon-neutral by 2025. To do that, the city must consume much less energy than at present and must switch to green energy. The many initiatives in the CPH 2025 Climate Plan fall under four main topics:

- Energy consumption
- Energy production
- Mobility
- City administration initiatives

4.2.1. Energy consumption

Reducing energy consumption plays an important role in the CPH 2025 Climate Plan. Although it accounts for only 7% of total CO_2 emissions, reducing energy consumption is the most economical way to reduce those emissions. By reducing energy consumption, the capital could realize savings of DKK500 million on heating bills.

The following table gives the city's targets for 2025 in the energy consumption sector, the results in previous years and the city's plans for action from 2017 to 2020. It should be borne in mind that the Plan is subdivided into three phases: 2013-2016, 2017-2020 and 2020-2025. As we are currently in the second phase, we do not yet have the figures for 2017-2018. However, stock was taken at the end of 2016 to compare with the initiatives started in 2013.

Table 6: *City's targets, status and results, and horizon of the energy consumption sector*

Goals for 2025	Status and results 2013-2016	Horizon 2017-2020
- Reduction of 20% in energy consumption for heating. - Reduction of 20% in companies' electricity consumption (commercial and service).	- District-heating consumption in 2015 was approximately the same as the previous years. The fact that there was no real decrease can be explained by the fact that the population has increased by 9%.	- Thanks to a partnership between the city and energy companies, service and commercial companies and private customers will be offered an energy-saving package

- Reduction of 10% in households' electricity consumption. -1% of electricity consumption to be produced by solar panels.	- Electricity consumption fell by 7% in the capital (mainly thanks to households). - For commercial and service companies, energy consumption in 2015 was approximately the same as the previous years. - Hofor, the city's district-heating supplier, has changed the way it works and has managed to significantly reduce energy consumption. Instead of using steam, it uses hot water in the system and reduces the temperature of the supply piping. It has also completely changed its business model to improve heating units in the city.	to save energy. - New building construction and building renovation will have to comply with Building Class 2020 in order to reduce energy consumption by 20% to 30%. - The city will use more renewable energy such as wind power. - Using smart grids to enable consumers to monitor their energy consumption more closely will be vital.

As the table shows, the city is still far from meeting the targets set for 2025. Copenhagen has found that many homeowners and construction companies do not know how to reduce the energy consumption of their buildings. They are also unaware of the various financial incentives available for renovating them. The city will tackle the problem in the next few years because there is huge potential for reducing energy consumption in these sectors.

Companies in Copenhagen do not have sufficient serious incentives to save energy. In the first phase, some work was carried out on new business models to encourage commercial and service companies to reduce their energy expenditure. Copenhagen realizes that there is still a lot of work to do and that if it is to attract many companies to change their business models, it must offer better incentives to meet its 20% target for electricity savings (City of Copenhagen, 2016).

4.2.2. Energy production

The production of electricity and heating are the largest sources of CO_2 emissions in the Danish capital. The objective is to reduce emissions by 80% by 2025. Copenhagen is keen to replace fossil energy (coal, oil and natural gas) by green energy (wind energy, biomass, geothermal energy and solar energy).

Waste incineration is a major source of heating and electricity in Copenhagen. The city needs to know how to transform organic waste into biogas and use it, for example, in the transport sector. The city will also ensure that gas, water heating and waste-water treatment systems are carbon-neutral by 2025.

Table 7: *City's targets, status and results, and horizon of the energy production sector*

Goals for 2025	Status and results 2013-2016	Horizon 2017-2020
- Organic waste to be transformed into biogas. - Plastic waste to be separated from other waste. - District-heating network to be carbon-neutral. - Production of renewable energy (wind energy) and biomass.	- The combined heating and power plant now uses biomass instead of coal. Using biomass means half the energy consumed in district heating is carbon-neutral. - Hofor, the city's district heating supplier, is installing a new production unit that combines biomass-based heating and electricity, so that all the electricity and heating generated by the plant will be produced 100% from sustainable biomass from 2020. - Hofor also has 23 wind turbines. - Since 2016 homes and residential buildings are required to perform careful sorting. New technology will allow	- Hofor will install 360 MW turbines by 2025 to help the capital meet its goal and be carbon-neutral. - Now that the technology has improved, Copenhagen and Hofor will build a lot of solar panels if it is profitable in the long term. - There are also projects that aim to reduce CO_2 emissions from the water-supply, district-heating, town gas and waste-water treatment systems. - The energy system of the future will have to be more flexible in terms of production and consumption as well as between electricity, gas

	residual waste to be converted into biogas. It was tested in 2012 but still needs further development if it is to be optimal.	and district-heating services. - Several projects testing heat pumps and surplus heat will be carried out to improve the energy system's flexibility and efficiency. - When coal has been fully phased out of combined heating and power plant, plastic will be the biggest source of CO_2 emissions in heating production. The city will thus promote the recycling of plastic. - A treatment plant will produce biogas from household waste and will also develop methods for recycling the nutrients in the residual products.

