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Smart cities: an innovative solution for the management of global risks.

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Introduction

In this essay, we examine the concept of smart cities and why it is gaining relevance all over the world. To answer this question, we take a closer look at the global scenario. First of all, we discuss the risks currently present, we analyze them, their impact and likelihood based on the Global Risk Perception Survey (GRPS), the annual investigation elaborated by the World Economic Forum. The highest risks identified in 2018 are related to the environmental problems and in particular, the threatening derived from climate change and global warming. We then review the technological development that has taken place in the developed countries and that has led to a situation in which technologies are present in every aspect of our daily life and everywhere inside our society. Also, this phenomenon creates troubles and risks: the technological dependence and the pervasive presence of technological tools seem to be irreversible and expected to increase. The highest level of uncertainty is detected in the labor dimension. Starting with this scenario in mind, we built on an analysis to evaluate the smart city approach and its features, to demonstrate how this model of city's development may exploit the newest technologies to develop a better city context. The use of technologies is not the aim of the smart city approach, it is the key tool to start the smart journey of a city. The long-term goal is to build a more efficient city, that is able to use in a sustainable way its resources, reduce inequalities, improve the environmental conditions while maintaining the economic attractiveness for business and develop a transparent and open background. In other words, the purpose of the smart cities approach is to create a better quality of life for citizens.

Our research starts with an analysis of the smart city concept, through an evaluation of the different definitions developed during the last ten years. A unique definition of the smart city is still lacking and, authors describe this phenomenon from different points of view. The technology, human and institutional dimensions are the basic elements of every smart city. Furthermore, we analyzed the elements of a smart city: smart infrastructure, smart transport, smart environment, smart economy, smart services, smart governance, smart people and smart living.

Our work continues highlighting the effects of the urbanization process. In particular, we provide first the assessment of the urbanization effects on the global scenario, measuring how the increase in the number of people living on our planet is going to

exacerbate the global risks analyzed in chapter 1. As we reported in more detail in the second chapter the more problematic trends in the global scenario are: the levels of CO2 emissions, the biodiversity loss and the higher production of anthropogenic pollutants. Then, we provide an in-depth analysis of the effects of urbanization in the city-local context. In particular, we analyzed the problems of air pollution, water scarcity, waste management, climate change mitigation and resilience to extreme weather events. The analysis continues with the evaluation of the improvements that a smart city solution can provide to this local and global problems. The results are summarized in table number 3 that compares the effects of the traditional urbanization process and the achievements of the smart cities approach.

In the third chapter, we decided to evaluate how cities implement a smart plan. We focus on three successful cases that are represented by the city of London, New York and, Rotterdam. Other examples of smart city actions or programs are provided to fully understand how a smart project may improve particular situations. Also, the developing countries which usually have a low level of resources to invest, are moving towards smarter approaches.

In the last paragraph, we evaluate the different methods available to measure the level of "smartness" of a city. This represents the last step in our analysis of the smart city approach. In particular, we decided to evaluate three types of measurement. The first one is the IESE City in Motion Index developed by the Business School of Barcelona. It is useful for its wide geographical extension and the wide range of elements that it considers. The second is the European middle-sized cities ranking, that evaluates the level of smartness of the medium cities in Europe, usually not considered in other measurements. And the third one is a method of evaluation that focuses on the smartness of a single project, and it is not related to a city ranking. The CITY Keys project can be used as a measure of those project that is not implemented inside a full plan of actions. The three methods are different and each of them has some strengths and weaknesses. In general, we can see how the different components evaluated can be more or less measurable. In particular, when we face aspects such as the quality of life or social inclusion, it's difficult to find appropriate indicators to measure subjective elements. Sometimes the economic and technological evaluation take over the other elements. Furthermore, some elements that are evaluated as positive inside these

measurement approaches, can have a negative side. This reveals some gaps in the measurement processes of the smart city, that it's a human-centered approach.

By examining all these aspects of the urbanization process, city's developments and global risks we want to provide evidence of the strength of the smart city approach in dealing with a new way of development. Our goal is to demonstrate how the smart city can improve the economic, social and environmental conditions of a city and its city dwellers, without impacting on global problems and risks.

Chapter 1: General overview on global risks

1.1 The Global risks currently present

The concept of the smart city gained relevant success in the last years and it is usually mentioned as the model for the city of the future. It represents a model of development of the city, in which the use of different types of technologies and infrastructures has the aim to provide an improvement in the quality of life of citizens and support the environment in a sustainable manner. It is a multi-level approach that wants to reduce the negative effects of urbanization processes and at the same time maximize the benefits of a modern, connected and informed city. This includes many aspects and actions to implement, that goes beyond to the simple establishment of the latest technologies.

At the base of the smart city, there is the so-called smart grid, which is an intelligent network that provides efficient management of the energy supply and storage inside the city. Through this system, the city is able to collect any information about the consumption and demand for energy and at the same time connect all the main actors of the smart cities: businesses, governments, citizens, energy producers, in a multi-faced network. The intelligent use of technology is only the starting point, the collection and information processing leads to a numerous type of applications inside the urban center: an intelligent management of the urban lights, systems of smart parking or traffic management, an increased level in education and culture, the efficient waste and water management, the control of air pollution, the possibility to connect your device with the smart home and the construction of safer and smarter buildings and many others. When we read about the smart city we can run into a myriad of different aspects: green economy, internet of things, security of building in case of weather events, autonomous vehicles, social inclusion or the use of renewable resources only to provide some examples.

The smart city consists of six basic elements:

- a Smart Economy, which is the ability of the city to be the spawning ground for the most innovative and competitive businesses

- a Smart Governance, which is the ability to provide an open and transparent administration of the public sector
- a Smart Environment, related to the creation of a place that reduces the pollution, emissions, and waste in a sustainable perspective
- Smart people: open-minded, creative, skilled, flexible people inside the city with a high standard of education, culture, and the ability of integration
- Smart mobility, which is related to the presence of intelligent and safe transports and more in general the access to infrastructures
- a Smart living, which encompasses security, health-care, social cohesion and a high standard of life (Lombardi et al, 2012).

The various components are interconnected each other and in a smart city approach, every single aspect needs to be sustained and nurtured. At the same time, the always increasing level of technological developments and discoveries can provide new boosts for the other elements in a process of continuous innovation. None of them is more or less important of the others and all these different faces explain why the smart city is a complex concept and it's not easy to fully understand it.

The label smart city is used in many and different contexts and also with different meanings: every entity, company or institution that launch a smart project, try to provide a definition of this complex phenomenon. We'll see in the second chapter that there isn't an accepted standard definition, and we'll figure out the common ground among the many.

The 2018 Revision of World Urbanization Prospects (UN DESA, 2018) made by the Population Division of the United Nations Department of Economic and social affairs (UN DESA) revealed that more than half of the world population (55%) lives in urban areas and the trend is raising: after 2007 when the 50% threshold was exceeded, the 68% of the world population will live in urban centers by 2050. The majority of movements will take place in the developing countries, from rural land to city, in particular, the biggest expansions will be in Africa and Asia. But the urbanization phenomenon spreads its effects also on the western countries, we just need to think about the many migrations flows of the latest years in Europe. Only to think about an example, until 1950 there were only two megacities (New York and Tokyo). With the term mega-city, we refer to those cities which exceed 10 million people. Nowadays there

are 28 mega-cities and the trend is growing: in 2030 we will probably have 41 mega-cities in the world. It seems clear that it's important to understand the dynamics which are taking place inside the city: "cities and their populations are thus drivers of global environmental change, while at the same time being affected by it" (WBGU, 2016, p.2). Better services and job opportunities inside the city center are the main reasons that push people to move to the city. The consumption patterns and the services are usually more efficient than outside: in a smart city, the public transport provides a lower level of air pollution, better health-care services for residents, and intelligent management of urban lights, only to provide some examples (WBGU, 2016). This is not enough, because inside the city the technologies have to deal with the accumulation of different situations and risks. For example the problem of ageing population, is not confined within the family: the increasing average age of the population poses serious challenges, such as the need for adequate social assistance, appropriate living conditions and accessibility to services to accommodate a growing part of the population, so the opportunities introduced by the new technologies have to be properly managed by the governments to provide a fair standard of living for all the city dwellers (WBGU, 2016).

The process of urbanization is in the first place a demographic process which can have two types of origin: it is in the first place a process of natural growth, such as in Africa, in which the birth rates is increasing, and caused by migrations. In this latter case, there are many and different types of migration, such as from country to city in search of a higher quality of life, in case of civil war or conflict in the state of departure or for temporary reasons. The process of migration is also connected with the problem of the aging population: it is estimated that by 2050 more than a quarter of the global population will be over 60 years old (UN DESA, 2018). This expectation provides many troubles: the elderly are usually less willing to migrate and this growing portion of the population has new and costly needs, that have to be properly held by governments and public administration. In the second place, it is an economic process: urbanization is caused by the more attractive job opportunities available inside the city center. This is associated with research of better living condition for the inhabitants of developing countries, but these migration flows need to be managed, otherwise they lead to a deterioration of people's conditions. Inside industrialized countries, the economic reason of migration flows can lead to worse environmental conditions inside the city, with an increase in waste and pollution levels and sometimes with a lack of a sufficient

number of houses and a consequent expansion in the dimensions of the urban center. The third aspect is the social dimension of the urbanization. This is a bit more difficult to assess because it's more subjective, but in general, we know that the city center can offer better opportunities in terms of heal-care, education and culture and these factors can provide an additional reason to move toward a city (WBGU, 2016). So, we can easily understand that the growth of world population is taking place inside cities and would probably lead to an increase in tensions and risks inside the urban area and this process cannot be inverted or stopped. The growth in urban population automatically leads to an expansion in the urban infrastructures. This phenomenon of urbanization call for some actions in terms of sustainable development and management of the urban growth and the connected risks. With the increase of the number of people living in cities we need to understand how the resources can be efficiently used, how the quality of life can be maintained or improved, how the level of social security can be ensured and how education and health-care can be provided to all citizens, but these are only a few examples of the questions that this process posed. In Africa for example in 2012 (UN DESA, 2015), more than 850 million people lived in slums at the borders of the city center in degradation mode; with an increase in the number of people moving to the city how can the governments prevent the doubling of the number of people living in slums? And how can be found more resources to provide an adequate lifestyle for everybody? There are many factors to consider and a higher level of uncertainty to deal with. From a general perspective, we can say that sustainability has to be implemented under three different points: economic, social and environmental. (UN DESA, 2015).

The concept of the smart city is born as a long-term approach, after the increase of urbanization's rates, that can encompass the three areas of sustainable development of a city and in particular to tackle the emerging urban risks. The smart city approach is a complex system which, from a problem-solving perspective, try to empower the innovation and creativity inside the city to create different and real solutions for risk's management. When we talk about risks we refer to one of the most important studies about them, that is called "The global risk report" and it is presented every year by the World Economic Forum.

Looking at the current context in the majority of developed countries people have a quality of life that has never been so high, but at the same time, we can see that the

twenty-first century stands out for its social and economic changes all over the world. These changes can be assessed in terms of risks, which can affect the socio-cultural and economic context in the long run. These risks evolve over time and it's important, not only to understand the new ones but also their interrelationships. The World Economic Forum provides every year an evaluation of the risks and the underlying trends in the global scenario, through a survey analysis which takes the name of Global Risks perception survey (GRPS). Thanks to this assessment they provide a clear picture of the main elements of risks as we can see in the figure number 1 below, which contains the first 10 risks in the ranking: each risk can be analyzed both from the point of view of likelihood and impact. The survey respondents can assess the likelihood and risk choosing a number on a scale ranging from 1 (low probability or impact) to 5 (very high probability and huge impact).

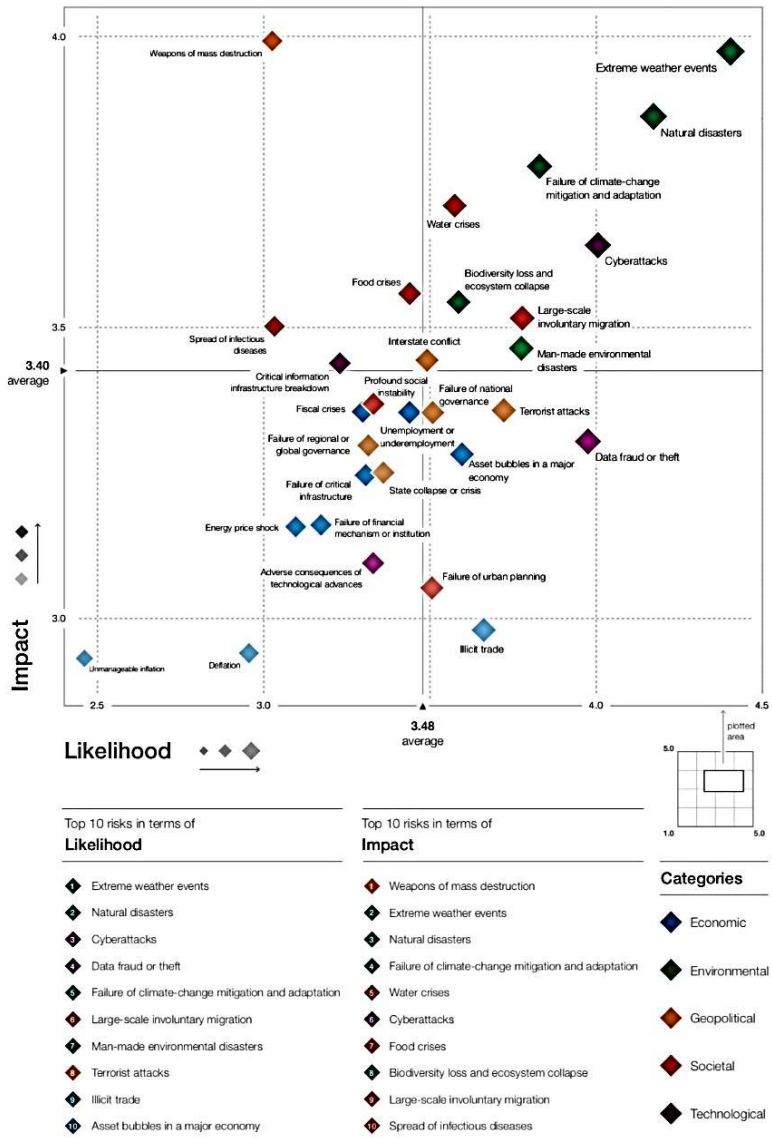


Fig. 1 – The map of the global risks landscape of 2018, based on the Global risks perception survey of 2017/2018 (World Economic Forum, 2017, p.). Inside the picture there are the risks with the higher ratings evaluated in terms of impact and likelihood.

As we can see the risks are divided into five main categories which are: economic, environmental, geopolitical, societal and technological. The Global Risks report, through different studies, aims at summarizing the current risks and the underlying trends on a global scale. The presence of a higher number of risks can have a significant impact in particular for their uncertainty and consequences. In addition, it's not easy to understand the different processes that originates from them and the cascading effects that they can produce inside our system (World economic forum, 2017).

The types of risks cited in the Global Risk report of 2018 are similar to those contained in the report of the previous year. Looking at the map, it appears that three of the top five risks are environmental: extreme weather events, natural disasters, and failure of climate-change mitigation and adaptation are among the highest both in term of likelihood and impact (World economic forum, 2018). Over the last ten years, the environmental risks have increased their importance and this, in particular, is caused by some underlying trends such as the changing climate, the degradation of the environment and rising in urbanization rates. All these trends lead to the development of a high number of risks and problems for the human being. The most alarming is the risk of water and energy crisis, the increase in temperatures, the loss of biodiversity and the natural and human environmental disasters. The data collected are alarming: the loss of biodiversity caused by human intervention and activities is 50% higher than in 2015; the majority of the world population live in countries in which the level of pollution exceed the regulations and more than 80% of the tap water contains plastic traces (World economic forum, 2018). These phenomena create serious problems in terms of environmental harm and also in term of health.

Based on the information collected by the American Meteorological Society's in its State of the Climate in 2017 (Lindsey, R. and Dahlman L., 2018), we can see that temperature are constantly rising at a sustained pace since 1975. In particular the situation worsened after 2014: except for 2011, every year was recorded as one of the top ten in the ranking of higher temperatures, with 2016 as the hottest ever.

This trend in the temperatures creates serious hazards inside the city context as the risk of the creation of heat island effect, drought, and water crisis. 2017 was one of the worst years for the United States which had to face many hurricanes such as Harvey, Maria, and Irma, which reached the highest level of intensity, causing huge damages and putting at the margin those families that already had a difficult situation. In the same year on the other part of the planet, the regions of India, Pakistan, Nepal, and Bangladesh have to deal with terrible flooding situation, which caused more than 1000 dead. The climate change is one of the biggest challenges of the 21st century and it would seriously threaten the human-life if not properly managed. One of the most important things to consider is the impact that these events may have on the other categories of risks, creating serious cascading effects.

The second category of risks that emerged as perceived with a high likelihood is the technological one. The risk of data fraud or theft and the risk of cyber-attacks are in the first positions. This category, is called cybersecurity risks. It measures the level of virtual security faced by organizations and the resulting costs in case of crisis, which may create some trouble for businesses that are not always prepared to handle this types of situation. Related to this category of risks there is the disclosure of sensitive data from a particular type of organizations, that needs to be avoided (World economic forum, 2018).

These kinds of risk emerge from the current technological situation: after the fourth industrial revolution (4IR), the technology affects every aspect of society and life, creating disruptive changes at an increasing level of speed. In particular technology could have a negative impact on labour market, with a higher number of jobs that can cease to exist after the introduction of new technological machines, an increase in the use of virtual jobs which are more difficult to assess in terms of law and protection and the rise of new kinds of jobs that don't fit the traditional employee-employer model (Schwab, K., 2015). This processes will not only produce a radical shift of income, from labor to capital but also exacerbate the situation inside the city, providing a higher number of unemployed people. The scarcity of resources and the prolonged inability to find a new job can create an enhancement in the crime rates inside the city with a lower level of security for citizens. This problem has to be properly taken into account, but a simple solution is not feasible (World Economic Forum, 2017).

