UNIVERSITY OF THE PELOPONNESE & NCSR "DEMOCRITOS"
MSC PROGRAMME IN DATA SCIENCE

Smart Cities: Issues and Challenges towards a human centric paradigm

by

Nektarios Dimitrakopoulos

A thesis submitted in partial fulfillment
of the requirements for the MSc
in Data Science

Supervisor: Nousias Alexandros
Research associate

Athens, October 2022

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MSc. Thesis, MSc. Programme in Data Science

University of the Peloponnese & NCSR "Democritos", October 2022

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Declaration of Authorship

(1) I declare that this thesis has been composed solely by myself and that it has not been submitted, in whole or in part, in any previous application for a degree. Except where states otherwise by reference or acknowledgment, the work presented is entirely my own.

(2) I confirm that this thesis presented for the degree of Bachelor of Science in Informatics and Telecommunications, has

(i) been composed entirely by myself

(ii) been solely the result of my own work

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Nektarios Dimitrakopoulos

Athens, October 2022

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To my son, Chris.

Περίληψη

Οι τεχνολογικές εξελίξεις των τελευταίων ετών συνέβαλαν σημαντικά στην ανύψωση του ανθρώπινου βιοτικού επιπέδου και στη βελτιστοποίηση των συνθηκών διαβίωσης μεγάλης μερίδας του ανθρώπινου πληθυσμού. Η τεχνολογία είναι πλέον παρούσα σχεδόν σε κάθε πτυχή της καθημερινής ζωής, από την επικοινωνία με άλλους ανθρώπους και τις μετακινήσεις, έως τη χρήση προσωπικών πληροφοριών και τη λήψη ιατρικής περίθαλψης. Όλα τα παραπάνω έγιναν δυνατά μέσω εφαρμογών που έχουν δημιουργηθεί με τη βοήθεια «έξυπνων» συσκευών και του διαδικτύου και οι οποίες κατακλύζουν καθημερινά την ανθρωπότητα. Καταβάλλονται συνεχώς προσπάθειες για τη μεταφορά και αξιοποίηση αυτής της τεχνολογικής εξέλιξης σε μεγαλύτερο επίπεδο, σε επίπεδο πόλης, μέσα στο οποίο θα πρέπει να συντονίζονται διάφορες καθημερινές δραστηριότητες με στόχο τη βελτίωση της ζωής των πολιτών. Με μια τέτοια πόλη είναι πλέον γνωστή ως «Έξυπνη» Πόλη. Κατ΄ επέκταση, ο όρος «έξυπνη» πόλη αναφέρεται στην απλοποίηση των διαδικασιών που είναι διαθέσιμες στο ευρύ κοινό με σκοπό τη βελτίωση των συνθηκών διαβίωσής του. Η παρούσα εργασία εξετάζει και παρουσιάζει το φαινόμενο της «έξυπνης πόλης». Σκοπός της παρούσας εργασίας είναι η παρουσίαση και ανάλυση του φαινομένου της «έξυπνης» πόλης και των ηθικών προκλήσεων μέσα από ενδελεχή βιβλιογραφική έρευνα σε παγκόσμιο επίπεδο, συμβάλλοντας στη διάδοση ενημερωμένων πληροφοριών, λόγω της ταχύτητας των εξελίξεων στον τομέα της πληροφορικής και της κοινωνίας.

Ειδικότερα, η δομή της εργασίας έχει ως εξής:

- Στο πρώτο κεφάλαιο εισάγεται το θέμα, ορίζοντας την έννοια της έξυπνης πόλης, εξετάζοντας την έξυπνη πόλη διαχρονικά και παρουσιάζοντας τα κύρια στοιχεία και χαρακτηριστικά της.

- Στο δεύτερο κεφάλαιο εξετάζεται η βιωσιμότητα των έξυπνων πόλεων και τα ηθικά ζητήματα και προκλήσεις που προκύπτουν σε αυτές

- Στο τρίτο κεφάλαιο δίνονται παραδείγματα έξυπνων πόλεων από το παρελθόν και από το παρόν, αναλύεται λεπτομερέστερα η τρέχουσα φάση ανάπτυξης της έξυπνης πόλης (Smart City 4.0) και παρουσιάζονται καινοτόμες και πολλά υποσχόμενες τεχνολογίες.