Copenhagen has a vision for the future. Although all the projects undertaken by the city have not yet had a real impact, this will be a matter of time. The city will also work out a plan to be fossil-free (free of coal, oil and gas) by 2050 (City of Copenhagen, 2016).

4.2.3. Mobility

In Copenhagen, a large percentage of CO_2 emissions in the transport sector is due to road traffic (68%). The city needs to optimize and restructure its road network to minimize CO_2 emissions. Mobility within the Danish capital should be simple, healthy and efficient. The city accordingly intends to create the best possible traffic conditions for pedestrians and cyclists. The only way to achieve greener mobility involves close coordination between the various modes of transport (train, bus, bicycle, car sharing, etc.) and their development throughout the city. Vehicles for deliveries and unavoidable journeys by car must be as clean as possible if the city

wants to achieve carbon neutrality (City of Copenhagen, 2016).

Table 8: *City's targets, status and results, and horizon of the mobility sector*

Goals for 2025	Status and results 2013-2016	Horizon 2017-2020
- 75% of all journeys in Copenhagen to be made on foot, by bicycle or by public transport. - 50% of all journeys to school or place work to be by bicycle. - 20% increase in passengers in public transport compared to 2009. - Public transport to be carbon-neutral. - 20-30% of all light vehicles to run on new fuels. - 30-40% of all heavy vehicles to run on new fuels.	- Various initiatives have been started to improve green mobility (development of intelligent traffic control and information system, development of cycle lanes, expansion of public transport, support for use of electric and hydrogen-powered cars). - Since 2010 there has been a 9% fall in CO_2 emissions in the transport sector. - There has also been a 3% fall in road traffic and a 12% rise in bicycle traffic. - In 2015 41% journeys to school or work were by bicycle. - Denmark has become the first country in the world with a national infrastructure for hydrogen-powered and electric cars, but the number of cars involved is still low. - A call for tenders was	- Improve city bicycle network (better cycle tracks, cycle lanes, more bicycle parking, safe routes for schools, etc.). - Open new underground train line in 2019 to increase number of passengers carried in city centre. - Replace older buses with new ones that run on electricity and biogas. - Conduct trials with alternative fuels for heavier vehicles (vans and lorries).

	issued for carbon-neutral buses. Since 2017 buses on one line have been gas-powered. These new buses aim to reduce greenhouse gas emissions by 20%.	

4.2.4. City administration

Even though the work performed by the Copenhagen municipal administration accounts for only a small percentage of the reduction in CO_2 emissions (5%) compared with other sectors, the city has become a source of inspiration for other municipalities and has set an example to other cities. It is among the first few cities to ensure its own vehicles use alternative sources of fuel. In addition, it works with many private stakeholders in the construction and mobility sector to achieve carbon neutrality. The efforts it has made show that cities can reduce their energy consumption and CO_2 emissions significantly.

Table 9: *City's targets, status and results, and horizon of the administration sector*

Goals for 2025	Status and results 2013-2016	Horizon 2017-2020
- Reduce energy consumption in municipal buildings by 40%. - New municipal buildings to meet the requirements. Buildings constructed up to the end of 2015 to comply with the 2015 classification and those constructed up to the end of 2020 to comply with the 2020 classification. - The city administration's vehicles must use	- Energy consumption in municipal buildings has fallen 10% since 2010. - In 2015 5 000 m^2 of solar panelling was installed on municipal buildings. - In 2015 approximately 62% of the City of Copenhagen's fleet of cars ran on hydrogen or electric power. - By the end of 2016, 20 000 streets lamps used LED technology to reduce energy consumption.	- At present, 30% of water and heat meters are controlled remotely. The target is for all municipal buildings to have remote meters only. - Ventilation and heating systems will be renovated and buildings will have LED lighting by 2020. - Hydrogen-powered vehicles have replaced many tourism vehicles. The city plans to buy a lot of electric and hydrogen-powered cars in coming years.

alternative fuels such as biofuels, hydrogen or electricity. - Energy consumption for street lighting to be halved. - 60 000 m^2 of solar panels to be installed on municipal buildings.	- Refuse-collection vehicles must run on gas. -All city departments' projects must now include environmental and climatic requirements.	- The city will insert requirements for alternative fuels (e.g. for deliveries) in transport contracts. - Since 2009 Copenhagen has been training climate ambassadors in schools. These pupils are trained to spread their knowledge of climate problems and prepare the younger generations to act positively on climate change in coming years. The city plans to train another 250 ambassadors by 2020.

5. Copenhagen, the Smart City

As we explained above, Copenhagen aims to be the first carbon-neutral city in the world by 2025. To meet that target, the city is ready to use new innovative solutions in several fields, including mobility, healthcare, energy and climate control. The goal is to improve the inhabitants' quality of life, be more and more innovative, attract investors and create more and more jobs in the capital (Cisco, w.d).