Passing from 2017 to 2018, we observe that the majority of GRPS respondents believe they are in a phase of increased risks. We can see a different direction this year, due to an increase in environmental concerns, and the economic ones seem to reduce in terms of importance. Many actions have already been implemented to address the economic problems after the 2008 financial crisis. Now, a major effort is required for those permanent problems that continue to affect our society, such as the increasing gap between those at the top and those at the bottom of income pyramid and the high level of inequality perceived by the respondents. The trouble is exacerbated by a substantial increase in debts and the lack of an appropriate level of pensions or saving plans. These types of problems are not only economic but also social because they influence the quality of life of city dwellers; on the other side the problems are connected with a

situation of poverty, degradation, increase in crime and health diseases in a vicious cycle which is difficult to stop. The increasing number of people living in our world is also connected with two big geopolitical trends which affect our society: the increased national sentiment and greater polarization of societies, which exacerbate the whole situation and the other risks (World Economic Forum, 2018). The current situation is characterized by a big contradiction: the creation of a bigger amount of wealth, that is going to improve the lives of a little set of people, and the worsening of the situation for the majority of the population, not only in developing countries but also in industrialized ones. The city structure reflects this situation: the big city center has many luxuries and abundance, but it is surrounded by poor and degrading districts.

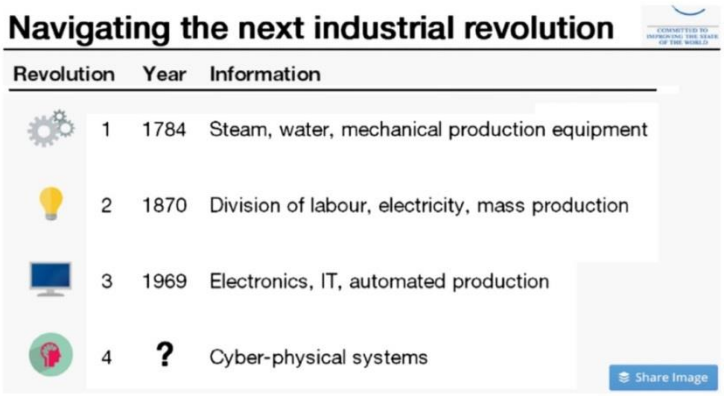
All the different types of risks are interconnected, and they need to be evaluated and managed systematically: the decision of the next few years are going to determine the cities of the future.

1.2 The technological development

If we put our attention on the technological aspect, first of all, we need to understand the technological landscape and the drivers of the current scenario. When we are able to understand it, we could perceive the real impact of technologies in our way of life and communicate. The current situation is the result of what Klaus Schwab (2015), executive director of the World economic forum, calls "The four industrial revolution".

From his point of view, the changes that are currently taking place and their impact on our society are a sign of a new and distinct industrial revolution. The progressions of the different industrial phases are described in the following scheme in figure number 2.

This view is not universally accepted and there are many researchers that see this technological evolution only as an extension of the third industrial revolution (Schwab, K., 2015).



Navigating the next industrial revolution

Revolution	Year	Information
1	1784	Steam, water, mechanical production equipment
2	1870	Division of labour, electricity, mass production
3	1969	Electronics, IT, automated production
4	?	Cyber-physical systems

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Fig.2 – The development of the four industrial revolutions and the main characteristics of each (Peters, 2017, p.3).

The concept of fourth industrial revolution is supported by three different points (Schwab, 2015): the velocity of the changes that are taking place, the breadth and depth of these changes which are intertwined and interconnected and the systemic impact of this revolution, which is not affecting a single sector or country, but the whole system.

Every industrial revolution is characterized by a distinctive innovation, such as the steam power and electricity, respectively in the first and second industrial revolution. These innovations are called general purpose technologies (GPTs). With the use of this term, the economists describe a kind of innovation which is radically new, in terms of ideas or techniques involved, and that can affect different sectors, generating a stream of new ideas and innovations. From this description we can easily understand that also ICT technology is included in the category of general purpose technologies, due to its ability to match all the characteristics of GPTs. It is a widespread technology, it refines over time and may generate other innovations. But it's important to notice that the ICT technology adds something a bit different. When a new technology, such as the steam engine, emerges, it usually produces its first benefits slowly and then increases over time when the number of adopters rises, until its replacement (Schwab, K., 2015). But, if we focus our attention on other types of innovation we can see that they are nothing more than a new combination of existing elements. For example, the driverless car is a mere combination of different elements including the steam engine, a computer, many sensors and a relevant amount of information about traffic and streets. So, the innovation it's not contained in the single elements, but it's the innovative ability to mix

them in a valuable way. With the ITC we have now the ability to create an infinite number and exponentially growing new combinations. The huge amount of data created every day and the non-rival and free character of this information are the distinctive results of IoT. So the fourth industrial revolution provides a new way to create innovations, which can be made with ongoing recombination of elements. What is needed for this process of recombination is the so-called innovation-participation: including a higher number of people in the process of discovering new combinations that leads to a higher probability of success and accelerates the rate of innovation itself. Furthermore, the growing number of people on our planet could provide not only more innovative ideas, but also modify and adjust the existing one to solve themselves the challenges that the global population is posing, in a sort of process of self-adjustment (Brynjolfsson & McAfee, 2014).

1.2.1 Trends underlying the fourth industrial revolution

Before analyzing its effects, it's important to catch the main phenomena underlying the fourth industrial revolution. Schwab (2015) identifies three categories of megatrends, which are all intertwined with each other. The first is related to the physical form of technology. From the point of view of the author there are four types of technology that are leading this revolution: the autonomous vehicles, not only cars, but also drones, trucks and airplanes; the 3D printings, which at the moment is used only in particular sectors; the advance robotics, which is spreading in all sectors and the last one that is related with appearance of new materials. The second cluster of drivers is the digital one and in particular the internet of things: "it can be described as a relationship between things (products, services, places, etc.) and people that are made possible by connected technologies and various platform" (Schwab, 2015, p.22). The third category is the biological one and the study of the genetics with the support of the new technologies, that will probably lead to the ability to create and personalize the DNA and the creation of new and genetically modified living organisms. All these technological developments are characterized by an emergence of autonomous intelligence of machines, which seems to resemble the human capacities and intelligence. The four different clusters and the correlated technologies can be combined and the result would be an increased level

of newness inside the phenomenon of the fourth industrial revolution. In this type of context with different and interconnected trends, businesses and people need to be able to adapt to all these rapid changes and provide society new skills, products, innovation, and services, to survive and sustain inside the market. Society as a whole will benefit this process of adaptation. On the other side, the rising inequality and the inability to handle it shall generate a vicious context and some associated problems that can range from stress to mental illness (Schwab, 2015). The current landscape can be fully understood from the sentence of McAfee, during an interview called "The great decoupling" (Bernstein and Raman, 2015), who said "Digital technologies are doing for human brainpower what the steam engine and related technologies did for human muscle power during the Industrial Revolution. They're allowing us to overcome many limitations rapidly and to open up new frontiers with unprecedented speed. It's a very big deal. But how exactly it will play out is uncertain".

1.2.2 Effects of the fourth industrial revolution

The effects of the fourth industrial revolution can be seen anywhere and new technologies affect every aspect of our lives and society. In the context described above, it's easy to imagine that the fourth industrial revolution will create some troubles inside society, generating both benefits and risks, tightening up inequalities. One of the main areas in which technology has a huge impact is in the field of work because a higher level of technology usage implies a shift from labor to capital. Actually, only a minority of jobs, lower than 5%, will be completely automated in the future, but more than 60% of occupations are made by activities which can be carried on by technological tools (Manyika, J. et al, 2018), due to the ability of new technologies to perform also those non-routine tasks, which were previously confined to human beings.

The concern about the consequences of technology for the labor force is not new. Rifkin (1996), wrote about what he called "the end of the work", referring to the process that was taking place after the third industrial revolution. The technological achievements permitted machines to perform increasingly complex tasks, threatening many positions and leaving large parts of employees without a job. From his point of view it was impossible to find new allocation for all the workers replaced by machines, and the

solution can be found in two different directions: the first consisted of more fairy share among all part of the society of the benefits derived from new technologies and the second consisted of a higher commitment to volunteer activities, which can fill the social and personal needs of people who lost their jobs (Rifking, 1996).

So, if in the past computers were good in repetitive activities, which were defined in terms of rules to follow and described by algorithms, now, in less than ten years the situation is radically different. The technology reaches those kinds of activity which were always been related to human abilities, such as pattern recognition or engage in complex conversations. We have only to think about the Apple Siri, or the autonomous Google vehicle to understand that technology has recently reached a new level of progress, which was unimaginable only a few years ago. This leads to a radical transformation inside many working activities and jobs, and a need for higher adaptability of workers. Technological innovation can create wealth inside a market and provide an economic reward for the innovators, but at the same time reduce the demand for many types of jobs. Faster and faster technological development is able to create a higher level of wealth, but these means are not equally distributed among the majority of workers: "Consumers are better off and enormous wealth is created, but a relatively small group of people often earns most of the income from the new products and services" (Brynjolfsson & McAfee, 2014, p. 75).

Nowadays, we return in front of the old question, and we ask ourselves if the technology is able to create unemployment and in particular if the pace of new technological discoveries and innovations is getting too high, and we are not able to respond to it and find new ways to employ the labor force. We can find in the famous economist J. Maynard Keynes (as reported in Schwab, K., 2015) a big supporter of the theory of technological unemployment, but the dominant idea among economists is that our society is able to find always a new way to create more jobs than those destroyed by the new technologies. In the future, this ability seems to be threatened due to the exponential rate of technological innovations that makes impossible to foresee the types of activities that future technologies will be able to perform. When a new technology enters a market and eliminates an entire category of workers, we know that those people need to develop new expertise and skills to find a new type of accommodation. But if the time used by these people to adjust their abilities is too long and the

technology in the meanwhile is changing again, we can say that technology is creating a situation of permanent unemployment. So, if the future is highly uncertain, and we cannot know what computers will be able to do in the next years, at the moment we can only be sure that computers are not always better than human and the best situation is a coordination between humans workforce and technology, in which people can provide all those types of skills that today computers are missing such as creativity, the ability to guide processes and ideas generation (Bernstein, A., Raman, A., 2015).

The effect on employment is not the only one: within the economic sector, there are other factors that have been modified by new technologies. For example, if we look at the growth and the GDP index of United States (Bernstein, A., Raman, A., 2015) we can see that after the 2008 recession, it is now stagnating and the most important indicator for the measure of growth is the productivity of a country. Unlike the always growing technological evolution and a higher level of innovation, productivity remains weak. The explanation of this trend has to be found in the effects of the fourth industrial revolution: the ability of new services developed thanks to technological innovation are usually non rival and free, so they tend to create a big value for both people at home and employees at work without being count inside the traditional measure such as the GDP. It's important to recognize this shift and provide new and better ways to catch the enormous benefits introduced by new technologies and innovations.

With a macro perspective, there are also effects on a country level, such as those on the developing economies. In these areas of the world the benefits of new technologies could be huge, but at the same time, it's important to recognize from the beginning that these countries need more help in developing the right models and systems to tackle innovation. If this doesn't happen, there will probably be higher instability on a global scale and exacerbation of social insecurity (Schwab, K., 2015).

Leaving the field of economy and entering those of business, we can see that the way of doing business is radically changing thanks to technology. Nowadays entrepreneurs have to tackle the sources of disruption on both sides of supply and demand. Business leaders have to understand and forecast an increasing number of variables and data and deal with the ability of new start-ups to enter the market and reach a high level of market share in few years thanks to technological innovations. In the future the number of businesses is going to grow up and in particular the small and medium-size

companies which can be more flexible in managing the innovations. On the other side companies have to always provide innovative products to customers, who are better informed and aware of the products and services they buy and expect to participate in a higher degree in the process of creation through user-generated contents. Furthermore, a big amount of data has to be analyzed to understand and gather useful and precise information about customers. So, for a company is fundamental to develop the ability to always innovate, not only the products or services offered or the production system used, but also the way of doing business, the model implemented and the opportunities that emerge constantly inside the market, in a process of steady innovation which cannot be stopped (Schwab, K., 2015).

The third area in which the fourth industrial revolution spreads its effects is related to society and government. As in all other spheres, technology can provide amazing benefits for public administrations that become faster and more efficient with the implementation of new technologies and a higher amount of information about citizens at their disposal. On the other side technology can constitute a danger for governments, due to the ability of technological innovation to provide power to lower level entities: "Technology will increasingly enable citizens, providing a new way to voice their opinions, coordinate their efforts and possibly circumvent government supervision" (Schwab, 2015, p. 67). In this way also non-governmental institutions have the possibility to gain power and support of large shares of citizens. This risk is exacerbated by the fact that also regulations seems to be inappropriate to the new technologies emerging from the fourth industrial revolution. The speed of development and the continuous flow of innovation don't provide the possibility to policymakers to understand the innovations and to catch its impact before they are already spreading their effects. To provide an easy example we can think of all the new types of jobs that emerged recently, such as in the case of an Uber's drivers, in which employee thanks to the use of technology became more flexible and independent, but at the same time the regulations don't provide social security and protection for this category of new workers. It's clear that the current governments need to develop new models for performing their activities, which are capable of adapting to changes in the market. The increasing use of technology in every activity of our life can put some dangers in terms of global security: the technological tools can be used to threaten international security, and it's now common to hear about extremists gathering influence and supporters

online, especially those who stay at the margin of the society or feel drop out of it. (Schwab, K., 2015). Also, in this case, seems to be important to recognize the underlying trend and provide better management of society which provides inclusion of all citizens and a culture of acceptance and tolerance of diversity, that is not easy to create. More, in general, we can understand that the fourth industrial revolution is providing both benefits and risks to the society and the ability of balance these two with a process of adaptation and re-organization is fundamental (Schwab, 2015).

After the analysis of the trends that are taking place on a global scale, in particular those related to the population growth and the most dangerous risks that can threaten countries and their main actors, such as governments and businesses, we are able to understand the huge impact of technologies in every aspect of life and the whole society. This trend is impossible to reverse and now we are going to see how the use of the technological tools can be implemented efficiently to enhance the quality of life, and at the same time without exacerbating the global risks.

We are going to analyze the concept of the smart city in more detail in chapter two, to show how this approach can be useful for the management of global risks and how the technology can generate positive impacts inside the urban center. First of all, we are going to see the threats of the urbanization and then, the opportunities introduced by the smart city approach to understanding the positive effects that the smart city deliver. This approach may provide a comprehensive strategy to deal with current challenges.

Chapter 2: A solution for mitigating the impact of global risks: the smart cities approach.

2.1 The concept of the smart city

As we have seen in chapter one, nowadays societies are facing a high number of problems and risks that have an impact on different aspects, such as the development of the socio-economic well-being and the environmental sustainability. After the analysis of all the different types of risks it seems to be hard to find a proper approach that can sustain the economic activities on a global level and at the same time provide a better way of lives for citizens at the local level (Schaffers et. all, 2011). In recent years, from the analysis of the current situation and landscape, it emerged the concept of the smart city as a practical solution for the management of the city context. More specifically the city is seen as a hub of innovation and urban development which can take a bigger role in the creation of welfare and sustainability. Due to the increase in the urbanization rate, cities are become more and more important, assuming a central role in our society. It's a real necessity to find a solution to many problems that emerge: higher unemployment rates, a higher level of greenhouse gases emission, modified consumption patterns only to provide some examples. The growing popularity of the smart city label is a consequence of the investigation for a solution to these problems (Albino, V., Berardi, U., Dangelico, R.M., 2015).

Despite its popularity the smart city has never found a unified definition and this is caused by the use of this terms in reference to many and diversified situations, in particular we can imagine that every single country or city has different features, different level of development, of technology, but also different geographical conditions, natural resources and problems to deal with. So, we can summarize our point of departure as a situation in which the majority of people is living in an urban area and the city represents the place where people strive for find better job opportunities and improved way of life. The dark side of the situation is an increase in the level of pollution and consumption, poorer management of resources and many other critical aspects which are interconnected each other. These two sides have been efficiently managed and one of the solutions proposed takes the name of smart city approach (Hayat, 2016).

To find an answer to our question about what a smart city is, we can look at the work of Caragliu, Del Bo and Nijkamp (2009). They try to analyze the main elements that characterized the smart city contained in the previous definitions, with the aim of providing an explanation that could encompass all of them, adding also some quantitative measure to demonstrate the validity of their study. First of all, they recognize that the smart city approach is based on a network of services and infrastructures that are intertwined each other's and always connected with citizens. Other two common aspect in every smart city is represented by the city as a place where new or innovative companies can find the best site for their activities, enhancing the urban development. At the same time it is a place of integration of every social class, also the lower one, in particular providing to all people not only the possibility, but also the ability to use technologies and to benefit from them. Another aspect is the ability of the smart city to attract creative and talented people, which can boost the process of innovation and development thanks to their skills and creativity. The last one is related with the capacity of a city to reflect and adapt to the problem of environmental sustainability which affect our society due to the scarcity of the resources that we use and the creation of waste and pollution related to the city's activities, and the social inclusion of all people through a creation of a smart community. Taking all together these elements and focusing on the human level of the smart city, not only on the technologies implemented, they said "We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) 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 & Nijkamp, 2009, p. 6). This definition of the smart city provides a complete picture of the phenomenon and is a useful touchpoint between the economic and the social needs that a smart city approach has to meet. Schaffers and his colleagues point up that the city is not only the object of innovation, but it's now the most important place in which innovation and technologies can be created not only used and implemented (Schaffers et al, 2011). The concept of the smart city seems not to be related with the diffusion of technology, this is only the basic tool of the model, but a focus has to be put on people and community (Albino, V., Berardi, U., Dangelico, R.M., 2015).

Some doubts about the term "smart city" arose a few years before and in particular they have been discussed in a paper called "Will the real smart city please stand up?"

(Holland, R.G., 2008). The author points out that the terms smart is vastly used with many and sometimes far meanings: from the definition of a smart city which uses a system of e-governance, or a city which relies on many technological tools (ICTs), to those cities which are smart because they commit with social and environmental problems. So, the term smart city can be used with reference to many ways a city is committed to the use of technologies and the internet of things, and it can be equally used with reference to two different cities that prove to have different level of development or two cities which follow different approach to the smartness. For example, one can give more importance to the human capital and the other to the economic one, and none of this seems to be wrong because many definitions are accepted. What's the author points out is that the main element of the smart city is the ICTs, but providing a city with the major technologies, does not automatically lead to a high adoption rate of them from citizens: providing a city the latest technology does not lead automatically to the creation of a smart city, due to the complexity of all its elements and the contradictions contained in the different facets of the definition (Hollands, 2008). With regard to technology many other labels exist, such as digital city, intelligent city or virtual city, and sometimes there are mixed with the concept of the smart city. Looking more carefully we can see that smart city is a broader concept which incorporates the technology implemented in the city but extends further (Albino, V., Berardi, U., Dangelico, R.M., 2015). In particular, the term digital city is mentioned as interchangeable with regard to the smart city, but as we'll see briefly below, the two concepts evolved in different ways over time.

If there isn't an accepted definition of the smart city, we can provide an overview of the many definitions used. Inside the systematic literature review of Cocchia (2017), we can find a collection of different definitions of the smart city concept, as we report in the table number 1.

AUTHOR	DEFINITION
California Institute	"A smart community is a community that has made a conscious effort to use information technology to transform life and work within its region in significant and fundamental rather than incremental ways" (California Institute, 2001).
Caragliu et al.	"A city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure

	fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" (Caragliu et al., 2011).
Dameri	"A smart city is a well-defined geographical area, in which high technologies such as ICT, logistic, energy production, and so on, cooperate to create benefits for citizens in terms of well-being, inclusion, and participation, environmental quality, intelligent development; it is governed by a well-defined pool of subjects, able to state the rules and policy for the city government and development" (Dameri, R.P., 2013).
Giffinger	"A smart city is a city well performing built on the 'smart' combination of endowments and activities of self-decisive, independent and aware citizens" (Giffinger et al., 2007).
Hall	"A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens" (Hall, P., 2000).
IBM	"Smart city is defined by IBM as the use of information and communication technology to sense, analyze and integrate the key information of core system in running cities" (IBM, 2010).
Northstream	"Concept of the smart city where citizens, objects, utilities, etc., connect in a seamless manner using ubiquitous technologies, so as to significantly enhance the living experience in 21st-century urban environments" (Northstream, 2010).
Setis-eu	"Smart city is a city in which it can combine technologies as diverse as water recycling, advanced energy grids, and mobile communications in order to reduce environmental impact and to offer its citizens better lives" (Setis-eu, 2012).
Su et al.	"Smart city is the product of Digital City combined with the Internet of things" (Sue et al., 2011).

Table n. 1 – Different definitions of the smart city and the related authors (Cocchia, 2017, p.31).

We can add to this catalog other definitions that can help us to obtain a comprehensive overview of the concept of the smart city, as seen in the table number 2.

AUTHOR	DEFINITION
Harrison et al.	"A city connecting the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city" (Harrison et al., 2010).
Holland	"Territories with a high capacity for learning and innovation, which is built into the creativity of their population, their institutions of knowledge production, and their digital infrastructure for communication." (Holland, R.G., 2008).
Komninos	"Territories with a high capacity for learning and innovation, which is built-in the creativity of their population, their institutions of knowledge creation, and their digital infrastructure for communication and knowledge management". (Komninos, N., 2006).
Kourtit and Nijkamp	"Smart cities are the result of knowledge-intensive and creative strategies aiming at enhancing the socio-economic, ecological, logistic and competitive performance of cities. Such smart cities are based on a promising mix of human capital (e.g. skilled labor force), infrastructural capital (e.g. high-tech communication facilities), social capital (e.g. intense and open network linkages) and entrepreneurial capital (e.g. creative and risk-taking business activities)" (Kourtit, K., and Nijkamp, P., 2012).
Lombardi et al.	"The application of information and communications technology (ICT) with on the role of human capital/education, social and relational capital, and environmental issues are often indicated by the notion of the smart city" (Lombardi et al., 2012).

Table n.2 –Other definitions of the smart city concept and their related authors (Own elaboration).

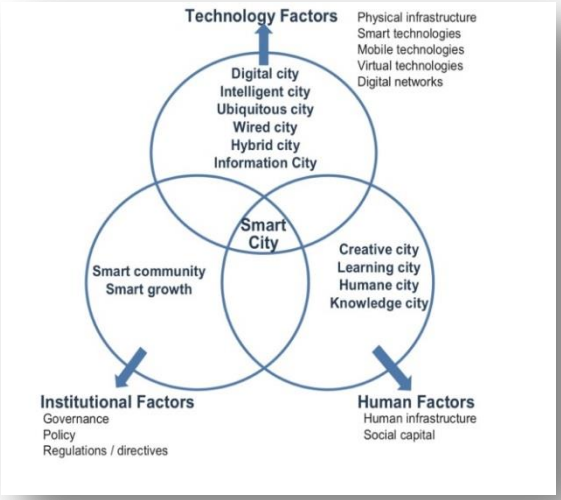
Inside the work of Nam and Pardo (2011), we find three different dimensions related to the concept of smart city, and they represent the core factors of every smart city:

- The technology dimension, which refers to the use of ICTs and innovative technology. The technological dimension of a smart city takes sometimes the name of the digital city and includes the physical infrastructure of the ICT, the latest technologies available and all the technological components needed to improve the communications and the exchange of information.
- The human dimension, which refers to the social aspect of a smart city related to people, their education and knowledge. In a good smart city approach, there are a lot of measures that help to improve the well-being of people, creating an

environment in which the creativity finds the perfect climate to grow. A city that pays attention to human needs, is a city which can not only attract higher skilled people but also educate and create more talented and creative people.

- The institutional dimension, which refers to the models and the way of governance and the rules at their base. The strategic synergies and partnerships, networks and promoting activities are useful to develop and sustain a smart city. This part is fundamental to obtain good results from the smart activities and projects implemented; they also need to be carried on in a transparent manner and give citizens the possibility to obtain all the information about these activities, and if it is possible to include the citizens in the decision process, with an orientation toward a human-centered process.

From the intersection of these three components, we obtain effectively what we call



"smart city", as summarized in the figure 3 which contains also all the different terms that have been used to talk about the three main components of the smart city.

Fig. 3 – The three dimensions of the smart city with their fundamental components. Inside the circles, we can see the different labels used to describe the different components of a smart city (Nam, T. & Pardo, T.A., 2011, p.286).

Often the term smart city is not implemented in a holistic way, but it is divided into different "smart components", which are used separately. The smart city ecosystem is made by:

- smart infrastructure, as we have already seen with this term we consider all the technologies and technological tools installed inside a city (Wi-Fi connections, smart grids, smart sensors and so on)
- smart transport and the connected system of traffic control
- smart environment, which includes pollution and emissions control, waste management and other tools for sustainable development of the city
- smart services, such as health-care systems, technological forms of education and culture initiative, crime control and similar
- smart governance, based on the principles of transparency and openness
- smart people, people inside the communities which can participate in the innovation creation with an enhancement in the level of creativity
- smart living, the possibility to conduct a better life inside a smart city
- smart economy, the possibility of a smart city to provide a better ground for new and/or more prosperous economic activities and improvements in the level of growth and job opportunities.

All these different components are intertwined inside the ecosystem and it's important to remember that every single aspect has to be nurtured systematically (Anthopoulos, L.G., 2017).

Different activities and projects defined as smart can be more inclusive in some dimensions and weaker in others, based on the specific characteristics of the city involved and these are visible also from the high number of synonymous used to indicate the concept of the smart city. So finally, we can say that there isn't a unified definition of the smart city that is accepted by academics or institution and this is for two main reason: first of all the ambiguity of the term smart which is used in literature with different meanings such as green, digital, technological and second because the name smart city is usually adopted by a country which defined by their own activities and the characteristics which are relevant to be smart (Cocchia, A., 2017).

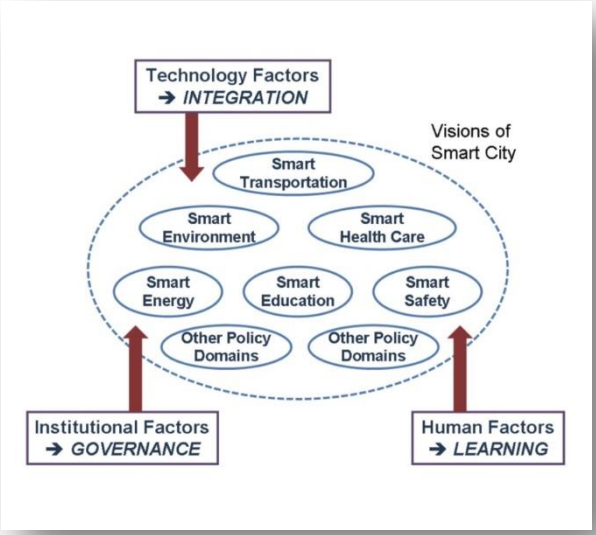


Fig. 4 – The smart city components. The main components of the smart city activities and their strategic directions related to the three dimensions previously described (Nam, T. & Pardo, T.A., 2011, p.288).

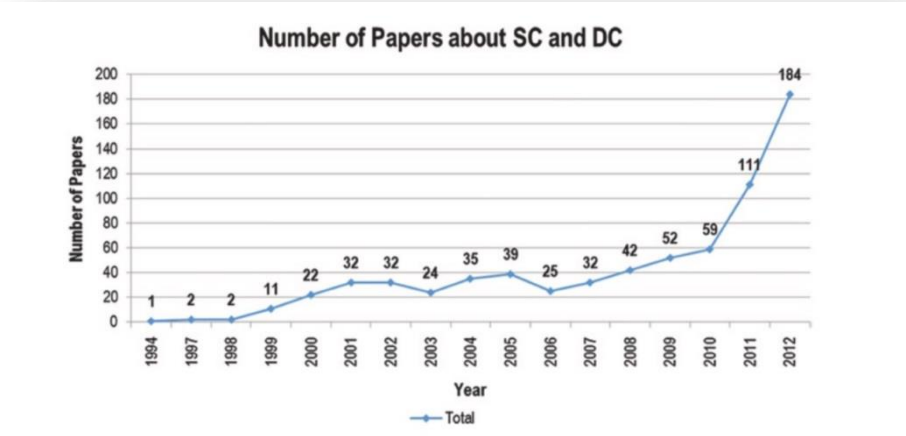
As we have previously mentioned above, the idea of a smart city emerged after the evaluation of the positive and negative effects of the phenomenon of urbanization. In particular, the advent of information and communication technologies has increased the attractiveness of the city as an urban center in which people can find higher opportunities and a better social context. As the number of people living in the urban center increases, at the same time, some challenges arise, such as the needs for adequate infrastructures and the ability to manage an increased number of waste and the demand for more resources.

The concept of the smart city emerged at different times and with different labels, but the first appearance of the term "smart city" dates to 1997 and it's linked to the idea of a virtual city, which wants to use Internet and the connections to provide a better management of the urban activity, at the beginning in particular in tourist, cultural and public administration area. Shortly after, the term digital city appears and the main element of distinction is the inclusion of the human aspect: in this case citizens become an actor involved in the process of urban development. In 1994 in the city of Amsterdam took place the first project of a digital city. In the years that follow many other labels have been created to follow the improvements in particular with increasing attention to the environmental problems and the social side of the urban development (Anthopoulos, L.G., 2017).

More specifically the terms smart city start its diffusion after the introduction of the Kyoto Protocol, now ratified by more than 180 countries. This international agreement

poses many objectives for sustainable development of the countries, in particular, it is based on the idea that the current situation of global warming is an effect of human activities and in particular, it sets some restrictions on the levels of emissions and pollution. So, with the introduction of the Kyoto protocol many countries start to develop different kinds of projects or activities that take the name of smart, but the term was used with multiple and different meanings as a synonym of green city, technological city, digital city, wired city and so on, but the most common terms used are smart city and digital city. The most used term after the smart city is the digital city, and it is usually mentioned as synonymous of the first, but it's not exactly the same thing. There are some little differences between the two terms. One distinction is related to the contents of the two terms: digital city refers to the implementation and use of ICTs in the urban center, but smart city refers to the activities which can improve the environmental situation of the urban area. Another distinction is in the nature of the phenomena, the smart city is a more systematic approach in which many institutions develop some programs to reach a situation of the city that can be defined as smart (waste management, reduction of gases emissions and so on). On the other hand the digital city phenomenon appears to be the free consequence of the increase in the daily use of the technologies and devices, which transform the city in a digital one. The smart city concept seems to include the digital city idea, adding at the technological transformation of the city due to Internet diffusion, the human/social side of the urban development with a particular focus on environmental concerns. In particular, after 2010 the concept of the smart city overbears the term digital city.

Looking at the results of a systematic review made by Cocchia (2017), we can see that after the introduction of the Kyoto protocol in 1997 the interest on smart city has grown steadily, until 2010, when there was a considerable increase in the number of articles



and papers about the smart city as we can see in the figure 5 below.

Fig. 5 – Number of papers about smart/digital cities over time. It shows the increase over time of the number of papers on the smart/digital city, which can demonstrate the increase in the interest of the smart/digital city topic. The sample is made by 705 papers previously selected by the authors. (Cocchia, A. 2017, p.25).

This evolution of the interest in smart cities is punctuated by some important steps. In 1997 the most important was the introduction of the Kyoto protocol as mentioned above. It provided an initial interest and commitment toward the smart city. The second step is in the year 2000 which see the diffusion of the Internet among citizens and the spread of ITC infrastructure, at the same time also mobile phones became more popular and accessible to everyone. The third step is in 2005 when the Kyoto Protocol entered into force. This provides once again a boost in the process of smartness creation. The fourth step took place in 2008 and it contained two important events: for the first time a company demonstrated its interest in the smart city approach developing the concept of Smart Planet, in which private companies, institutions, and citizens are intertwined and together, through collaboration, they can provide a better way of life. With this step forward IBM was the first to enter the market in a different way focusing on all those aspects which are important in a smart approach, not only technology and communications but also security, transport, health and so on. The second event in 2008 was the Covenant of Mayors, which is a Europe-based agreement with the aim of reduction of the emissions of CO2 and to stimulate the use of renewable resources. The last step was in 2010 and was made by the European Union. The EU started a project called Europe 2020 Strategy, that posed some objectives in terms of reduction of pollution, waste management, use of renewable energies, social inclusion, technological innovation and so on, always in a smart city perspective which increased another time the process of diffusion and study of the smart city phenomenon (Cocchia, A., 2017).

The concept of the smart city is difficult to define because it's a bottom-up approach (we can see the smart city journey in figure 6) which starts from the diffusion of technology, ITCs in particular, among people and inside the urban area. It's not a top-down phenomenon that starts from well-defined rules and with a clear vision and governance. So, for this reason, it's more difficult to find a proper definition that can satisfy all the different types of real experiences of smart city approach around the globe.

Fig. 6 – The smart city bottom-up journey. It starts from the technologies at the bottom of the pyramid (Dameri, R.P., 2013 p.2545).

Many tools of the smart city approach follow a bottom-up appeal such as the use of apps to communicate and exchange information with sensors and the other technologies inside the urban center, for the exchange of data and information about traffic management, level of pollution and waste or similar. “The widespread use of the Internet enabling bottom-up approaches to innovation and urban development has stimulated citizens' involvement. This may accelerate the actual deployment, use, and experimentation of advanced network infrastructures and applications in societal and business domains, such as healthcare & autonomy, energy management, and supply chain" (Schaffers et al, 2012, p.10).

There are four main elements inside every smart city (Dameri, R.P., 2013):

- the geographical area involved
- the technologies and in particular ICTs

- the citizens, as primary actors inside the smart city
- the government

The geographical area in which the smart city takes place is related to the physical ground on which it arises and evolves, but also its boundaries. The smallest ground is in the city, but the project could also have a regional dimension. Usually, the possibilities offered by technologies allows the creation of networks of cities, that can lead to a situation of connection and collaboration among different initiatives. With the development over time of some rules and objectives stated by international institutions such as the European Union or the Organization for economic co-operation and development (OECD), the smart city approach can evolve in a project with a national or global scale, in a climate of collaboration and mutual exchange of information to provide always better solutions for every single city involved in the process. If we look at the technological component of the smart city, we are referring in particular to ICT, but it includes also, for example, the newest cloud computing. Technologies can have much different application from transport and traffic management, to healthcare, buildings constructions, waste and pollution control and so on. People are the third component and are the most important because they are directly involved in every single aspect of the smart city: they use technology and take advantage of every single improvement inside the city, which has the aim of providing a better way of life. The last component is the government which is very important to establish some common rules and create a network of collaboration among different projects. At the same time, governments can ensure the creation of synergy and avoid the waste of resources. The four elements have to be integrated and a focus has to be posed not only to provide the urban center with the newest technologies but to become smart also a higher attention has to be placed in the human side of the process; the intellectual and social capital of a smart city is at the center of the process and can help to sustain and develop the smartness itself. So, it's important to create a collaboration between the technological-physical part of the phenomenon and the social-human part (Dameri, R.P., 2013).

But providing a definition of the smart city does not imply an end to the problems, because if we look at the real situations, we can easily notice that every city which is implementing a smart approach has different features and no one can be fully developed in every single aspect. Some brief examples can help to understand:

- Barcelona: it is one of the most famous smart city due to its high number of technological services offered to businesses and the community, ranging from intelligence systems of open data that permit sharing information to technological assistance for elderly or traffic control cameras.

- Rio De Janeiro: the city won the prize as the best smart city in 2013, and it is committed to a project of sustainable urban development, with the use of technology to better control the city area, an improvement in local transport, in particular making a connection with the poorest areas of the city (Favelas) and an increase in the level of education with the use of technological devices.

- Singapore: this city is highly committed to the improvements in buildings and urban development, in particular, it wants to reach a level of 80% of buildings in accordance with its certification levels. But this is not all, Singapore is a center of innovation and experimentation which use new technologies to provide a better life-style inside its community, such as a system of child-care, safe system of public transport and a system of data collection and analysis in many areas of the economy.