The Danish capital has received numerous awards. The *EasyPark Group's Smart City Index* has ranked Copenhagen several times top of the world's the most liveable cities. By analysing 500 cities around the world and ranking them on the basis of various factors, the Group identifies the best city to live in. Its analysis also takes account of the opinions of over 20 000 journalists specializing in technology and urban planning.

Copenhagen and Denmark have also already received awards for their efforts in achieving Smart City solutions. In 2017 the *Digital Economy and Society Index* (DESI) declared Denmark the most digital country among the 28 European countries selected. In 2014 Copenhagen also received the *World Smart Cities Award* for having one of the best plans in the world for Big Data and using those data to create a greener and more liveable city. The city also won the *European Green Capital*

Award in the same year (Copenhagen Convention Bureau, 2017).

Copenhagen has two main strategies to make the city smarter. First, it seeks to become a testing laboratory for intelligent and sustainable solutions. This will allow it to attract many new businesses. For example, the city has created a sustainable neighbourhood where nearly 40 000 people can live and where an equal number of jobs will be created. To facilitate the development of the neighbourhood, the city works in collaboration with public authorities and private companies. Creating a smart city also involves breaking down the barriers between the public sector and the private sector.

Furthermore, the city applies a 'sharing is caring' approach by seeking to share the knowledge it has acquired over the years with other cities in the world and vice versa. The capital is thus becoming an attractive place to invest in. Many companies are also ready to invest in Copenhagen because they are aware that companies that work closely with the public authorities there have enhanced their reputation around the world (Copenhagen Cleantech Cluster, 2017).

The capital therefore wants to maintain its position as a world leader in the field of sustainable and smart cities. The growth of Copenhagen's population brings new challenges for the city, which must constantly innovate to improve. By transforming the city digitally, Copenhagen and its stakeholders will provide a real opportunity to harness digital innovation to improve services to citizens, improve community experimentation and create new sources of income and new operational models (Copenhagen Solution Lab, 2017).

5.1. Initiatives

Copenhagen's municipal departments have identified some key areas for developing the Danish capital intelligently. This calls for a suitable infrastructure for collecting and processing data for use in creating smart urban solutions. As we show below, in addition to good infrastructure, new solutions need to be developed in partnership with the rest of the city without undermining the inhabitants' privacy.

Figure 8: *Smart at several levels*

Source : Copenhagen Solution Lab. (2016). *Smart City Copenhagen*. Retrieved the 20th of June 2017 from https://www.gate21.dk/wp-content/uploads/2016/06/Smart_City_Copenhagen_FOLDER_2016.pdf

The above figure shows that Copenhagen seeks to build sound foundations before focusing on other areas. The basement and ground floor therefore concerns the infrastructure of the Smart City, a data platform and privacy area, and co-creation and partnerships.

5.1.1. Foundations

To implement and develop such solutions, the city needs good infrastructure incorporating sensors to collect and analyse data. Copenhagen is in the process of setting up basic infrastructure to allow it to develop Smart City solutions.

Copenhagen intends improving the use of data with a view to proposing new intelligent solutions for the city. The aim is to analyse the data needed to make the city smarter while putting restrictions in place to protect individuals' privacy. Copenhagen supports the development of a city data-exchange market project, in which data are collected from public and private sources and can be used to create new smart solutions for the city.

The city seeks to work in collaboration with citizens, companies, entrepreneurs and universities to find solutions to the many challenges facing it. Collaboration with these partners is important because it allows the city to identify the challenges clearly and it also helps in developing smart solutions. Copenhagen has decided to set up a Copenhagen Solutions Lab and other initiatives to find new private and public partners.

5.1.2. Areas to focus on

Copenhagen focuses on various areas – health, smart mobility, energy and climate, smart citizen and smart learning – to achieve the city's targets using smart solutions.

Health

Healthcare is a constantly evolving area. Today, the average lifetime and the duration of working life are increasing. More and more people are suffering from chronic diseases. New and smart technologies could improve the lives of people with special needs and enable them to make healthier choices.

Copenhagen has already undertaken several initiatives in this area. The city wants to use data better to provide telehealth services for people with chronic diseases. It also intends increasing the visibility of its free public sports facilities using digital tools to encourage people to play more sport.

Smart mobility

Intelligent transport solutions are useful both for reducing urban traffic and for making it safer. Urban traffic is an important sector for the city if it wants to achieve carbon-neutral status.

The Danish capital is implementing an IT-based traffic congestion system that seeks to offer a global real-time view of traffic, so action can be taken when the traffic situation becomes critical.

Energy and climate

Smart technologies are needed to manage cities' energy production, storage and consumption. Denmark and Copenhagen produce a lot of renewable energy through wind turbines and production is expected to increase up to 2050. We therefore need to concentrate on other intelligent technologies applicable to the building and transport sectors.

Copenhagen is already considered a leader in this area. It is working with utility companies on the use of smart meters for electricity, water, gas and heating in private households.