- San Francisco: the city develops a high number of projects as a smart city which could encompass different products and activities such as electronic vehicles, waste management, the use of renewable energy and a system of smart parking. One important aspect is that San Francisco poses a zero-waste aim by 2020.

These are only four examples, but the smart city approach is implemented in different parts of the world and usually in different ways, related to the specific characteristics of the city (Hayat, P., 2016).

If we want to look in more detail at the real tools implemented to become smarter, we can examine some examples in more detail, because, as explained above, every single city has particular and unique features and in each case, we can see differences in the strategies and technologies used. The first example is related to the city of Barcelona, that put a great effort into becoming smarter. The smart city strategy of Barcelona is based on open data/open environment in which citizens can catch information and help develop new ideas. To provide a smart environment the city is using multiple tools and projects such as:

- the 22@Barcelona district, a research space with the aim of providing a smart solution for urban, economic and social renewal. The project transforms an industrial land in the center of the city into an innovation district, in which new ideas and models of smart development can be implemented in a climate of collaboration, not only with universities or institutions but also with residents. This is a long term project that in 20 years wants to change the urban model and to provide new and better space for businesses, citizens and also tourists.
- the 22@urban labs is a living lab project that uses the city space as a playground to test innovative and different solutions. Started in 2008 this plan is part of the 22@Barcelona district project.
- Infrastructures development: the city of Barcelona puts a big effort in the development of a wide net of infrastructures and provide a widespread diffusion of ICTs, public Wi-Fi connection, optic fiber and other new technologies available.
- Services for citizens and made by citizens. The city of Barcelona pays high attention to citizens' needs and the process of becoming smarter is focused on people, enabling citizens to actively participate in the process of innovation creation, basically using an open data model based on cooperation and information share.
- Open data: as mentioned above the information collected through the use of urban technologies and monitors are accessible to everyone, in an open environment. It also uses an open smart government model, based on transparency.

Another city-example is Lisbon in Portugal. Thanks to its particular geographical position, the city is a point of connection in the middle of Europe, Africa, and America. To exploit in a better manner this good position, the city starts a process of smart renewal, to create a good environment for innovation, creativity and a better lifestyle for citizens. This is happening through the use of different tools such as:

- Create new spaces: in particular with the aid of two projects, called Co-working spaces and Fablabs, the city wants to improve the level of innovation and creativity, providing new and specific spaces in which people can study, innovate, create and collaborate.

- Encourage entrepreneurship: in this case, Lisbon is using different tools and initiatives to stimulate commerce and business development, providing also a favorable ground for start-ups.
- Other useful tools in collaboration with an open data system, that can be used also by citizens to create innovative solutions and to enhance the urban management and social activities inside the city. Lisbon focuses also on the possibility to connect the ideas' generators with the developers, helping innovative solutions to become real.

The case of Lisbon is a process in which many actors are involved, not only the private sectors and the companies, but also public institutions and citizens are incorporated in the process of becoming a center of innovation on a global scale. There could also be many other examples of cities in Europe and all over the world which are implementing projects and activities to become smarter; in all cases, every single city has some weaknesses and some advantages that have to be taken into account during the development of a better strategy (Schaffers et al, 2012).

2.2 The smart city is a conceptual tool to mitigate risks

2.2.1. Urbanization's effects on global risks

Today urbanization is a process that is taking place globally and affects not only the older developed countries but also, and in a different way, the developing countries: all over the world the number of people living in cities is growing and it is expected to continue to rise in the following years. The risks posed by these trends are huge and interconnected each other. The ability to provide a sustainable life in cities seems like a necessity more than an option for the well-being of the future generations. The processes currently taking place are difficult to reverse and find a proper solution is easier in the theoretical framework. Cities can be seen as drivers of change and at the same time as drivers of problems, in particular, those concerned the environment and consumption patterns. These problems can touch not only a single city, but also its neighboring area, leading to an increase in interconnected risks that can lead to global scale changes. So it's evident that a city has to tackle with a number of different risks, which affect its urban center, but at the same time they are created and raised by the city itself. If we look at the global level, the first risk that stands out for its dimension is related to the production of CO2 emissions. Many European and global organizations are stressing for the need to reduce this type of emissions to zero in a few years. Cities are responsible for more than 70% of the total amount of energy usage and related CO2 emissions (WBGU, 2016). The current trend of a higher number of city inhabitants poses serious risks for the years ahead: city expansion can lead to a dramatic increase in energy demand and consumption that, as consequence, provide a bigger amount of gas emissions on a worldwide scale. The urban development is connected with the energy demand and can impact the level of gas emissions: the level of traffic and transport, but also the building's structure are all examples of elements inside the city influencing the level of emissions. Also, the lifestyle of citizens can improve or deteriorate the situation. Under the framework convention on climate change for the adoption of the Paris Agreement (UNFCCC, 2015), the United Nations highlight the urgent need to reach a zero level of emission by 2055, or at latest at 2070 to be able to mitigate the climate changes. In addition, by achieving a carbon neutral situation by 2050, it will be possible to restrict the increase in temperature to 2° C, which can provide a great reduction of

the negative effects of global warming. This should be done without delay, through reduction's efforts within 2020/2030.

A second problem that affects the whole world is the biodiversity loss. This is in particular related to land use: city expansion leads to massive use of land to widen existing cities or create new ones at the expenses of agricultural land. Also, the mass production system can provide an impact on land, because the majority of products are produced and consumed inside the cities, but the production processes affect also other places. We can think of an easy example, such as the production of palm oil which is largely used inside food industry but comes from huge plantations with a considerable environmental impact (WBGU, 2016). This is not all, the higher levels of consumption inside cities are not only related to the fact that the number of city dwellers increased, but also because the lifestyle of city inhabitants is more consumerist-oriented, and this provides as consequence the destruction of ecosystem and biodiversity due to the use of land for monoculture and the increase in pesticides utilization which lead one more time to worse climate conditions.

The third type of risk is connected to the city production of anthropogenic pollutants. It's called anthropogenic all kind of emission which is caused by human activity, in particular, we refer to mercury, plastic, and fissile material. Also, the use of these materials needs to be reduced to zero by 2050, or at latest by 2070, to reduce the consequences of their impact on the world (WBGU, 2016).

If we look at local level problems that affect urban centers, the first that stands out is the air pollution. Cities are nowadays places in which the quality of the air is usually bad and the related health problems are dangerous and costly. This situation doesn't affect only large cities in developed countries, where many levels of pollutants exceed the regulation levels, but also the emerging countries: India and China are now facing extreme levels of air pollution after the rapid economic growth of the past years. The problem of air pollution inside the city is usually underestimated, but the consequences can be catastrophic. In 1952 for five days, from 5th to 9th December the city of London was affected by one of the biggest environmental disasters: a thick layer of smog covered the sky of the city. The impact was huge: this dense fog cause the estimated death of more than 12 thousand people and other 100.000 people became ill after those days, in the months that follow this episode the level of mortality and morbidity was

higher than normal (Bell, M.L.; Davis, D.L. & Fletcher, T., 2004). The events were caused by a combination of climate condition and unchecked factories emissions. Britain was famous for its tremendous thick fogs all over the 1900s, but in particular, in those days the Azores high created a layer of cold air that was trapped by another layer of hot air, which didn't allow the air circulation and exchange. This in combination with the emissions of carbon made by factories and homes, which used low-quality carbon, created a coating of smoke, fog, and pollutants such as Carbon dioxide (CO2) and Sulphur dioxide that was lethal for city dwellers. In those days the visibility was reduced to zero and it was impossible to drive. After this dramatic episode, the British government provided a new law for the regulation of emissions that was called Clean air act (1956) which restricted the burning of coal inside the city and established smoke-free areas with the aim of avoiding another similar environmental disaster. What happened in London some years ago provides a boost in the environmental protection among European countries, but nowadays similar situations continue to exist: China is now facing similar air pollution problems and the government is trying to solve them. High levels of pollution create serious harm for population health and huge impact in terms of health-care, social and economic costs. The country is now at the same level of economic development of London in the years near the Great Smog, so it's fundamental to change the direction to avoid other disasters (Zhang, D.; Liu, J.; Li, B. 2014).

A second problem inside cities is related to water, in particular, its use, the water pollution, and the water scarcity. Cities are characterized by high demand for water, which is usually satisfied with the transfer of a big amount of drinking water from land to city or using groundwater with a rate of consumption that usually exceeds the regeneration capacity. Must, of course, be added to these the problem of water pollution: in particular in those countries in which the sewage generated don't pass through a treatment process, and should pollute the water. Also, the industrial sewage when not properly treated can threaten the quality of groundwater, with the result of high concentration of pollutants inside it (WBGU, 2016).

A third problem that has to be carefully handled is related to waste. The number of tons of waste produced by cities is growing at an increasing pace and new type of waste are emerging, not only radioactive materials but also the newest e-waste, the electronic devices that become waste at the end of their life-cycle. Based on some research

conducted by the United Nations Organization, every year we produce an amount of e-waste that ranges from 20 to 50 million tons (UN EMG, 2017). If we hear these numbers it's impossible not to think about where this e-waste ends. Only on a few countries, there is appropriate take-back legislation. The majority of this e-waste is conveyed in a legal or illegal manner to Asia or Africa, where there are no or less restrictive regulations. In Agbogbloshie, the biggest landfill of technological devices in Accra, the capital of Ghana, there are hundreds of men that work removing by hand parts or components of materials such as aluminum or copper from technological waste to reselling them, working in tremendous conditions that threaten their health and their safety. This should provide not only serious harm to the health conditions of those people working inside the landfill but also the contamination of the environment, land, air and the food production of the town (Caravanos, J. et al, 2011). The practice of burn e-waste for obtaining materials is harmful not only for the workers but also for the inhabitants of the neighborhood. This is only one example, but the real situation is not properly defined due to the lack of data about it. The amount of e-waste is going to increase in the future and the doom of the entire city could be to become a giant landfill. This challenge is surely one of the hardest that the modern world is facing. The waste treatment is a problematic theme for many governments, on a global scale we can see that the majority of urban waste is treated in landfills, a minor part (11%) is burned with the use of incinerators and a portion (19%) is recycled (Scheinberg, A., Wilson, D.C. & Rodic, L. 2010). Through this division, we can understand that the dimension of landfills is going to increase further and the management of waste is a problem both for developed countries which need more space and for developing countries which need to develop the necessary regulations and efficient management systems. Is not only the number of people living in the city that increases the level of waste, but it's the same amount of waste per person that is growing and also its composition is more complex. A glaring example is a former landfill called Fresh Kills in Staten Island, New York, that was considered the biggest human-created building of the world with its 890 hectares (WBGU, 2016). The treatment of waste is a serious problem then is not easy to manage and needs a great number of resources, every initiative has to be properly evaluated in terms of feasibility and costs and needs to be sustained over time. A connected bad experience is those of the so-called Love Canal which is a project developed near the Niagara Falls in New York, that takes the name from its creator William Love. He

decides to build an artificial canal to connect Lake Ontario with the Niagara River. This was only the starting point for the bigger project which forecasts the creation of a model city in which the use of hydroelectric energy could provide the birth of many industries and a flourishing economy in that area. All this never happened, after a financial crisis in 1893, many investors decided to withdraw from the project and the canal initially built became a municipal landfill. In the 1940s the site was used by a chemical company which became the only owner of the site, the Hoocker Chemical Company. The company used the ground to bury many barrels filled with chemicals and other waste. In 1953 the landfill closed and the company sold the property of the area for only one dollar with a liability limitation clause. Notwithstanding the presence of chemicals in the ground the municipality decided to start the construction of a school. A few years later the area was sold and the new owners of the ground never known the previous use of that land. Due to the construction of a series of new homes and a highway, the chemical bury on the ground started to come out and the groundwater to enter, polluting all the area. Only at the end of 1970's the information became of public domain and many kinds of research demonstrated that that water and ground were polluted. In particular, they discover the presence of 15 different organic chemicals, that could harm people and the environment. Further studies permitted to discover a high incidence of spontaneous abortions and malformations, with an incidence of more than 30% of chromosome damage among the population of Love Canal (Department of Health, 1981). Only the 2nd August 1978 the state emergency of the site was declared. The president Jimmy Carter asked for the allocation of federal funds and for the first time in the American history they used them for a cause that was not related to the natural disaster.

If we think about the Maldives, the picture that immediately comes to our mind is a place with blue and crystalline water and white sand. But what the majority of people don't know is that there is an artificial island called Thilafushi, only 7 kilometers from Malè. From 1992 it is the landfill of the capital. Due to the high impact of tourism, the capital Malè wasn't able to properly manage the big amount of waste daily produced and the municipal waste was collected and sent to Thilafushi, which is now the biggest landfill island of the world. (Ramesh, R. 2009). This is only another example. But other countries, such as Thailand and The Philippines, are experiencing the same boost in tourism and are usually not prepared to deal with it.

Another entire category of risk is related to climate changes and their disruptive effects inside the city. These can range from flood to hurricane and drought that can threaten the city infrastructures and buildings. The responses depend on different factors such as the particular location of the city (on the coast, for example, have to face the rising of sea level), the ability to manage these events and the availability of contingency plans. In general, they have to be properly managed because they generate a number of cascading effects which tend to exacerbate the other risks. The increase in temperature provides problems in terms of heat island and glacial melt, which increase the risk of water scarcity and drought another time. Nowadays it is estimated that more than 150 million people (WBGU, 2016) are living in conditions of water scarcity, and with the foreseeable increase in the world population of the next years, this phenomenon will be exacerbated.

The climate changes have the power to influence extreme weather events, such as hurricanes and earthquakes. They have the power to deteriorate the situation such as in the case of consistent and copious precipitations that can lead to a higher risk of floods. More in general climate change is important because it may affect the intensity and duration of extreme weather events. The climate change may also exacerbate a situation of air pollution because the climate is responsible for the air exchange and the dispersion of pollutants (WBGU, 2016).

After the analysis of many and different definitions of smart city and looking at some disasters happened in the recent past, are we able to say that the smart city approach is a solution? Can we implement the smart city approach as a unique solution to all our problems? Is the smart city a real model that can use the technology to monitor and collect real-time data about the current situation inside a city? Is it able to use the information collected in real time to deal with a potentially critical situation? Or is it usually proposed as a way to improve urban development with the introduction of any new devices? The smart city concept is sometimes used to define a process that can improve the quality of life of citizens through the implementation of innovative technological solution inside the urban center of a city. But the smart city is not only related to the implementation of technologies to improve the city's infrastructure and its services. The technology is not only providing a better way of life for people, but it's also changing the social model, we need only to think about the new model of work through the use of a popular platform such as Uber or Deliveroo, which were unknown only a

few years ago. But are people realizing the changes that are taking place? In the next paragraph, we'll evaluate if the smart city concept can be really implemented to mitigate the global risks and social trends, making cities more resilient or it will remain a fancy word used to describe all the technological improvements that are taking place inside the city. We try to make out if the technology is the end of the smart city or its basic mean to reach sustainable development, "when we refer to sustainable development we are not just talking about the mere ecological aspect. It is, in fact, a vital issue for human survival in the years ahead" (Ménascé, D., Vincent, C.E. et Moreau, M.M., 2017, p.56) due to the increasing rate of urbanization.

2.2.2. The smart city approach: an opportunity to mitigate risks.

As we have seen above the urbanization process introduces a lot of hazards inside the city context, exacerbating those already existing. The challenges that the governments face are harder and larger than in the past. Help can be provided through the implementation of the smart city approach, that can be seen as real improvements in the quality of life inside the city, and also as an opportunity to mitigate the risks previously analyzed. This is not mean to be the best and only option but as one of the many tools that can be used to deal with the issues of the city of the 21st century.

One of the most discussed problems is related to the level of CO2 emission. We know that fast-growing cities can represent a further risk inside the process of climate-change mitigation. At the same time, if we change perspective they can become an opportunity: internet of things and all the technological tools brought inside the city from the urbanization process could be a useful tool for the global and local risks management if they will be used in a smart way. With the term smart way, we refer to the holistic approach that characterized the smart city approach: taking into account all the interconnections, the quality of life of citizens, the participative governance, the underlying risks and the needs of the future generations. The problem of CO2 emission has a huge impact and it is connected with different types of risks. From the Energy, transport and environment indicators of Eurostat (2017), we know that 12% of global CO2 emissions are generated from transport. The use of smart technologies can improve the traffic system inside a city: through the use of smart meters and control systems,

technologies are able to collect and immediately process real-time information, that can be used to find better solutions for citizens, reducing or avoiding waste of time, energy and traffic congestion. But we need also a shift in the transport system: many cities all around the world rely on a system which is based on private transport means, and this generates an increase in the number of traffic congestion and jams, and a deterioration in the quality of air and noise levels. To change this perspective, it is useful not only to provide better traffic management but to promote other means of transport. For example, Governments can create traffic-free zones inside a city, implement more inclusive systems of public transport and incentives for the use of non-motorized means of transport (WBGU, 2016). Also, the use of smart parking technologies can provide a reduction in the levels of CO2 emissions and a lower level of wasted time for car owners. These supportive actions combine with innovative and eco-friendly vehicles represent a holistic approach that must be taken into consideration for the development of the future cities in developing countries. The transport systems have a great impact on the city structure, and build a city center in which all the main needs of a dweller can be satisfied without using his car is a smart achievement (WBGU, 2016).

The high levels of GHG-emissions is not only related to the transport sector, a relevant part comes from buildings and the related activities: in 2010 the building sector accounted for 32% of global final energy consumption and 19% of energy-related CO2 emissions, and 51% of global electricity consumption (Lucon et al., 2014). Due to the urbanization process, the trends are increasing and the energy consumption will further increase. More people are going to live inside a city center, also in developing countries and a higher number of people are getting access to electricity and energy-related services, thus raising the global levels of emissions (WBGU, 2016). The energy is used for different types of activities inside a building and the level of consumption varies greatly from one city to another. The higher levels of energy consumption are related to domestic heating, illumination, and hygiene. It's fundamental to understand the energy consumption patterns and the building sector regulations of a city. Inside the Smart City approach, we can see a combination of innovative technologies and behavioral patterns that have the aim of reducing or inverting the current trend. There is a wide range of tools, such as smart lighting, efficient appliances, and heating, the use of solar panels and innovative air-conditioning systems, the installation of smart grids and meters, that can be implemented to reduce the impact of buildings, taking into consideration the specific

features of every city. The use of smart lighting, for example, permits to modify the level of urban lighting based on the weather conditions, time and the presence of people in that street (WBGU, 2016). In the case of developing countries, these approaches need to be supported by the central governments and nurtured over time. The benefits resulting from these measures are demonstrated: it is possible to reach a reduction of 46% the global amount of energy consumed by buildings by 2050 (Ürge-Vorsatz et al., 2012), with many related energy-cost savings. The use of most innovative electronics has the capacity to reduce the energy consumption inside buildings by 65% by 2020 (Ürge-Vorsatz et al., 2012). And it is also demonstrated that with the implementation of renewable energy sources, it is possible to reach a zero-level of emissions in specific kind of city. Furthermore, applying a smart buildings approach leads to improvements in the levels of air pollution, that automatically leads to better life-conditions inside the city and a reduction in health problems of city dwellers. The smart city model can also boost the effectiveness of these strategies through the diffusion of new lifestyles and promoting some behavioral changes (WBGU, 2016). The problem of buildings is also linked to the issue of providing adequate housing to the poorest section of the world population. This is a big social challenge that needs to be tacked on a global level with a particular focus on inclusive strategies. The smart city approach helps in dealing with it.

The second effect of the urbanization process that we have analyzed above is the biodiversity loss. In this case, there are different kinds of improvements that the Smart City approach can afford. One of these is related to smart building, previously analyzed, because the ruthless use of land and the destruction of eco-systems is usually a consequence of cities expansion. The use of natural resources is also connected with the production systems currently present in the global scenario, that usually results in overuse of agricultural lands. The consumer society and the lifestyles of city dwellers lead to a city context in which one of the biggest challenges nowadays is waste management. The Smart City approach has the opportunity to introduce some improvements through the use of smart systems of waste management that can range from smart-bin to the automatic identification of waste objects inside the bin, with the possibility to collect information and data about the waste levels of a city with the use of smart metering and sensors. Waste management is fundamental for the quality of life inside the city and also for the level of hygiene. The problem of waste has to be properly managed by the policy-maker of each country, especially in the case of developing

countries. It's fundamental to provide waste management plans that have the aim of reducing the total level of waste, increase the process of recycle and also reduce the cost of waste collection through the electronic measurement of waste levels. The most important way to reduce the level of waste in landfills is through the reduction of waste produced, and it will be helpful to provide a change in the consumption patterns of citizens, toward a more responsible way of buy and consume products and services. A good or bad system of waste management can increase or decrease the quality of life especially in terms of health-related problems (WBGU,2016). A more recent type of pollutant that affects the cities is the noise, which reduces the level of well-being and the quality of life of city dwellers. Noise and density need to be taken into account because they increase the stress levels of the population: the Smart City approach includes noise-reduction strategies, based on the specific cultural and social characteristics of the context.

Turning to the third kind of problems that affects the city, we know that the anthropogenic pollutants pose serious hazards on the city center: water, air, and land pollution are among the biggest challenges for modern cities. As already mentioned above for the quality of air, that in many cities does not comply with the regulation thresholds, also the water quality is usually threatened inside the city. For example, Copenhagen's main seaport is now closed for bathing due to the high level of water pollution, that can harm the human health (The Climate Group, 2011). The Smart city approach put in place systems of smart water metering that collect information about the water consumption and can provide a reduction of 10-15% in water consumption per household (The Climate Group, 2011). This reduction in the quantity of water wasted can counterbalance the critical situation of millions of people who live in the condition of water scarcity (WBGU, 2016). The water management system has to be integrated with waste management systems and measurements of pollution levels, to reduce the water contamination inside the city. At the same time, the policy-makers is responsible for the implementation of the needed regulations, to keep under control the levels of emissions and pollution. Also, an efficient sewage system impacts on the quality of water, and it is especially significant for those coastal zones which are more exposed to flooding and storm risks (WBGU, 2016).

Every single component of the Smart City approach is seen as a useful tool for improving the single problem described above, and at the same time, as a way to improve also the related problems. Urbanization hazards are intertwined each other and the positive effects of smart components (such as waste management, smart lighting, smart metering and so on) can address more than one problem at a time. There isn't the best course of action in the Smart city approach, because factors such as economic development and the structure of a city influence the specific needs of each case. From the studies of Neirotti et al. (2013), emerges that American and Asian countries are more committed to the development of hard technological infrastructures, and on the other hand in Europe there are more projects and initiatives related to the social and human capital of the Smart City approach; but each city needs to follow the best strategy based on its specific features and its current level of development.

But the Smart City approach is something more: it's not only a solution for the main urban problems. It is also a process of shaping the quality of life of citizens and the sustainability of environment in a holistic way. The Smart governance, also called the e-governance, is providing a solution for a more inclusive society, through the active participation of citizens in the political context and a higher level of transparency on government activities. Furthermore, the Smart City approach provides incentives for social inclusion of the poorest sections of the population, with a special focus on a solution for elderly and disables. These actions lead to an overall improvement in the quality of life, a reduction in frictions inside society, lower levels of criminality and a higher level of participation. Similar relevant smart actions are implemented in education and cultural sector, for improvements in the education system, in the tourism and the cultural related activities of a city. The last benefit relates to economic sector, the overall Smart City approach, with its technological infrastructure and its improvements in quality of life and environmental sustainability, provide an enhancement of the economy of a city, especially in terms of innovations, attractiveness for businesses and competitiveness in the global markets (Neirotti et al., 2013).

To acquire a complete overview of the links existing between global risks and urbanization processes, and the improvements introduced by the Smart City approach, we create a summary of the information collected that are presented below in table number 3.

GLOBAL RISKS	***TRADITIONAL URBANIZATION PROCESS***	***SMART CITY APPROACH***
Failure of climate change mitigation and adaptation	· Heath island effect · Air pollution / GHG's emissions · Noise pollution · Rise in temperature	· Air quality · Smart transport · Smart lighting · Smart energy · Smart parking
Biodiversity loss and ecosystem collapse	· Deforestation · Loss of animal species · Rise sea level · Drought · Production systems linked to consumerism	· Smart environment · Green areas · Resilience city · Intelligent drainage system
Natural Disaster and Extreme weather events	· Hurricanes · Storms · Heatwaves · Flooding · Health-related problems	· Resilient city · Smart systems of health-care · Smart spatial planning
Water crisis	· Water scarcity · Water pollution · Water infectious diseases · Drought	· Smart water management · Sewage treatment
Food crisis	· World hunger · Rise of poverty	· Social inclusion · Smart education
Large scale involuntary migration	· Overcrowded cities · Rise of criminality / Security risks · Unemployment	· Smart buildings · Smart waste · Social inclusion

Table n.3 – The connections between global risks, urbanization development and the smart city approach. It contains the links between the global risks currently present on a worldwide scale (analyzed in chapter 1) and the tradition urbanization processes which take place inside the city. In the right-hand column, we see the improvements introduced by the Smart City approach (Own elaboration).

The global risks contained in the table in table number 3 result from the Global Risk report of 2018 (World Economic Forum, 2018) that are characterized by a high impact

and likelihood. The correlated effects inside the traditional urban center in the central column of the table are interrelated each other and in many cases, a single phenomenon should belong to different categories of risks. Furthermore, the different categories are intertwined, so the division made in the table is not fixed. In the last column there are the smart actions that can be implemented to change the traditional urbanization processes and in the next section, we are going to analyze some of the best practices implemented in different part of the world, to provide a complete picture of the smart city approach.

Chapter 3: Prominent cases of Smart Cities .

3.1 Introduction

In the last paragraph above we analyzed the most common actions to implement the smart city approach. Now, we are going to provide a short description of a few cases to understand how the cities deal with the problems inside the urban center and how some smart actions are developed and implemented. We present three main cases that are represented by the city of London, New York, and Rotterdam. Then, we describe other actions implemented in other parts of the world that focus on specific problems.

The first city is London. One of the main challenges of this city is related to climate change, and its high level of pollution. The city has implemented different kinds of actions to enhance its air quality. This has the aim to reduce the cost of air pollution which is both a financial cost and a cost in terms of years of life reduction for people living in the city. Other types of problems that affect the city of London are related to the increase in the number of people living inside the urban center. The increased number of city dwellers are calling for better water and waste management, improved energy supply system, greater transport system and the availability of buildings and housing (GLA Economics, 2016). Analyzing the smart approach of London we are going to see how the city will respond to these challenges, improving its future conditions.

The second city is New York. This big city has to deal with a great number of social and environmental challenges. The high population density, and the heterogeneity of the population living in New York lead to sustainability challenges in terms of energy supply, levels of consumption, transport, and water systems, but also in poverty levels, conflict, crime rates, and public safety. Through the analysis of New York Smart City approach, we will provide an overview of the areas of application that range from social services, transport, and education, to employment and environment. New York is one of the best examples of a comprehensive application of smart city concepts (https://www1.nyc.gov/).

The third selected city is Rotterdam. Due to its position, this port city has always dealt with the risk of flooding being under the sea level. Starting from this big challenge the

city develops a smart strategy to handle its other problems. To deal with its climate change problems and related risks, the city is currently carrying out more than 200 smart initiatives, encompassing all the sectors of activities. Through the creation of a digital city, Rotterdam wants to improve the quality of life inside the city center, support the economic growth, preparing for the future challenges and opportunities with a focus on environmental sustainability and citizens involvement (Georgieva, O., 2018). We are going to see in more detail the strategies in the next paragraphs.

3.2 London, New York, and Rotterdam

3.2.1. The city of London

As we have seen in the second chapter, the risk of failure of climate change mitigation and adaptation releases a number of negative consequences, such as air pollution, noise pollution and environmental footprint that need to be addressed by policy-makers to sustain and nurture the quality of life inside the city-centers. London, shortly after the terrible event of the Great Smog of 1952 started to introduce environmental regulations to deal with this problem with the aim of avoiding other similar disasters. Many improvements have been made, however, the problem is still present and the quality of air in London is usually above the regulation levels. The air quality is the biggest challenge for this city, taking into consideration that in 2010, 9000 people die prematurely, due to the effects of air pollution (Walton, H. et al., 2015). Other major challenges are the loss of biodiversity, the reduction in green spaces, the high level of greenhouse gas emissions, waste and water management, and noise levels. All these challenges are interconnected and the only way to provide a long-term solution is through a holistic vision. The London Environment Strategy of 2017 (Mayor of London, 2018) is a new type of strategy which aims to improve the environmental conditions of London, which in turn leads to an improvement in every aspect of life for citizens. The program has many goals:

- more than half of the London area will be green by 2050
- a zero-emission transport system by 2050

- the best air quality among the world's largest cities by 2050
- reaching the zero-carbon goal by 2050
- climate change neutrality
- zero-waste to landfill by 2026 and recycle of 65% of waste by 2030 (Mayor of London, 2018).

To make these long-term and ambitious goals real, four different strategic approaches are presented. The first is the Low Carbon Circular Economy, which stresses the importance to find new models of economic growth, more sustainable, inclusive and with low carbon emissions. A low carbon model is fundamental to reach the zero-emissions level and the subsequent expansion of low-carbon sector that is currently taking place in London. The second approach is the Smart Digital City, consists of using technologies and smart meters to improve the quality of services and reduce their impact. The use of technologies to deal with environmental challenges can range from a smart system of energy monitoring, that help people to become aware of their consumption patterns, to a high level of connectivity inside the city, Wi-Fi and 5G for the collection and elaboration of real-time data (which are part of Connected London program). The third approach is called Green Infrastructure and Natural Capital Accounting and is related to the green capital of London. It aims at increasing the green areas in London. The benefits of green spaces are usually underestimated; they can improve the quality of air and water, sustain the biodiversity and increase the physical and mental health of city dwellers. The last one is the Healthy Street Approach, in which ten indicators are used to assess the human well-being on the streets of London. As we can see in figure number 7, which contains the ten indicators, this approach is human-centered.

Fig. 7 – The ten healthy street indicators. There are used for the implementation of the healthy street approach (made by Saunders, L. 2017 inside Healthy Streets for London. Mayor of London, p.12).

The four different approaches described above have to be carried on simultaneously, in a holistic way. The boldest action of this program is related to the aim of improving the air quality of the city, up to be the city with the best air quality. Nowadays two toxic substances threat particularly the air of London: the particulate matter and nitrogen dioxide. The process will take years, and the number of toxic substances cannot be eliminated in a short period. So, first of all, it's important to reduce the exposure of city dwellers, especially children and the poorest sections of the society, securing, for example, the schools. The second action to implement is to achieve compliance with the regulations levels (both at UK and EU levels). To meet this goal London is going to replace old buses and taxis with zero emissions vehicles. This is an important step because half of the emissions of Nitrogen Oxides results from road transportation means (Mayor of London, 2018). The TfL, Transport for London, is famous for the implementation of technologies inside the transport sector. It has introduced the contactless payment on transport means and is going to introduce other tools, such as virtual reality and artificial intelligence to control routes and streets (Greater London Authority, 2018). Also, the non-road transports need a boost towards avoiding fossil fuels emissions. Other actions in related fields have to be implemented, such as the construction of more efficient buildings, promoting zero-emissions vehicles and the public transport means, the use of renewable energy, more restrictive policies, that together can improve the quality of air in London year by year (Mayor of London, 2018).

The importance of a collaborative approach is stressed by the Mayor of London, Sadiq Khan. Last year he developed a roadmap to make London the smartest city in the world. The "Smarter London Together" (Greater London Authority, 2018), focuses on five goals which move towards a higher level of inclusion for citizens. In particular, the first objective is to develop more technological tools and services that directly come from the user's needs. People have to be put at the center of the process and every single person needs to have access to technological tools. For example the government decides to support some inclusive projects such as the Crowdfund London, in which people propose innovative solutions and projects that need resources. Furthermore, the MiWiFi Programme in Lewisham, provides people without job or with more than 50 years old, the access to a computer and a training course to increase the possibility to become part of the digital world. The second goal is to provide an improvement in data availability, processing, and cybersecurity. The LODA (London Office for Data Analytics) program is the most important action in this field, which is a new way of sharing data among different actors, in an open manner. It has the aim of increase the level of collaboration and the problem-solving performances. The cybersecurity, on the other hand, will be fostered through the MOPAC (Mayor's Office for Policing and Crime) program to improve the security against data fraud and theft. The third goal is to create a higher level of connectivity inside the city, preparing the city to implement 5G and providing a widespread network of Wi-Fi for businesses and creative people. The fourth objective has the aim of improving technological skills of city dwellers. In this case through the Skills for Londoners Strategy, the Mayors wants to share information and knowledge about technologies and improving the skills of citizens. The last goal focuses on the creation of a more collaborative system of public services and infrastructure. The LOTI (London Office of Technology and Innovation) will help in the creation of shared innovation and improve the quality of many public services through technological collaboration. The last point includes also a collaboration among health organizations: the use of MedTech can improve the data about Londoner's state of health and sustain a fair and inclusive social-health system (Greater London Authority, 2018). The list of examples mentioned above is not exhaustive, the city of London is implanting a huge number of programs and activities to become a smart city and the great effort at involving citizens in this process is witnessed by the Smarter London Together strategy started in 2018.

3.2.2 New York City

Leaving the European Union, another city that for a long time is committed to the development of a smart city approach is New York.

Starting for 2015, New York develops a program that wants to provide a comprehensive set of measurements with the aim of make New York an equitable city: to be a smart city means also to be an equitable city. Equity is the most important principle underlying the action plan for the next years. First of all, it was important to guarantee internet access to everybody. Through a project called LinkNYC, that was launched in 2016 the government set up the widest and fastest coverage of Wi-Fi connection, providing access to every person around the city to a high-speed connection. The LinkNYC kiosks are useful not only for the connection but also for the availability of chargers and tablets to tourists and citizens. One year later the LinkNYC reached one million users and the majority of the population holds a positive opinion about it (New York City – Office of the Mayor, 2017).

The mayor of New York City, Bill De Blasio explains that making a city equitable means ensure to everyone the accessibility to facilities. Many actions are implemented to improve the quality of city dwellers' life, and they can be divided into 5 main categories:

- Smart buildings and infrastructure: the city aims to develop high-standard buildings and infrastructures that can sustain its economic growth, resilience, and sustainability.
- Smart transport and mobility, these include also the availability of safe, accessible and cleaner streets around the city.
- Smart energy and environment: with a commitment to reach a reduction of 80% in greenhouses gas emission by 2050 (compared to 2005 levels) and a reduction in storm and flooding risks.
- Smart public health and safety: the goal is to make New York City the safest large city in the US, and ensure access to everybody to the healthcare system and safer streets.
- Smart government and community: to become a more inclusive society in which every citizen can access real-time data and information, and interact with city's government (New York City - Mayor's Office of Tech + Innovation, 2015).

Inside this action fields, there are a lot of initiatives. In the first one we find a system of smart indoor lighting, through the Accelerated Conservation and Efficiency (ACE) program many buildings and infrastructures set up smart lighting alternatives, such as LED solutions and lighting control system. This leads to a significant reduction in GHG emissions and energy spending. In more detail, all the actions implemented through the ACE program are going to reduce the spending by $43 million every year and reducing by 107.000 tons of carbon dioxide emissions (New York City - Mayor's Office of Tech + Innovation, 2015). Another program permits the development of an efficient water management system: through more than 800.000 water meters, the city Department of Environmental Protection is able to collect real-time information about the consumption patterns of water (New York City - Mayor's Office of Tech + Innovation, 2015). Every meter is connected to a transmitter, which in turn sends the data collected to a Network Operations Center. Then, the information is elaborated and sends to final users, and since 2011, when a Leak Notification Program was introduced, customers shall also be informed of possible leaks.