Smart inhabitants

Both the city's residents and visiting tourists must feel that the city is becoming smarter and that its services are becoming easier to use. To remain the most liveable city in the world, Copenhagen must constantly develop new intelligent solutions for services to such people as tourists and the disabled.

Copenhagen has decided to propose public participation activities and co-creation methods using new intelligent technologies. The idea is that the inhabitants (students, residents and businesses) will adapt to working with 3D printers, open-source materials as well as more conventional equipment.

Smart learning

A reform is being implemented in primary and secondary schools, which are now based on the 'open school' plan where learning takes place in interaction with the surrounding society. Schools in the Danish capital thus have access to a unique platform for training skilled employees / entrepreneurs in innovative and technological fields.

Copenhagen is interested in working with certain players in providing creative areas for supporting creativity and digital education in schools to meet the city's current challenges (Copenhagen Solution Lab, 2017).

The above five areas for intervention are very similar to the six levers of the Smart City presented by Rudolf Giffinger and Boyd Cohen, but can one call Copenhagen a Smart City? That question is answered in the following section, which analyses the various factors that make a city smart according to Rudolf Giffinger and Boyd Cohen.

6. Is Copenhagen a Smart City? Analysis in terms of the Giffinger model

The Rudolf Giffinger model seeks to classify cities on the basis of their smartness. According to Giffinger, a city is smart if it meets the criteria for the Smart City, namely smart governance, smart mobility, smart people, smart environment, smart living and smart economy.

Even if the previous point gives us some examples of smart initiatives that the city has launched, Giffinger's model will allow us to further analyse the different criteria that make a city smart.

This section will determine whether Copenhagen is a smart city in line with those criteria. If it has undertaken initiatives or will be starting projects in those six areas, we can call Copenhagen a smart city.

This model seemed the most appropriate because it offers an up-to-date view of the

efforts being made by the city in terms of the various dimensions of the Smart City. It also highlights the areas requiring special attention for the city's sound development.

To answer this model, we studied the CPH 2025 Climate Plan report, which contains a lot of information relating to the reduction in CO_2 emissions in many areas such as mobility, energy and administration. We also collected a lot of information directly from the Danish Embassy, where we were in contact with Alicia Miasko, the Ambassador's trainee, with whom we had a telephone conversation and email exchange.

For the realization of the table, We were inspired by the thesis presented by Donald De Meester in 2016 and entitled '*Aéroports et villes intelligentes; points d'intégration et de convergence'* (De Meester, 2016).

All the information dates from 2015 until now.

6.1. Smart Governance

Participation of inhabitants in decision-making	The city's inhabitants are involved in the decision-making process. Through polls or meetings, the inhabitants can put forward their opinions freely and help the city to come up with intelligent solutions to the many challenges facing it. For example, the Danish Technical and Environment Department has collected feedback from the inhabitants on how to improve cycle tracks. 10 000 feedback responses were received, allowing the city to adapt the infrastructure in line with the inhabitants' views (Miasko, 2018)
Transparency	- Denmark is doing everything they can to fight corruption. The proof is that the country is ranked second in the least corrupt country rankings (Miasko, 2018). - Data on inhabitants, businesses and real estate are made public and free with a view to stimulating innovation (Copenhagen capacity, 2018). - A report on the Copenhagen climate

	plan is published annually. - An information website exists on how the city works (business, working, living, investing in the city, etc.) at http://www.copcap.com.
Availability of public and social services	The Danish capital delivers services to inhabitants through various specialised administrations, namely the Employment and Integration Administration (EIA), Social Services Administration (SSA), Health and Care Administration (HCA), Children and Youth Administration (CYA), Culture and Leisure Administration and Finance Administrations (FA).

6.2. Smart People / Citizens

Level of qualification	- 93% of a year group complete a youth education programme. - 62% of a year group complete a higher education programme (The Ministry of Higher Education and Science, 2016). - The country is considered the 3rd best country to study in Europe (The Ministry of Higher Education and Science, 2016). - The workforce is constantly upskilled to adapt to changes on the labour market. - Many Danes do not hesitate to take additional training to acquire more experience (Miasko, 2018).
Access to education	Free school fees for all because education is financed by taxes (Miasko, 2018).
Participation in public life	- The city encourages the inhabitants to participate in public activities and co-creation methods using new technologies and data. - 79,23% of registered voters in Danmark (ElectionGuide, 2016).

Creativity	- Many experts and politicians have realized that it is not enough to have a great knowledge but rather to know how to use the knowledge acquired to boost creativity. For the Danes it is important to have a creative workforce and the country is thinking more and more about changing the classical education system (Miasko, 2018). - Many initiatives have been launched so that young people think more innovatively. For example, the University of Copenhagen (Science Innovation Hub) is working with the municipality of Frederiksberg to set up competitions such as the Smart City Challenge, which aims to boost creativity.