For the development of a smart traffic system, New York City uses the Midtown motion program. Different tools such as video cameras, sensors, and EZ - Pass readers collect real-time data. These data are subsequently sent to a Traffic Management Center, that processes them in real time and can solve traffic congestion and related problems. The project provides benefits both on traffic management and level of greenhouses gas emission. Another improvement in the traffic management system was made by the introduction of the Transit Signal Priority (TSP) for buses. Through the use of sensors, GPS and traffic control software, buses can quickly pass through intersections with priority over other means of transport. This results in a reduction in the bus delays of nearly 20% and lower levels of emissions (New York City - Mayor's Office of Tech + Innovation, 2015). New York City is also committed to a Vision-zero objective, which aims at reducing to zero the number of victims of traffic crashes. The data collected show a steady decrease in the number of lost lives thanks to the Vision-zero program. The 28% decrease in traffic fatal crashes and a 45% decrease in the pedestrian losses witnesses the effort of the city in planning and building safer streets (City of New York, 2018).

One of the most famous programs established in New York is related to waste management. Due to the high concentration of people inside the city, the waste represents a big challenge for New York. In 2015 the City set the ambitious goal of reducing the amount of waste sent to landfills of 90% by 2030. The different actions implemented, such as the zoned collection systems and the indoors organic collection, are providing benefits. 2017 was the year with the lowest level of waste produced in New York ever (City of New York, 2018). An innovative solution is implemented also through the streets of New York: the BigBelly bin uses a wireless sensor to measure the level of garbage. It communicates with the system when it is full and it's able to collect 5 times more than a normal bin, due to its solar-powered compaction system. There are more than 700 BigBelly bins around New York city center and this system provides an estimated improvement in waste collection efficiency of 50 – 80% (New York City - Mayor's Office of Tech + Innovation, 2015).

To enhance the level of public health and safety, the city has implemented two different strategies. The first is related to the use of smart metering to collect data about the quality of air and the levels of pollutants around the city. The information obtained is elaborated and used for the release of specific regulations. The other tool is a real-time system of acoustic gun-shot detection, implemented through the use of hundreds of sensors. When 3 sensors detect a gun-shot, the information is immediately sent to the system which can inform the Police Department (NYPD). This improves the promptness of interventions and at the same time it is estimated that 75% of the gun-shots detected, are not usually reported to the police (New York City - Mayor's Office of Tech + Innovation, 2015).

The great number of people living in the city of New York is going to increase further in the years ahead. For this reason, innovative solutions need to be found in terms of smart buildings and spaces. A project called Lowline has the goal to create the first green space underground, renovating a disused trolley terminal. The Lowline is an intelligent space that can be used for many types of activities, such as art and culture, education and social inclusion. The aim is also to create a green space for protecting many species of plants. The official opening will be by 2020, but it's yet been possible to visit part of the underground park of Lowline (Karp Strategies and replace Urban Studio, 2017).

New York is a city characterized by high levels of heterogeneity through the population and creates a more inclusive and equitable community is one of the biggest challenges. The government implements different programs to promote gender and race equality and inclusion. For example, the Minority and Women-owned Business Enterprises (M/WBEs) is safeguarded through specific policies and incentives. Becoming equitable means also an effort in poverty reduction: New York achieves significant results in reducing its poverty rate from 20.6% in 2014 to 19.5% in 2016. The current level is the lowest since the Great Recession (City of New York, 2018).

Furthermore, in 2016 a project called Home-Stat (Homeless Outreach & Mobile Engagement Street Action Team) started functioning. Its ambitious goal is to move away homeless from the streets, providing them with shelter and basic conditions of subsistence. The program works through a network of people, that physically scour the streets on a daily basis. More than 300 people work inside the shelters and 500 volunteers and non-profit personnel provide the needed medical care and assistance. It also involves the community collaboration because citizens can point out the presence of a homeless on the streets by phone or mobile app. They can also be kept informed through some public dashboards that show the data about the program. Another useful tool is the 311 app, that permits citizens to share information or send requests to a proper agency (New York City – Office of the Mayor, 2016). The effort towards a system of open and inclusive governance is witnessed by the NYC Open Data, a platform that makes data and information generated by several agencies, available for every citizen. The data access increases the level of transparency of government actions.

In March 2017, Bill De Blasio, Mayor of New York City, announced the opening of the first innovation lab in Brownsville, a reference point for the development of innovative and collaborative projects, to keep pace with the increasing and changing challenges of the city. This is only the last action that demonstrates the big effort of the New York city in implementing in a holistic way the most innovative technologies to overcome its urban challenges, with a focus on citizens and human well-being.

3.2.3. The city of Rotterdam

The city of Rotterdam is one of the biggest city in The Netherlands and its port is one of the most important in Europe and globally. It is an important point of exchange on the banks of the Maas river. Due to its position, the 80% of the city is below sea level, and the 1.2 million people living in the city-region are exposed to flooding risk (Mackenzie, L., 2010). Furthermore, the effects of climate changes, the increase in the amount of rainfall and the soil subsidence push the city to find innovative solutions for the management of the flooding risk. The main challenges are four. The first is the rise in the sea level and rivers flow that enhances the river level threatening many infrastructures and services. The second is related to the rainfall patterns, which are going to become more frequent and more intense in the years ahead, jeopardizing the city center, its drainage and sewage systems. As reported in the "Resilient cities and climate adaptation strategies" (Molenaar et al., 2013) the Royal Dutch Meteorological Institute foresees an increase of 14% in the average intensity of rainfalls for each degree rise in temperature. The third problem is the drought and the long periods of lack of rainfalls which create lower river levels, lower groundwater levels, salt intrusion in the ground and subsidence which exacerbate the situation of the city. The last challenge is the increase in the heatwaves, due to higher temperatures. Inside the city, this results in increased heat island effects.

The old system of dikes and pumps, which keeps the city safe from flooding are now combined with other more innovative systems. Through the Rotterdam Climate Initiative, the goal is to reach a neutral situation reducing the level of CO2 emissions of the city, in particular, the aim is a reduction of 50% of emissions by 2050 (Mackenzie, L., 2010). Several solutions have been implemented inside Rotterdam city:

- The Benthemplein water square: since December 2013 this square retains water during the period of high-intensity rainfalls and collects the rainwater that falls on the surrounding rooftops. It provides a lighter load for the sewage system of the city. It can collect 1.7 million liters of water. The square is also an infrastructure that decorates the city center and serves as a leisure space with its basketball court and skate park. More water squares are going to be created in Rotterdam and other cities (Molenaar, A., 2014).

- Multifunctional rooftop program: the city of Rotterdam is characterized by a huge amount of rooftop spaces, more than 14 km2 of flat rooftops cover the city (De Urbanisten, 2015). This is a big opportunity to find a solution to the existing challenges. The municipality find four different types of use for rooftops, which are described by a different color: the green roofs are covered by plants and vegetation to sustain the biodiversity of the city, the blue roofs serve as rainwater collectors to improve the flooding resilience, the yellow roofs are used for energy generation, through solar panels or wind turbines, and the red one is creative and social spaces in which people can meet, reducing the problem of overcrowding inside the city
- The floating pavilion: this is a pilot project initiated in 2010, and its starting point is the idea of adaptive housing through the creation of a community of floating homes. The structure consists of three spheres located in Rijnhaven. It is a sustainable building: its heating and cooling systems use the solar energy and the pavilion purified its own water. It is also an example of a resilient building because when the sea level rises, also the pavilion will rise as a consequence. The floating pavilion is a unique combination of flexibility and sustainability (Aerts, J. et al., 2013).

More recently the city of Rotterdam decides to develop a strategy to become smarter and this strategy is based on 7 different goals that we can find inside the Rotterdam Resilience Strategy, that made the city part of the 100 resilient cities network. These seven goals are linked to 68 different actions that need to be implemented in the following years to achieve the objectives. By 2030, Rotterdam will be a city with a sustainable system of energy supply, an efficient system of water management that ensures to derive value from water, an increased level of digitalization taking care to the problem of cybersecurity, and a more flexible government. By 2025 the city wants to become climate-proof (City of Rotterdam and 100 Resilient Cities, 2016). Starting from the water-management problem, Rotterdam develops many innovative and adaptive solutions, and a complete program to deal with the other challenges of urbanization, in a holistic way. The first goal is to create a balanced society: government is implementing a series of activities to enhance the education of people, and provide them with the knowledge they need to work in a technological world. Furthermore, there are actions

for sustain the public health of citizens through the development of a Public Health Act 2016-2019; and a program called WE-Society to enhance the social cohesion and reduce the tension among city dwellers. The second goal is to improve the production of clean energy and the implementation of the Bio Port program through the use of vegetable and natural materials inside the energy and fuel industry. Through the use of raw material such as maize or grain, and biomass it is possible to reduce the level of CO2 emissions. In this way, the city of Rotterdam is moving towards alternative sources of energy and fuels. The city has also implemented a system of smart waste management with the use of sensors that can detect the level of bins and provide a more efficient collection system (City of Rotterdam and 100 Resilient Cities, 2016).

The port is the most important part of the city and many companies are located there. Due to an increasing level of technologies, the government stresses the importance to enhance the level of cyber-security, to avoid economic losses. For these reasons, the Port of Rotterdam in collaboration with Microsoft develops a Cyber Resilience Strategy to become economically resilience. The strategy has the goal to provide the cyber-security of the ICT tools used by the companies working in that area (Nicholas, P., 2017).

Another collaboration with a private multinational, IBM, is currently taking place. The collaboration between the biggest port of Europe and IBM wants to create the Smartest Port of the world. The boldest goal is to arrive at automated ships by 2025. Through the application of IoT technologies and cloud computing, there is the possibility to create a digital copy of the port in which all the strategies can be tested. Moreover, with the use of digital dashboards time can be saved in different types of operations. Furthermore, with the use of weather and water sensors, the company is able to forecast the future conditions of water, wind, and weather, providing an increase in the efficiency of port operations. This relationship with IBM will increase the technological improvements in the port of Rotterdam in the next few years and at the same time will provide cost-efficiency and benefits for the region (Campfens, V., Dekker, C., 2018).

The city of Rotterdam is moving towards an open data system, in which people can access the data through the use of an open data platform. This is called Rotterdam Open Data and it increases the transparency level of the government. At the same time it enhances the relationships between citizens and local authorities. This can be made supporting bottom-up activities and initiatives and information sharing. The city

continues to increase its efforts to create a networked society, in which businesses, governments, citizens and other entities collaborate and cooperate to solve social issues (City of Rotterdam and 100 Resilient Cities, 2016).

The city of Rotterdam is ultimately an open innovator which wants to test innovative solutions to improve the quality of life, without fighting against its biggest problem, the water, but coming up with solutions that can be implemented in dealing with it. One of the most important action was the creation of the CityLab010, in which new ideas come out and are implemented with the support of public resources. This is another example of the holistic approach applied that take into consideration citizens and people in an inclusive way (City of Rotterdam and 100 Resilient Cities, 2016).

We have now seen the different actions and programs implemented in three different cities: London, New York, and Rotterdam. The specific features of each city determine the best actions to implement, taking into account the local risks and the resources available. To provide a complete overview of the three different smart strategies, we collect in table number 4 the programs and the related categories of smart components that they affect.

CITIES ➡ SMART COMPONENTS ⬇	LONDON	NEW YORK	ROTTERDAM
Smart Infrastructure	- New Connected Program (5G) - Smart Digital City - Digital Inclusion - MiWiFi Programme - LOTI Program	- Smart meters and monitors - Sensor networks - Link NYC	- Weather and water sensors - Smart meters and monitors - Shipping sensor
Smart Traffic	- Low Carbon Economy - Contactless payment on transport means - Zero-emissions busses - Smart system of traffic control	- Action for a safer city - MidTown Motion Program - TPS system for buses	- Smart Port project with IBM
Smart Environment	- Increase in green areas - Zero-waste by 2050	- High standard and resilient buildings	- Bio-Port project - Multifunctional

	- Low-Carbon Economy - Compliance with air pollution regulations - Green infrastructures	- ACE Program for smart lighting - Smart water system and Leak Notification Program - Air quality monitoring - BigBelly bins	Roofs program - Water squares - Floating buildings - Smart Waste management
Smart Services	- Services designed on users' needs - MedTech Innovations - MOPAC Programme - Skills for Londoners Strategy - Technological tools in schools and cultural institution	- Acoustic Gun-Shot detection system - Minority and Women-owned business enterprises protection	- Training and education programs - Public Health Act 2016-2019
Smart Governance	- LODA Programme - Open ecosystem - Shared information	- 311 app for - NYC Open Data	- Rotterdam Open Data platform
Smart People	- Green Infrastructures - The Healthy Street approach	- Vision-zero Program - Home-Stat Project - Lowline Program	- WE-SOCIETY Program - Rotterdam Networked city program
Smart Living	- Circular economy - Crowdfund London Project - Programs of technological education	- Brownsville Innovation Lab - Safer Streets	- Cyber Resilience Strategy with IBM - CityLab010

Table n.4 – The smart components implemented in the cities of London, New York, and Rotterdam (Own elaboration).

3.3 Other smart initiatives implemented around the world

When we talk about extreme weather events and natural disasters the challenges are huge. In case of storms, hurricanes or heart quakes it seems difficult to find a solution, especially for those countries that are already dealing with other challenges such as poverty, social inclusion, high levels of emission and suchlike. An ambitious program has been implemented on 9th August 2018, and it's called Caribbean Climate-Smart Accelerator. It is based on a collaboration of 27 countries inside the Caribbean area, some private companies, international organizations and also some public figures such as Usain Bolt, who as ambassador promotes and sustains the project. The aim is to create the first climate-smart zone in the world, improving the area in terms of resilience to weather events and climate change. Higher sustainability, renewable energy, oceans conditions, buildings, and infrastructures are the other goals without missing the economic growth of Caribbean countries. It consists of a number of projects and initiatives financed by partners such as the World Bank, Airbnb, IDB and the UN Green Climate Fund (*https://www.caribbeanaccelerator.org/*). The initiative is only at its starting point, but it should be recognized that a partnership with private and public entities may provide progress in dealing with one of the most hazardous challenges of the 21st century.

Another global risk that affects many parts of the world is the water crisis which leads to situations of water scarcity and drought. A clear example of the effects of these trends is represented by the Cape Town case, in South Africa. The reduction in the levels of rainfalls in addition to the increase in temperatures and the population growth, create a situation of water scarcity. This, in turn, will affect many areas: the proper functioning of businesses and infrastructures, the agricultural field, the biodiversity and the human life in general. But the water scarcity is not the only problem: the city is also characterized by high levels of carbon emissions, with levels that are comparable with those of cities like London or New York. The curtailing in rainwater levels can exacerbate the problem of wildfires, which increases the health-related problems of the population. Also, the higher acidification of the ocean, due to high levels of CO2 emissions, results in hazards for marine species, threatening as a consequence also the food system (City of Cape Town, 2017). As we can see the climate changes are posing many and interconnected challenges to the city, that presents high levels of social instability and overcrowding.

The water shortage is one of these challenges, and it's spreading its negative effect also on the other risks, exacerbating them. Cape Town city has a water system made of six major dams that supply water to the population, which reached 4.3 million people in 2018, with an increase of almost 80% from 1995 (Bohatch, T., 2017). The water consumption is grown over the years, as the population. This, in conjunction with the extreme reduction in rainfall levels between 2015 and 2017 (Welz, A., 2018), and the decrease in the levels of dams, pushes Cape Town on the hardest water crisis. Since 2015 the government starts to implement a program to reduce the water consumption, with a massive effort, the city reduces its consumption of water by 57%, from 317 million gallons per day in 2015 to 137 million of gallons per day in 2018 (Welz, A., 2018). This big reduction had the aim of avoiding the "Day Zero": that day of 2018 in which the municipal water supply system stops to provide water to Cape Town, leading the city to become the first big city of the world to run out of the water. Through severe consumption restrictions, the goal was achieved, but the Day Zero has not yet been deleted but most likely postponed. The situation remains dangerous and innovative options need to be found in order to develop long-term solutions. There isn't an easy way to do it, and Cape Town has also to deal with high levels of inequality and poverty that increase the trouble. The major options that the government is going to implement are desalinization plants, the purification of wastewater or drilling of the boreholes (Welz, A., 2018). What is needed is a reduction in the water consumption and waste that starts from the city dwellers first of all. Smart meters are useful tools for collecting information about the consumption levels of citizens. Cape Town is turning to a system of smart water management which, through the use of smart meters and the development of dedicated apps, permits the diffusion of real-time data among people. This is useful for the proactive solutions of problems, but also for a more inclusive way to make people aware of their consumption. As demonstrated by the work of Booysen, Visser, and Burger (2019), the release of information through the media provides a bigger response in terms of consumption patterns of citizens rather than the consumption restrictions imposed by the central government. Cape Town is moving toward a smart city approach and if it will be able to include city dwellers in this process, involving them and making them aware of the social responsibility they handle, it results in a long term sustainable journey.

Droughts have always marked California's history. The most severe droughts take place in 1929-34, which lasted six years, like that in 1987-92, and the shorter one between 1976-77, in which forty-seven of the fifty-eight California's counties declared the state of emergency. More recently drought affected California in 2007-2009 and between 2012 and 2014 (California Department of Water Resources, 2015). From the bad experiences of the 1920s and 1930s, the California State initiated to develop a water resilience system that permits the water transfers and exchanges, to avoid the runoff. The government is at the forefront in developing water recycle systems and water storage systems. Furthermore, the California water code provides for an annual water management plan for those municipalities that provide water for more than 3000 customers or serve more than 3000 acre-feet per year (California Department of Water Resources, 2015). This plan has to include responses to a situation of a severe shortage in water supply, a situation of supply interruption and also a single year drought and multiple-dry years circumstances. The proper management of drought is important, due to its impact on related risks such as wildfires and forest losses. One of the first solutions implement has been the desalinization. This is an optimal alternative source of water. The ocean water is processed to remove the excess of salt making it available for domestic use. Desalinization plants require a huge amount of resources, so the government is trying to find out other innovative alternatives. The use of recycled and gray-water is also implemented in the state, through treatment processes that make the water safe again. Also, the storm-water is a viable solution that occurs through the collection of precipitations water. The largest part of water consumption in California, almost 80%, goes to the agricultural sector. In this field the first smart solutions are emerging: through the use of a number of sensors, there is the possibility to obtain information about the weather conditions and the soil and temperature features. This permits an estimated reduction in the water consumption levels of 20-30% (Alder, L., 2015). Sensors are introduced also in irrigation systems, to permit more efficient use of water, avoiding waste and reducing the level of pollution, due to better use of fertilizers. In the Climate and Action Plan for California (California Environmental Protection Agency, 2015), the Government states its involvement in creating a plan that encompasses climate-change policies with the aim of a comprehensive study of climate challenges.

The different circumstances of California and Cape Town are a useful tool to understand how a climate-related problem such as drought is addressed. In a developing country, the resources are limited and the government is usually unable to solve the problem without the aid of other entities. On the other side California has the monetary resources needed for creating huge desalinization plants but strives to find out more innovative solutions, with technological integration.

Rio De Janeiro has experimented many Smart City initiatives over the past few years, implementing a wide range of technologies with the aim of creating more innovative and inclusive spaces around the city. Putting people first is one of the pillars of Rio's Smart Programs. The city government focuses both on the technological inclusion and the social inclusion of its population. In addition, to implement training programs to promote technologies access, the city stresses the importance of citizens participation, to create a strong link between citizens and government. After a terrible rainfall in April 2010, that causes terrible damages in terms of lives lost and infrastructures, the government understood the need of a system that permits to protecting Rio's population. The city stars to monitor the different activities taking place inside its boundaries, through the Rio Operation Center (called COR). The 86% of the city's economy comes from services (Schreiner, C., 2016), so it's easy to see the benefits of implementing new technologies inside this sector. Furthermore, this center of control allows the government and agencies to promptly take actions in case of unforeseen events or problems. The system operates through more than 1000 cameras and approximately 500 employees that take care of the city. The operation center works 24h a day, 7 days a week and enables the collection of a huge amount of data, that can be stored and processed. The use of a wide network of cameras is useful for weather conditions monitoring and the detection of expected rainfalls and storms, for the congestion and accidents management, and also for the management of the events taking place inside the city. The COR system is integrated into other smart actions, such as in the smart traffic, through the collection of data about traffic congestion and levels of emissions. It also shares information with public entities and bodies (police, ambulances, fire department) to improve the security of citizens, and coordinates its actions with the Center 1746, through which citizens can call and report relevant situations or information to the central bodies.

The city of Rio De Janeiro is also committed to the reduction of its CO2 emissions, through the implementation of renewable sources of energy: 88% of the city energy derives from renewable sources, especially hydropower. In 2009, inside the Rio Sustainable program, the city set out a reduction of 20% in CO2 emission by 2020, that will be implemented through different kinds of actions, such as smart waste management, an increase in lighting efficiency through LED lights, and improvements in the transport system. The city is already facing hazard challenges, such as its water management system. The water consumption in the city is high due to many leakages, that account for 58% of water wasted (Siemens AG, 2010). The water system is also weakened by illegal connections that drive water to favelas.

Another big problem that affects, not only the city of Rio but the whole Latin American is the deforestation. This is not the only area in the world affected by forest loss, similar trends take place also in Asia and Sub-Saharan Africa. Deforestation causes 11% of the total amount of greenhouses gases emissions, a percentage higher than the entire transport sector (UN-REDD Programme, 2016). The main causes of these losses are the cultivation, for the production of soy, palm oil, paper, and beef. Due to the fact that deforestation is caused by the private economic sector, this problem is difficult to solve only with public regulations or initiatives. Private companies carry the majority of this burden and for this reason, a partnership between the private and public sector is needed. For these reasons, the Zero-Deforestation movement provides one of the most important steps forward in creating a partnership between the private and public sector. After the creation of REDD+ (Reducing Emissions from Deforestation and Forest Degradation in Developing Countries) during the United Nation Framework Convention on Climate Change (UNFCCC) ten years ago, and the success of the Brazilian experience in reducing deforestation levels in the Amazon Forest, many entities and states decide to commit to the Zero-Deforestation goal. Brazil achieves a reduction of 67% in the level of emissions between 2005 and 2010 (Boucher, D. et al., 2011). These awesome results increase the spread of the Zero-Deforestation system.

REDD+ represents a sustainable solution that provides economic incentives to developing countries to avoid deforestation, reducing the levels of forest carbon emissions, involving also the local communities in the process (UN-REED Programme, 2016). Many other actions have been implemented and since 2010 also some private

multinationals (such as Unilever and Danone) have joined the program. The commitment to Zero-Deforestation of private companies consists in large part of product certifications, but this may not be enough. In this case, the technologies could improve the process through monitoring systems, giving to the companies upstream in the supply chain the possibility to directly monitor the production process to detect the real situation. Governments can enhance the efficacy of these programs through a unified body of regulations. Furthermore, it's important to remember that also the smaller producers need to be taken into account: they are not always able to comply with the new regulations, so they need specific protection to avoid being cut out of the production process. Working on a more inclusive Zero-Deforestation movement will lead to higher benefits for every stakeholder and the global environment as a whole (FAO, 2018).

In addressing the problem of food crisis, malnutrition and poverty, it's difficult to find a smart city program. The data about food insecurity and poverty contribute to providing a picture of the situation: more than 150 million people suffer from food insecurity in 2014/2015, poverty levels of Africa are the highest in the world, and the food issue of this country comprises malnutrition, undernutrition and overweight/obesity (FAO, 2017). More than 12 African countries have an undernourishment level higher than 40%, and in those countries affected by conflicts, the percentage reaches 50% (Benson, T., 2004). The food availability, the access of a sufficient quantity of food and the food accessibility, the access of an adequate amount of physical and economic resources to obtain food are fundamental to provide food security in a country. Some steps have been made and it’s important to provide adequate support through programs and governmental policies that push for food security. Since 2015, the African Union Commission (AUC) works on African Regional Nutrition Strategy (ARNS) with the aim of a 40% reduction in stunting and a 50% reduction in anemia by 2025 (FAO, 2017). Another program is the "Feed Africa" strategy of 2016, with the African Development Bank. Also, in this case, the main goal is the end of hunger and poverty in the region. These are only two examples, but different actions are taking place in many parts of Africa, based on the different features of every city. A big role in dealing with the food issue is playing by agriculture. The African food market is growing and the 60% of Sub-Saharan people work in the farming sector, and in the future, it will increase further (The World Bank, 2018). According to the idea of the World Bank (2018), technologies

can improve the agricultural system and provide smart solutions to some challenges. In particular, the technological component can:

- expand the access of capital and resources for African farmers
- break up the value chain, providing small producers the possibility to reach consumers
- increase food production sustainability, through the use of technological tools that provide more information about soil, water, fertilizer and so on.

Some projects have already shown their benefits. The Ministry of Agricultural and Rural Development in Nigeria develops a program called Growth Enhancement Support (GES), which consists of an e-wallet system that provides soft loans to small farmers and at the same time provides information about farming practices and the use of fertilizers to educate people. Furthermore, the system is able to collect data about farmers and increase the transparency of the system. The major benefits are easier access to loans for farmers and a reduction in the corruption levels of Nigeria (Uwalaka, T., 2017).

Hello Tractors is another project implemented in South Africa last year. A software connects tractors owner with small farmers in need of a tractor, giving African farmers the opportunity to rent a tractor. This shall provide a practical solution to a big problem, considering that the majority of farmers doesn't have the resources to buy a tractor and at the same time in Africa there are 13 tractors every 100.000 square kilometers (The World Bank, 2018). In Kenya, Illuminum Greenhouses, a start-up company, builds modern greenhouses and drip irrigation systems. It provides technological kits to small farmers, that improve the agricultural production and enhance its efficiency. In this way, little farmers have the possibility of increasing their incomes and use technologies that are usually not affordable (The World Bank, 2018).

Setting aside the specific initiatives, the general trend is toward a Climate-Smart Agriculture (CSA), a holistic approach that try to solve the challenges posed by climate change and food security. Regions affected by food crisis and poverty have to deal with a higher risk in case of extreme weather events or natural disasters, due to inadequate and poor buildings. The three pillars of this approach are: increase the productivity of rural areas, enhance the climate-resilience and decrease the level of emissions. The World Bank (2018) supports many initiatives all around the world to spread a CSA

approach and to reach the three goals mentioned above. A fully integrated smart approach can be developed in these areas only when the basic human needs are met, but the technology can speed up the process through innovative solutions that involve private companies and other countries.

As early mentioned in the second chapter, the forthcoming population growth will take place especially in Asia and Africa. This phenomenon will lead to a higher demand for social inclusion and accommodation needs that have to be properly managed. The rapid evolution in technologies can provide support to the disclosure of innovative building solutions. In line with the World Bank (2015), Africa has to deal with a housing crisis: between 60 and 70% of African families live in slums, and the country is going to reach 1.2 billion citizens by 2050. It's not difficult to understand that the majority of people can't afford a house. The development of the building sector can provide a boost to economic growth because every new house could create new jobs. In the last few years, some actions have been implemented, usually in collaboration with private companies. IGS, International Green Structure, is an American construction company that works in Kenya to construct affordable houses in collaboration with local people. This project employs many Kenyan and at the same time provides sustainable development. Indeed, the construction panels are made of a natural material, that derived from the straw of wheat and rice. These Compressed Agricultural Fiber panels are eco-friendly, sustainable and energy-efficient (IGD, 2014). The IGS project is an example that illustrates some possibilities to improve the housing conditions of Africa. The biggest challenge for the region remains to enhance the conditions of the slums dwellers, that cannot afford even the cheapest house solution.

China is implementing a different approach towards the smart city. Smart solutions and actions are developed through a collaboration between the central governments and some leader companies in the technological field. Alibaba, one of the biggest Chinese retail and technology companies, creates in Hangzhou the ET City Brain project (launched in 2016). It consists of a system of sensors and networks that permit collection of a huge amount of data and their immediate elaboration integrated with the use of algorithms. The system provides an increase in traffic accidents identification of 92%, providing also prompter intervention (Alibaba Clouder, 2018). ET City Brain is able to provide better management of the traffic flows through smart traffic lights, and

collects data about traffic congestion. Integrating them with information from AutoNavi app is possible to understand the real causes of congestion and takes subsequent measures. It increases travel speed of 15%, and suggests faster routes to buses, through real-time analysis of traffic data. ET City Brain provides smart solution also for other types of challenges, not only for traffic management. It is able to enhance the level of security inside the city, through video-surveillance systems; it can be useful for water management through sensor measurement of soil conditions and weather forecasts; and can improve the hydro-electrical production that leads to a reduction in the fossil-fuel need (Alibaba Clouder, 2018). The wide range of applications of the ET City Brain system is summarized in figure number 8 below.

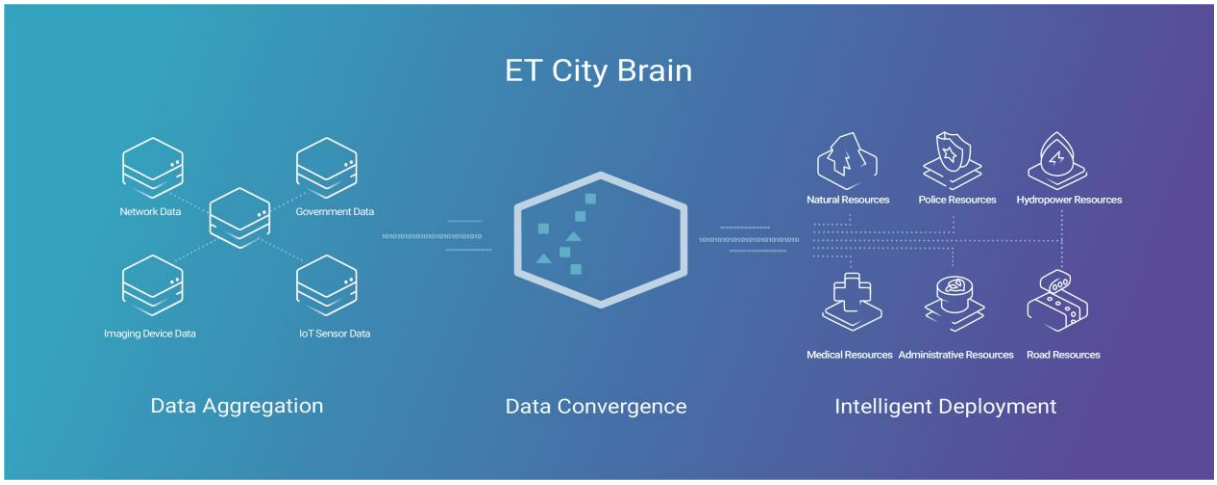


Fig. 8 – The ET City Brain system and its applications (source *https://www.alibabacloud.com/et/city*).

Similar solutions have been implemented in other Chinese cities, by other companies such as Huawei which launched smart parking systems, mobile payment apps, and traffic control systems. The trend is toward an increasing integration between public entities and the private sector to develop innovative solutions that can exploit the know-how of tech companies.

In the end, through an overview of different approaches implemented around the world, we can understand that the degree of smartness is not at the same level everywhere. The biggest cities are able to engage in a public smart plans, sustained by the central government. In these cases, the focus is on a holistic approach that can encompass

different urban challenges and at the same time promote social inclusion and enhance the citizens quality of life. On the other hand, many developing countries are not fully engaged in a smart city approach, because they are facing humanitarian problems. In these cases, food insecurity, poverty, and degradation need to be eradicated to open a path of economic growth. However, smart actions and the use of technologies shall improve the living conditions in those areas, usually through the aid of private companies. In the same way, other developed countries find a better solution through the integration of the private and public sectors, especially those that haven't adequate resources. Every year global organizations and entities provide guidelines and research reports, with the aim of spread information and promote the implementation of smart and sustainable measures all over the world.

What emerges, however, is that, despite small or big, these smart projects may improve the city contexts. It can consist of a reduction in the level of GHG's emissions or an increase in the quality of water management, but these are true improvements in the urban challenges and risks, that affect cities worldwide. The Smart City approach is able to enhance the city context, improving the conditions and dealing with its main challenges, without exacerbating the global concerns.

Chapter 4: Measurement of Performance: smartness indicators, and the importance of a holistic approach.

As we saw in the second chapter, there isn't an accepted definition of the smart city concept. Many definitions were created in the last few years, and many others will probably emerge in the future. From a review of the most important studies on this matter, we have seen that some common elements that make up a smart city may be identified. The smart components usually mentioned are transport, infrastructures, environment, services, governance, economy, living and people (Anthopoulos, L.G., 2017). But in every single project, the different components are not handled in the same way. Due to the specific features of every urban center, the programs implemented can be a very different one from another, and difficult to compare. Starting from this point, it could be difficult to find a method suitable for the measurement of a city's smartness. A system of smart indicators and measurements could be useful to understand if the actions implemented are successful or if not, to change the direction and enhance the future performances. Policy makers, governments and city dwellers need to evaluate the performances of smart projects and assess if the invested resources are providing a better quality of life, economic growth, and sustainable development. Thus, measuring the smartness of a city means to assess the well-being of citizens, not only the efficiency of the physical components. Find a set of performance indicators able to do this is challenging. For these reasons, there isn't an official smart meter or a list of smartness indicators. We decided to describe different approaches to provide an overview of some solutions adopted. The first one is the IESE Cities in Motion Index, developed by the IESE Business School in Barcelona, that provides a global ranking of smart cities. There are many global rankings, and we decide to analyze this for its greatest geographical scope. It evaluates 165 cities in 80 different countries all over the world (Berrone, P. et al. 2018). The second approach selected is the European Medium-Sized Cities Ranking, in which the smartness of medium-sized cities is evaluated. The majority of rankings consider only the bigger cities and the capitals. This evaluation provides an analysis that targets a different group of cities, usually not considered. The results are shared through the smart-cities EU website and can help governments and policy-makers to understand the strengths and weaknesses of a city (Giffinger, R. et al., 2007). The third type of measurement selected doesn’t generate a ranking, it comprises a list of key performance indicators based on five categories (people, planet, prosperity, governance, and

propagation) that assesses the positive or negative impact of a smart program. The CITY Keys project provides a framework and a number of indicators to allow a comprehensive evaluation of a program, and at the same time permits to compare different programs. The great number of indicators seeks to cover every possible type of projects (Bosh, P. et al., 2017). Nonetheless, in each ranking, a city may hold a different position. For these reasons, we are looking in more depth to the elements evaluated for the ranking and not the ranking list itself.

4.1 IESE City in Motion Index

The first approach is the IESE City in Motion Index (CIMI) developed by IESE Business School of Barcelona in collaboration with the Center for Globalization and Strategy, and it is one of the most comprehensive collections of indicators to measure the smartness of a city on a global scale. The 2018 City in Motion Index provides an analysis of 165 cities (13 new cities from the previous year), the majority of which are capitals (74 capital cities), all over 80 countries around the world. It is based on a framework that considers nine dimensions that are evaluated through 83 indicators (Berrone, P. et al. 2018).

The first dimension is the human capital. A smart city is a city in which people have access to education, stimulates and promotes creativity and cultural activities and improves their skills and talents. The second dimension taken into consideration is the social cohesion of a city. Its aim is to evaluate the level of social inclusion and the level of interactions among different groups. The third dimension is the economic one. One of the most important indicators of the economic success of a city is its GDP, but the City in Motion Index doesn't consider the GDP more important than other indicators. Then, the dimension of Governance aims to examine the quality of public administration and at the same time the level of citizens involvement. The Environmental dimension is related to the development of a sustainable city, that is committed to the reduction of emissions levels, and efficient management of its natural resources. The mobility and transportation dimension is related to the quality of transports inside a smart city, the level of efficiency/inefficiency of the transport system and the safety of streets and means of transport. The seventh dimension is urban planning, and it is related to many aspects of the city life and can impact on citizens physical and mental health, we can

think about overcrowded cities or the presence of green spaces. The eighth dimension is the international outreach, and the ability of a city to build an international presence and acknowledgment. The last dimension is the technological one, which represents the building blocks of every smart city. It considers not only the number of technological tools installed inside the city but also the level of utilization among citizens. The different indicators selected to evaluate every single dimension are collected in the table n. 5 below.