6.3. Smart Economy

Flexibility of the labour market	- Unemployment rate of 3,9% (Trading Economics, 2018). - The Danish labour market is very flexible with companies able to hire and fire staff very easily. - Wages are the most competitive in Europe because employer contributions are lower in Denmark than in other countries.
Innovative spirit	- R&D expenditure equals 3,2% of the GDP (Statistics Denmark, 2018). - The city must be innovative if it wants to achieve its goal of carbon neutrality. This is why Copenhagen creates, uses and implements many new technological innovations. - Denmark is one of the most innovative countries in Europe (ranking 3rd on the European Innovation Scoreboard) (Copenhagen capacity, 2018).

Entrepreneurship	- New companies account for 10% of the total in Denmark. - Copenhagen Hub aims to help start projects. - Access to great accelerators and investors (the Danish accelerator is the most active among the Nordic countries and is in the top 10 in Europe). - Entrepreneur Support Programme (Copenhagen capacity, 2018).
Productivity	- The Danes are considered the most productive and hardworking workers in Europe. - Work culture is important for Danish people, who enjoy wide autonomy, which makes them more motivated employees (Copenhagen capacity, 2018).

6.4. Smart Environment

Pollution	- Air quality in the city is considered as good. It means that it represents little or no risk[12].
Environmental protection	In recent years the city has set a far-reaching plan in motion to become the first city with no CO_2 emissions.
Management of resources	- Reduction of 20% in companies' electricity consumption (commercial and services). - The energy consumption for street lighting must be halved. - The district heating network must be carbon-neutral. - Transformation of organic waste into biogas. - Production of renewable energy (wind energy) and biomass. - Smart Grid for electricity, water, gas and heating.

[12] Real-time Air Quality Copenhagen http://aqicn.org/map/copenhagen/#@g/55.7077/12.5653/12z

6.5. Smart Living

Health conditions	- Average life expectancy is 81 years in Denmark. - The city has a very good health policy based on six initiatives: - Promote daily health everywhere (in schools, companies, etc.) - Provide special support for people in greatest need (e.g. children growing up in alcoholic families) - Lend equal weight to mental and physical health - Collaborate broadly to ensure high-quality solutions for inhabitants - Boost cohesive health efforts - Seek new paths for ensuring inhabitants enjoy a good life (City of Copenhagen, 2015).
Education facility	- Free access to education - Innovative universities - World-class education in various areas (IT, ICT, life sciences, etc.) - Unique university-industry cooperation
Security	- Ranked No 1 out of 162 cities, ranging from safest to most dangerous. - Low crime rate (Miakso, 2018).
Housing quality	- High standard of housing - Size of dwellings per person equal 51m^2 and it is the higher in Europe.[13]

6.6. Smart mobility

Local accessibility Copenhagen aims to ensure that 75% of journeys are made on foot, by	- Bus - Underground train - Train

[13] Appendix 4: Size of dwellings per person in Europe

bicycle or using public transport.	- On foot - Bicycle - Car - Taxi
International accessibility	- Plane - Train - Bus - Car
Availably of ICT infrastructure	- Green-wave traffic control - Smart parking - Optimised route planning according to real-time traffic information - Connected bins to reduce distance for rubbish collectors - Intelligent traffic lights
Sustainable, innovative and safe transport system	- Greener vehicles (electric or hydrogen-powered) - More public transport and bicycles - Many cycle tracks - Considerable bicycle parking - Infrastructure for hydrogen-powered and electric vehicles - Car-sharing

7. Conclusion

The aim of this chapter was to analyse whether cities nowadays have to be smart to be sustainable. To answer that question, we analysed the city of Copenhagen and the various projects it has put in place to reduce its CO_2 emissions.

In the first part of the chapter, we analysed the city's sustainable development plan (CPH 2025 Climate Plan). It plan focuses on four main topics: energy consumption, energy production, mobility and city administration initiatives. The city is therefore tackling those four main areas in order to achieve carbon neutrality by 2025. To that end, the city has undertaken projects in various fields to reduce its emissions. Many of the projects concerned were intelligent, such as the use of a smart grid and an intelligent traffic control and information system.

The second part focused on the Smart City and seeks to determine whether Copenhagen is a smart city. To do that, we used the model developed by Giffinger as

a basis for analysing the various criteria that make a city smart. If it met the six criteria, we could say that Copenhagen was a smart city. After analysing the city, we noticed that all the smart city criteria are met, making Copenhagen a smart city. The characteristics of mobility and the environment are those the city has developed most for the moment because it aims to achieve carbon neutrality. However, those two characteristics also have repercussions for the living conditions of the inhabitants and on governance.

Our case study of the city of Copenhagen shows that the concepts of sustainability and smart city are linked. Indeed, the use of new information and communication technologies brings benefits to the city and helps it to be more sustainable. A smarter city is therefore also more sustainable as it promotes the reduction of carbon emissions within the city.

Chapter 5: Constraints, recommendation and conclusion

1. Constraints and possible recommendations to the development of smart cities

There are many obstacles to Smart City development. In particular, not all cities have the same financial capacity, especially in developing countries. This chapter will therefore discuss the main obstacles to the implementation of smart infrastructure in western cities and recommendations on how they could overcome this.

Such constraints and recommendations concern any city wishing to develop intelligently and sustainably with a view to improving the quality of life of the inhabitants. There was no point in proposing recommendations to the Danish capital, given the many initiatives that the city has and will set in motion to make it more sustainable and more intelligent. The aim is rather to propose solutions that will help other cities to become more sustainable thanks to new intelligent technologies. This chapter covers five constraints and many recommendations linked to them.

1.1. Financing and business model problems

Cities all have different budgets: some have more resources than others and the cost of smart infrastructure development remains quite expensive for a city with limited resources. The biggest concern for cities is to find sufficient funding to cover the costs of Smart City projects throughout the process. This makes it difficult to engage in viable projects for the long term because they are complex, involve many partners and entail many risks.

Funding for Smart City projects may involve pooling public and private resources as well as using funding models and public-private partnerships. Governments also need to ask questions about policy, taxation and regulatory stability to help the private sector grow and innovate.

The lack of information on costs and benefits is also a constraint and citizens need to be aware of the costs and benefits that such projects may entail, as well as the prices that they will be charged before the start of each.

However, there are many solutions for addressing issues relating to the financing needs of smart cities.

First, cities can create new funding models based on technology. Given the savings (on water, energy, etc.) that new intelligent technologies can provide, these gains can be used to recover some of the initial investment costs. It is therefore a reliable way to finance smart city projects. Toll systems can also be introduced where significant rush-hour traffic jams in city centres favour the use of public transport. Installing

sensors and cameras on streets could make this feasible and it would increase revenue. Crowd-funding platforms can also be used to raise money for Smart City projects.

The data collected using smart technologies can also be sold. All these technologies provide a lot of data that the city can turn into information for sale to its partners. Establishing a suitable business model and a suitable value chain for each type of data will be important. Of course, the rules on privacy and citizen safety must be respected during the process.

Lastly, using public resources more intelligently could also free up additional funding for use in financing smart cities, while online platforms can be used to pool unused public resources and thus generate additional funds for states.

1.2. Governance

Another obstacle to the development of smart cities is governance issues. Developing a city in a smart way means transforming its governance, which is a key factor in the smooth running of a smart city. Furthermore, infrastructure is no longer specially adapted to the current challenges facing cities (such as the need to reduce CO_2 emissions and resources consumed).

Managing a smart city well calls for a good management and execution strategy. On the one hand, this means being able efficiently to exploit the data gathered from intelligent sensors and knowing how to make the right decisions afterwards. On the other hand, governance needs to be collaborative and transparent. Collaboration is very important: the administration must be ready to listen to the differing points of view of citizens and organizations and to collaborate with them, outside as well as through web platforms. Decompartmentalizing departments can also help to improve communication within the administration.

The current model for city governance must therefore be adapted to incorporate data provided by smart sensors into decision-making processes. Municipal administrators are finding it difficult to design new forms of governance which take the needs of citizens into account. Nonetheless, some avenues for facilitating governance in cities that seek to become smart are worth exploring.

First, cities can start promoting participatory governance platforms. Many applications currently exist for allowing municipal authorities to use participatory platforms that aim to maintain regular relations with citizens. This makes it possible to involve citizens' participation in decision-making. A good example is given in the previous chapter on Copenhagen (cf. p.61), which held surveys and meetings with citizens to ascertain their opinion on how they could respond intelligently to the new challenges facing the city. Jakarta has used social networks (Twitter) to warn the

population of the risk of floods (Gillis, 2014). This type of platform also allows for more transparency in governance for such citizens.

Next, decompartmentalizing administrative activities is important. Smart cities produce a lot of data and information collected by intelligent infrastructure and which is monitored by various municipal bodies. Utilizing these data and information better means decompartmentalizing administrative activities. A good way to do this could involve setting up an operations centre to collect all data directly from various sources. Such centres would make better use of data by utilising all different kinds of data, so expanding the information available to decision-makers. A system of this sort has been set up in Brazil, where an operations centre brings together the 30 municipal departments and private service-providers within the same control room (Frey, 2014).

1.3. Importance of adapting smart solutions to local context

Cities that seek to be smart need to pay attention to their local context. It would be a mistake to transfer the concept of a Smart City from one geographical region to another. The context in each city or region is specific to it and it therefore has different development needs. This is also an obstacle because cities need to analyse the urban problems they face before investing in smart technologies. It is not enough just to copy another city. Areas such as economics, culture and the environment are therefore important areas in smart solution planning.

One example is smart transport, which uses many sensors and data and may be too expensive and therefore unsuitable for developing countries. The latter should opt for simpler solutions that are adapted to their mobility needs, such as the use of mobile applications providing information on the timetables of the various means of public transport.

There are, however, solutions that cities can use to adapt their smart infrastructure to the local context. They can adapt to the situation in the area with the help of local institutions such as universities, businesses and research centres. They can work with the municipal administration to find smart solutions adapted to local needs. This was done in South Africa, where a local university and a city administration decided to work together to build smart buildings that met urban housing needs (Modisaatsone, 2014).