1. HUMAN CAPITAL	**2. SOCIAL COHESION**	**3. ECONOMIC DIMENSION**
- Level of education - Number of Business schools - Expenditure on leisure and recreation (overall and per capita) - Number of Universities - Museums and art galleries - Number of Schools - Number of Theaters - Movement of students present	- Mortality - Crime rate - Health - Unemployment - Gini Index (that measures the level of equity in income distribution) - Price of property - Female workers - Global Peace Index (which measure the level of conflicts/presence of war inside a city) - Number of hospitals - Happiness Index which is a measure of the overall satisfaction of people inside a city provided by the World Happiness Report - Global Slavery Index - Government response to situation of slavery - Terrorism	- Productivity - Time required to start a business - Ease of starting a business - Headquarters - Motivation for early-stage entrepreneurial activity - GDP estimate (an estimation of the annual GDP growth) - GDP - GDP per capita
4. GOVERNANCE	**5. ENVIRONMENTAL DIMENSION**	**6.MOBILITY AND TRANSPORTATION**
- Reserves (the financial resources available) - Reserves per capita - Embassies - ISO 37120 certification - Research centers - Strengths of legal rights - Corruption perception (is an index that measures the perceived transparency of administrative actions) - Open data platform - E-Government Development Index - Democracy - Government buildings	- CO2 emissions - CO2 emission index - Methane emissions - Access to the water supply - PM 2.5 - PM 10 - Pollution (with the use of the Pollution Index) - Environmental Performance Index (developed by Yale University) - Renewable water sources - Future climate (an estimation of the increase in temperature by 2100) - Solid waste	- Traffic Index - Inefficiency Index - Index of traffic for commuting to work - Bike sharing - Metro length - Metro stations - Flights - Gas stations - High-speed trains
7. URBAN PLANNING	**8. INTERNATIONAL OUTREACH**	**9. TECHNOLOGY**
- Bicycle for rent - Percentage of population with access to sanitation facilities - Number of people per household - High-rise buildings	- McDonald's (the number of restaurants in the city) - Airports - Number of passengers per airport - Sightsmap (measure the number of	- Twitter (in terms of number of users inside the city) - LinkedIn - Facebook

- Buildings	pictures taken in a city and posted on Panoramio website) - Number of conferences and meetings - Hotels	- Mobile phones - Wi-Fi hotspots - Apple store (the number of stores in each city, an expression of the citizens' demands for technology) - Innovation Index - Landline subscriptions - Broadband subscriptions - Internet (in terms of houses with internet connection) - Mobile telephony (in terms of houses with mobile phones)

Table n.5 – IESE City in Motion Index indicators. The table contains the 83 indicators of the nine dimensions used to evaluate the smartness of a city with the CIMI Index (Berrone, P. et al. 2018, pp.12-21).

The indicators are incorporated in the Index with a positive or negative sign, based on their positive/negative impacts on the corresponding dimension. The CIMI is now on its 5th editions, and every year new indicators and cities are added to provide a better ranking. The aim is to set up a model to evaluate the biggest cities all over the world, obtaining a tool to understand the better conducts, and also compare quite different situations. The use of nine dimensions allows to see the specific level of smartness reach in every single category; so a city may improve in those areas in which it ranks low. Due to the high different conditions that characterized cities all over the world, the CIMI includes the regional rankings, in which the best five cities of every region are listed. And an analysis of the evolution in the period 2015-2017 is also provided, to understand the evolution of the process implemented, because becoming smarter does not entail to launch a number of projects, it consists in developing a path.

4.2 EU medium-sized cities ranking

The second approach that we consider is the Ranking of European Medium-Sized Cities (Giffinger, R. et al., 2007). The smart characteristics selected to build this ranking are six:

- Smart economy
- Smart people

- Smart governance
- Smart mobility
- Smart environment
- Smart living

These characteristics are determined by a number of factors (33 overall factors for the 6 characteristics) and every single factor is outlined by some indicators (74 in total). In the table number 6, we provide an overview of the factors connected to each smart characteristic.

SMART ECONOMY	**SMART PEOPLE**
- Innovative spirit - Entrepreneurship - Economic image and trademarks - Productivity - Flexibility of labor market - International embeddedness - Ability to transform	- Level of qualification - Affinity to life-long learning - Social and ethnic plurality - Flexibility - Creativity - Cosmopolitanism / Open-mindedness - Participation in public life
SMART GOVERNANCE	**SMART MOBILITY**
- Participation in decision-making - Public and social services - Transparent governance - Political strategies and perspectives	- Local accessibility - Inter-national accessibility - Availability of ICT-infrastructure - Sustainable, innovative and safe transport systems
SMART ENVIRONMENT	**SMART LIVING**
- Attractivity of natural conditions - Pollution - Environmental protection - Sustainable resource management	- Cultural facilities - Health conditions - Individual safety - Housing quality - Education facilities - Touristic attractivity - Social cohesion

Table n.6 – European Medium-sized cities ranking indicators. Table contains the six smart characteristics and the related factors used to evaluate the smartness of the selected European cities (Giffinger, R. et al., 2007, p.12).

This ranking focus on medium-sized European cities. Due to the absence of a definition of medium-size, a process of selection aims at finding the relevant cities to evaluate.

First of all, the considered number of city dwellers is fixed between 100.000 and 500.000 and the second criterion for the selection is the availability of data to conduct the analysis. The public availability of data permits to conduct a transparent analysis, a fundamental criterion for the quality of the final ranking. In the end, 70 cities were selected. The different values are then standardized to permit the comparison among different cases. The results obtained from this analysis are not only limited to a rank of the best medium-sized cities in terms of the six smart features. Those cities that are listed higher may enhance their image and increase their attractiveness both in tourist and economic terms. On the other side, the cities listed at the lowest level may analyze their weaknesses, understanding which types of actions need to be strengthened, improving their conditions in the following years. At the same time, the data collected and analyzed permits to understand the critical areas shared by some cities, giving the possibility to start a collaborative discussion to find joint solutions on a European level (Giffinger, R. et al., 2007).

4.3 CITY Keys project

The European Telecommunications Standards Institute (ETSI) develops through the CITY Keys project a set of standards to measure the performance of the smart city. This project creates a number of KPIs (key performance indicators) that can be applied for the evaluation of a smart project (Bosh, P. et al., 2017). The aim of these standards of measurement is to create a method for smart city's analysis, that permits an improvement or change of direction in case of negative evaluation, and at the same time provides a way to compare different projects. Furthermore, the indicators can be implemented in the evaluating phase of a project, before its launch. It may enhance the public attention on the program, increasing the citizens' awareness, and facilitate the investors' approval.

The CITY Keys program provides a framework based on five elements: people, planet, prosperity, governance, and propagation. Then, the CITY Keys develops a list of KPIs that permits the evaluation of every smart program.

People are the first one and this category indicates the improvements in the quality of life and well-being of citizens. It is made up of six elements that we can see on the left

column of the table number 7. Every element composing the people category is associated with a number of KPIs that evaluate the smartness of a program (on the right column).

Sub-themes of People	**KPIs**
Health	- Improved access to basic health care services - Encouraging a healthy lifestyle - Waiting time
Safety	- Reduction of traffic accidents - Reduction in crime rate - Improved cybersecurity - Improved data privacy
Access to other services	- Access to public transport - Quality of public transport - Improved access to vehicle sharing solutions - Extending the bike route network - Access to public amenities - Access to commercial amenities - Increase in online government services - Improved flexibility in delivery service
Education	- Improved access to educational resources - Increased environmental awareness - Improved digital literacy
Diversity and social cohesion	- People reached - Increased consciousness of citizenship - Increased participation of vulnerable groups
Quality of housing and built environment	- Diversity of housing - Connection to the existing cultural heritage - Design for a sense of place - Increased use of ground floors - Increased access to urban public outdoor recreation space - Increased access to green space

Table n.7 – The sub-themes of the People and the related KPIs (Bosh, P. et al., 2017, pp. 24-26).

The second is the planet, and it is related to the environmental sustainability of the smart actions. And in the table number 8 we summarize its elements.

Sub-themes of Planet	**KPIs**
Energy and mitigation	- Reduction in annual final energy consumption - Reduction in lifecycle energy use - Reduction of embodied energy of products and services used in the project

	- Increase in local renewable energy production - Carbon dioxide emission reduction - Reduction in lifecycle CO2 emissions - Maximum Hourly Deficit - Local freight transport fuel mix
Materials, water and land	- Increased efficiency of resources consumption - Share of recycled input materials - Share of renewable materials - Share of materials recyclable - Life time extension - Reduction in water consumption - Increase in water re-used - Self-sufficiency-Water - Increase in compactness - Self-sufficiency-Food
Climate resilience	- Climate resilience measures
Pollution and waste	- Decreased emissions of Nitrogen oxides (NOx) - Decreased emissions of Particulate matter (PM2,5) - Reduced exposure to noise pollution - Reduction in the amount of solid waste collected
Ecosystem	- Increase in green and blue space - Increased ecosystem quality and biodiversity

Table n.8 – The sub-themes of the Planet and their KPIs (Bosh, P. et al., 2017, pp. 27-29).

The third category, called prosperity, is the economic evaluation of the smart project. It is useful to understand if the project is generating economic gains and sustain the overall economic growth of the city. It incorporates the elements contained in table number 9 below.

Sub-themes of Prosperity	**KPIs**
Employment	- Increased use of local workforce - Local job creation
Equity	- Fuel poverty - Costs of housing
Green economy	- Certified companies involved in the project - Green public procurement - CO2 reduction cost efficiency

Economic performance	- Financial benefit for the end-user - Net Present Value (NPV) - Internal rate of return (IRR) - Payback Period - Total cost vs. subsidies
Innovation	- Involvement of extraordinary professionals - Stimulating an innovative environment - Quality of open data - New startups - Improved interoperability
Attractiveness and competitiveness	- Decreased travel time

Table n. 9 - The sub-themes of the Prosperity and the related KPIs (Bosh, P. et al., 2017, pp. 29-31).

The Governance is the underlying factor that is fundamental for the implantation of every smart project. It is made of the following elements in the table number 10.

The Sub-themes of Governance	**KPIs**
Organization	- Leadership - Balanced project team - Involvement of the city administration - Clear division of responsibility - Continued monitoring and reporting - Market orientation
Community involvement	- Professional stakeholder involvement - Bottom-up or top-down initiative - Local community involvement in planning phase - Local community involvement in implementation phase - Participatory governance
Multi-level governance	- Smart city policy - Municipal involvement - Financial support

Table n.10 - The sub-themes of the Governance and their KPIs (Bosh, P. et al., 2017, pp. 32-33).

The last element is the Propagation, that is the possibility to apply the project in other contexts, or expand it, replicating the positive experience. The sub-elements of propagation are described below in the table number 11.

Sub-Themes of Propagation	KPIs
Replicability and scalability	- Social compatibility - Technical compatibility - Ease of use for end users of the solution - Ease of use for professional stakeholders - Trialability - Advantages for end users - Advantages for stakeholders - Visibility of Results - Solution(s) to development issues - Market demand
Factors of success	- Changing professional norms - Changing societal norms - Diffusion to other locations - Diffusion to other actors - Change in rules and regulations - Change in public procurement - New forms of financing - Smart city project visitors

Table n.11 - The sub-themes of the Propagation and the related KPIs (Bosh, P. et al., 2017, pp. 34-35).

As we can see the CITY Keys develops a comprehensive list of KPIs, these explore the different aspects of the project under evaluation. Furthermore, some indicators cannot be applied or the information may not be available in a specific context, this doesn't undermine the evaluation. The measurements are made in percentage terms or using a Likert scale, to permit comparability among projects. The CITY Keys program represents one of the most extended evaluations of smart projects and it is currently testing new indicators to add (Bosh, P. et al., 2017).

4.4 Measurability and efficacy of indicators

After the analysis of many indicators to measure the smartness of a city or a project, may be seen that not every single element is easy to measure. The economic indicators are those with the highest measurability inside every ranking. For example, in the IESE Cities in Motion Index the estimated GDP is evaluated in millions of dollars and the

measurement are provided by the Euromonitor. In the same way the time required to start a building (another economic indicator) is evaluated in terms of days and the assessment is provided by the World Bank. In the environmental category of CIMI we can see that indicators such as solid waste, measured in numbers of kg per person, and the CO2 emissions level, measured in terms of CO2 index, are relatively easy to quantify. When we enter the context of social cohesion and human capital indicators, a measure of the human well-being and quality of life is not easy to find. These aspects of life are highly subjective. The evaluation of the human capital of a city through for example the unemployment and crime rate can be misleading. Unemployed people and criminals centralize in specific area at the boundaries of the cities, and the measure cannot fully figure out the real situation and well-being. Likewise, inside the Governance dimension, the Corruption perception indicator is highly subjective and difficult to measure (Berrone, P. et al. 2018). More in general we can divide the long list of indicators in two main categories: measurable and not measurable. The economic data, the information collect about transport and mobility and the emissions are in general related to reliable data that can be measured and counted properly. Those indicators related to the well-being of people or the quality of life, that are usually associated with subjective perceptions or situations are more difficult to measure and the indicators cannot provide a reliable assessment of the human conditions inside the city. For example, the evaluation of the number of schools inside a city as evidence of the quality of the human capital of a city can be misleading. It may be more precise to evaluate the rate of social inclusion/exclusion in the education systems and the number of social interventions for those people that cannot afford the education costs, providing a measurement of the level of equity and inclusion. Due to the importance of the quality of life inside the smart city approach, it's important to evaluate the ability of indicators to measure these aspects.

Furthermore, some indicators that are listed as positive or negative (added to the evaluation with a positive or negative sign), have a double dimension. To put it as simply as possible we focus on two examples. The number of people connected to social media such as Facebook and Twitter and the number of mobile phones is two indicators listed in the technological dimension, that have a positive impact on the overall evaluation. A high number registered in these two indicators provide a better result in the city smartness evaluation (Berrone, P. et al. 2018). It's not difficult to understand that a

higher number in the adoption rate of smartphones and social media accounts has not only positive effects on the well-being of the population. There are indicators that have a double positive and negative effect and in this type of ranking only one of this is taken into account. Similarly, the measurement of the number of Apple Store inside a city, that is seen inside the CIMI (Berrone, P. et al. 2018) as a positive signal of the higher demand for technological tools is related to conflict in the social cohesion sphere. Not every citizen can afford an Apple product, and from the social point of view it is highly discriminatory. This focus on the positive side of technological tools and their diffusion, hides the negative side that is connected with the quality of life and social cohesion of a city. So, it seems now clear that some indicators that focus on the technological aspect are not well suited for the evaluation of human well-being. It's important to detect the indicators that are able to provide a complete evaluation of the multiple aspect of the smart city approach, and especially the quality of life which is the most crucial aspect to measure. Higher level of technology inside a city center does not mean a better quality of life. The technology constitutes the building blocks of a smart city, and it is the mean whereby the improvements are introduced. But the further increases in quality of life, citizens engagement and social cohesion need to be measured without focusing on the level of technology adopted. These aspects are undoubtedly the most complex to evaluate, and need to be taken into account during every smart city evaluation.

At the end of this brief review of the KPIs for smart cities, it's important to consider that there are many rankings and indicators developed by private entities or organizations. None of them has a validity or importance higher than anyone else, everyone stresses the importance to find a holistic approach that considers many aspects of the smart cities, ranging from the economic growth to the environmental sustainability. Furthermore, the smart city approach involves the creation of a better life for citizens and an improvement in the overall well-being, that are difficult to measure and very subjective. These challenges in the measurement process may be difficult to overcome, the commitment to find always better solutions is high both on European and international level. Every single ranking and measurement of performances is important to evaluate the steps forward in the long process of becoming smart cities. It's important to focus on the path and not only on the single results of an action, to understand and implement a path that hasn't an end.

Conclusion

We opened this essay investigating the global risks that affect the current scenario and the smart city concept. Through the analysis of the development of the smart approach and the different actions implemented in many countries we provide a complete picture of this phenomenon. During the evaluation of the efficiency of the smart city model to deal with global and local problems, we highlight some achievements. The use of the smart model of developments permits to:

- reduce the level of CO2 emissions through the use of more efficient systems of transport and building
- reduce the level of noise and provide green and sustainable solutions inside the city center
- improve the water and waste management through the use of smart meters and sensors
- develop an open and transparent system of governance, based on public availability of data
- enhance the economic attractiveness of a city for businesses and companies through the creation of networked and connected spaces all around the city
- provide a higher level of security both inside the city and in the digital field
- increase the citizens' well-being guaranteeing them access to education, culture and health-care

The specifics outcomes are described in more detail in the third chapter. But with this general overview of the results achieved through smart programs we can understand how the implementation of a wide network of technological tools can improve the city context. Furthermore, the smart city approach differs for its focus on the human dimensions: every improvement aims at raising the quality of life of city dwellers. As mentioned above, the smart city approach is an outstanding conjunction of technology, human capital and sustainable development. We have followed the smart journey implemented in many countries to demonstrate how this commitment to smart actions may represent an innovative solution in dealing with the urbanization process. It is not the only option and it is not applied uniformly due to the lack of a single definition and a global regulation on this matter.

Finally, evaluating the models available to construct measurement of the smartness, we notice that there are some gaps and further research need to be made, to provide an efficient way to measure the human well-being and quality of life. Further researches may be implemented to explore new ways to calculate the values of smartness indicators. With an evaluation of the data found in different years, it will be possible to measure the improvements given by the smart actions or programs.

In summary, we think that the smart city approach may be a current and future tool for the construction of more livable and equitable cities, putting the human being and the sustainability at the center of the process. Fundamental changes in the patterns of consumption and in the life-style can be boosted through smart programs, through the creation of a long-term path that includes the citizens in the decision-making process. This may lead to better management of urban risks, with the aim of reducing the impact of the global ones.

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