Cities can also create urban innovation centres and urban laboratories, where new ideas and concepts can be tested in real conditions to see if they are adapted to local needs. Such systems, which would be real incubators, are already in place in some African countries, thanks in particular to the Africa-EU Strategic Partnership (European Network of Living Labs, 2015).

However, some cities do not have the means to set up innovation centres or living laboratories or to adapt to the local context through local institutions. They can join forces with other cities with similar development problems, pool their skills and share their experience. The European Innovation Partnership for Smart Cities and Communities seeks to help in pooling cities' resources to fund projects, coordinate urban initiatives and projects.

Another possibility would involve Open Data and Open Science solutions. This means that governments and the private sector would make access to data open for local Smart City project departments, so they could make the best use of them. The Open Science option would allow progress to be made through free access to scientific solutions not protected by patents. These approaches would increase the innovation of smart solutions adapted to the local context.

1.4. Problems relating to competence

Another obstacle encountered is a lack of competence in a city's human resources. A city that seeks to be smart must have adequate human resources available to ensure that all its projects are undertaken as efficiently as possible. This means investing in smart people, not just smart technologies. We often find that there is a lack of competence in a world where technology is evolving constantly. This is a big hurdle that cities must overcome if they want to develop intelligently.

Cities can, however, put in place solutions that allow them to meet this shortcoming. First, they can step up teaching programmes in the fields of science, mathematics, technology and engineering. A population with a sound knowledge of these subjects will help fill positions relating to the design and maintenance of intelligent infrastructure. If the city wants to transform itself intelligently, it must put strong emphasis on the teaching of these subjects in schools. There are already special programmes (Smart Cities Programme[14] and Data School[15]) on smart cities and urban data to familiarize students with the application of scientific concepts to real life. This can encourage them to go into areas such as technology, science, engineering and mathematics.

Secondly, it would be worthwhile to have a fresh look at the curricula of primary, secondary and higher educational establishments. The goal would be to include the skills required for intelligent infrastructure. An important factor in the Smart City is a multidisciplinary approach, so it is important for schools and universities to support multidisciplinary research and learning. There are already programmes designed for the new sciences of the city, which cities can learn from. Another approach would be to offer online training/courses to teach various skills relating to smart cities.

[14] http://engineering.nyu.edu/k12stem/sosc/
[15] http://urbandataschool.org

Private companies can also play a role by contributing to finding intelligent, innovative solutions. An interesting point would involve setting up a partnership with technology companies to train staff in smart cities. Such companies could make courses/training available to students to fill the skills gap in cities.

1.5. Ensuring the Smart City is fair

One of the last big hurdles facing smart cities is equity. Smart City applications must be fair, they must be suitable for all and they must offer the same opportunities to all, without neglecting any groups. All must benefit from the positive effects of these applications. In their Smart City strategies, cities must not overlook the needs of vulnerable groups, such as women, the elderly and people with disabilities. It is therefore important to have participatory governance, so no group is left out. The following recommendations seek to ensure that smart cities are also fair.

First, smart cities need to address gender issues. Technology can be used in three ways to create intelligent infrastructure that takes gender issues into account. The first involves technology that connects women with urban planners, so the latter understand the formers' needs. The second involves technology to measure in real time the problems facing women in the city. Applications can be designed to collect information targeted by gender to understand the needs of women better (transport example). Lastly, the fields of technology, science and innovation can pay a role in improving communication tools relating to gender equity.

Secondly, smart cities need to create smart infrastructure for all vulnerable groups. New smart solutions can improve the quality of life for people with disabilities and the elderly. For example, 3D printers can recreate cultural objects to give the blind access to works of art that they can touch. Another example is technology to create a navigation system adapted to visually impaired people to make journeys more enjoyable. Municipal authorities should therefore focus on Smart City applications that do not leave certain groups by the wayside.

Another recommendation would be to formalize the informal sector of countries through mobile applications. Many countries do not have data on this sector and these are often forgotten by municipal institutions. The fields of technology, science and innovation can help to design solutions that take the informal sector into account. The data collected would make it possible to measure the impact of this sector and thus to build intelligent infrastructure adapted to the sector's needs.

The sector generally has no access to water or electricity. Smart infrastructure can be designed to provide it sector with access to these basic services. M-KOPA, a company in East Africa, uses mobile technologies and solar energy to enable the

sector to enjoy these services at affordable prices. Many countries can draw on that example and undertake similar projects to ensure that Smart City applications are equitable (M-Kopa, 2018).

2. Conclusion

Over the years, cities have undergone many morphological changes and have faced many challenges, such as population growth, greater mobility and energy needs, global warming and health problems stemming from pollution. As the population continues to increase over the years, cities are forced to rethink their approach to development. Current development models no longer meet the new challenges of the 21st century. Cities must therefore think differently and find new solutions to new issues. They must start to control their urban environment in a more sustainable way. This is a huge challenge that every modern city faces and will need to respond to in the years to come.

As a result, the new concept of the Smart City has appeared for some years now. It advocates sustainable development, which is defined as *'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'* (ONU, 1987).

The Smart City concept can provide solutions to the main problems currently facing cities, such as reducing CO_2 emissions and raw materials consumed.

To be 'smart', cities must undertake initiatives in the six characteristics covered by the Smart City concept, namely citizens, governance, economy, mobility, environment and housing. These features encompass many global factors that do not take account of predefined initiatives or those imposed by the concept. Each city is therefore free to choose the factors that correspond most closely to it, so allowing them to develop into smart cities using the means at their disposal.

Information and communication technologies (ICTs) are one way in which cities can plan their development by rethinking existing processes in various areas, such as transport, public services, education and buildings, governance and even water management to become smarter. ICTs, particularly computer technologies, constitute a key process that is relevant to achieving the objectives set in terms of sustainability. In addition, the incorporation of these technologies into urban infrastructure would make it possible to achieve the sustainable development goals set by the United Nations. For example, 'Goal 9' aims to build resilient infrastructure, promote sustainable industrialization and encourage innovation, while 'Goal 11' aims to create more sustainable cities and communities, i.e. granting access to safe, affordable housing, investing in public transport, etc (UN, 2018).

Many cities have already taken steps towards achieving 'smartness'. They include the city of Copenhagen, which we chose to analyse, and which has decided to achieve carbon neutrality by 2025. To achieve that goal and thus become a sustainable city, the city has implemented many smart initiatives.

In the course of working on this thesis, we observed that the Smart City has increasingly been seen as a vector for sustainable development. As the definition of the Smart City shows, one of its main goals concerns the sustainable development: *'A "smart city" is a multi-stakeholders' ecosystem – composed with local governments, citizens' associations, multinational and local businesses, universities, international institutions… – engaged in a sustainability strategy using technologies (ICT, engineering, hybrid technologies) as enabler.'* (Desdemoustier and Crutzen 2015, p.7).

Our main objective in this thesis has been to answer the question: '**To what extent is the Smart City seen as the necessary path to sustainable western cities?'.** Our case study of the city of Copenhagen has shown that becoming a smart city is a good way to make a city more sustainable.

Our recommendations also pointed out that new technologies make it possible to improve the standard of education and achieve gender equality. ICTs therefore act as catalysts in generating economic growth, social inclusion and environmental protection, on which sustainable development is based.

Achieving Smart City status is no longer just an option but is becoming a necessary step in developing a more sustainable city. It is viewed as the path western cities must take to achieve more environmentally friendly behaviour and safeguarding the well-being of their inhabitants. Of course, incorporating smart technologies into the environment is still a complex task for a city. It requires close cooperation and interlocking decisions between a large number of stakeholders.

Many still think that a smart city is simply one that uses new technologies to save energy, heating and water, or has applications designed to facilitate the daily life of the inhabitants. We should bear in mind, however, that to be 'smart', a city must take citizens' opinions into account. It is very important to incorporate them into the decision-making process. A city that seeks to be smart must therefore work to become sustainable and collaborative, while new technologies are an instrument for achieving smartness on its own. Only by incorporating the inhabitants' intelligence into its projects can a city truly develop in a smart way.

In Copenhagen, for example, several projects were carried out in close collaboration with the people directly involved. Opinion surveys were used to involve them in such projects as the development of cycle paths. By involving the citizens, the city can develop services that are directly adapted to them.

Of course, becoming smart cannot be achieved overnight. It is a lengthy process that calls for much effort on the part of municipalities and of the stakeholders (government, companies, citizens and so on).

Furthermore, many obstacles may act as constraints on the implementation of a smart city plan. These may include aspects relating to financing, governance, a lack of skills, the local context and efforts needed to ensure that the outcome of the city's projects are fair to all.

To that end, recommendations have been laid down to ensure that those obstacles do not prevent a city from developing intelligently. They apply to any western city that seeks to work intelligently to improve its services to the inhabitants and their quality of life, and to become more sustainable.

Even if they implement the recommendations proposed, some cities may still have trouble in developing intelligently to the full extent. It may also not be suitable for them to apply strategies to be 100% intelligent. Such cities can, however, focus on being smart in certain areas, such as mobility, health and smart buildings. This is the case of a city such as Wavre, which is not a smart city but does use intelligent lighting to save energy and reduce light pollution (Ville de Wavre, 2018).

Cities must be able to innovate when applying many technological tools to their services. This can allow them to develop and enhance their reputation on the international scene.

Cities that become smart have a lot to gain. In addition to the savings they can achieve through ICT, becoming smart allows a city to boost its competitiveness compared to others and their attractiveness too.

By making access to certain data free, young companies could develop more easily. This would make cities more attractive because a higher number of economic players within them would make it possible to build an attractive innovation ecosystem.

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