- Το τέταρτο κεφάλαιο εστιάζει στο θέμα της διακυβέρνησης της έξυπνης πόλης. Παρουσιάζονται οι τεχνολογίες των έξυπνων πόλεων και μελετώνται οι επιχειρηματικές προοπτικές, ενώ εξετάζεται η ανταπόκριση των έξυπνων πόλεων στο ξέσπασμα της πανδημίας Covid-19.

- Στο πέμπτο κεφάλαιο παρουσιάζονται οι Ανθρωπινες Έξυπνες Πόλεις (Human Smart Cities), στις οποίες ο άνθρωπος είναι στο επίκεντρο.

- Στο έκτο κεφάλαιο παρουσιάζονται συνοπτικά τεχνολογικές λύσεις και μεθοδολογίες για τα ζητήματα των έξυπνων πόλεων που εγείρουν προβληματισμούς.

- Στο έβδομο κεφάλαιο εξετάζεται η λύση του ΜψΔατα Νετωορκ σαν ένας πιο καθολικός και ασφαλής τρόπος.

- Στο όγδοο κεφάλαιο παρουσιάζεται αναλυτικά το παράδειγμα μιας ελληνικής έξυπνης πόλης, αυτή του Ελληνικού.

- Τέλος, η εργασία ολοκληρώνεται με το ένατο κεφάλαιο, όπου παρατίθενται τα συμπεράσματα της παραπάνω μελέτης, εξετάζονται θέματα για περαιτέρω έρευνα στο μέλλον και άλλοι προβληματισμοί σε σχέση με τις έξυπνες πόλεις.

Λέξεις-κλειδιά: *Έξυπνη πόλη, Διαδίκτυο των Πραγμάτων (IoT), Νέες τεχνολογίες, Καινοτομία, Βιώσιμη ανάπτυξη, Ηθικά ζητήματα*

Abstract

The technological developments of recent years have greatly helped to raise the human standard of living and optimize the living conditions of a large portion of the human population. Technology is now present in almost every aspect of everyday life, from communicating with other people and getting around, to using personal information and receiving medical care. All of the above has been made possible through applications that have been created with the help of "smart" devices and the internet and which overwhelm humanity every day. Efforts are constantly being made to transfer and utilize this technological development to a greater level, at the level of the city, within which various daily activities should be coordinated with the aim of improving the lives of citizens. With such a city it is now known as a "Smart" City. By extension, the term "smart" city refers to the simplification of procedures available to the general public in order to improve their living conditions. This paper examines and presents the "smart city" phenomenon. The purpose of this paper is to present and analyze the phenomenon of the "smart" city and ethical challenges through thorough bibliographic research at a global level, contributing to the dissemination of updated information, due to the speed of developments in the field of IT and society.

In particular, the structure of the work is as follows:

- In the first chapter, the subject is introduced, defining the concept of the smart city, examining the smart city over time and presenting its main elements and characteristics.
- The second chapter examines the sustainability of smart cities and the ethical issues and challenges that arise in them

- In the third chapter, examples of smart cities from the past and from the present are given, the current phase of smart city development (Smart City 4.0) is analyzed in more detail and innovative and promising technologies are presented.

- The fourth chapter focuses on the issue of smart city governance. Smart city technologies are analyzed and business prospects are studied, while the response of smart cities to the outbreak of the Covid-19 pandemic is considered.

- The fifth chapter presents the Human Smart Cities (Human Smart Cities), in which the human being is at the center.

- In the sixth chapter, technological solutions and methodologies are presented in summary for the issues of smart cities that raise concerns.

- The seventh chapter examines the MyData Network solution as a more universal and secure way.

- In the eighth chapter, the example of a Greek smart city, that of Hellinikon, is presented in detail.

- Finally, the paper concludes with the ninth chapter, where the conclusions of the above study are listed, issues for further research in the future and other considerations in relation to smart cities are examined.

Keywords: *Smart city, Internet of things (IoT), New technologies,Innovation, Sustainable development, Ethical Issues*

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Chapter 1

Introduction

1.1 Identify city - Identify Smart

First of all, we should identify what we talk about when we say "city", what "smart" means and what dimension such a word gives to the word "city".

According to *Wikipedia*, the "city" is a large and permanent settlement with many houses, residents and various administrative, financial or other services. Cities generally have extensive housing, transportation, sewerage, utilities, land use and communication systems. Their density facilitates interaction between people, government agencies and businesses, sometimes benefiting different parties in the process. The word "city" comes from the ancient Greek word "polis" (ie, a set of a large number of houses and / or citizens). In Greece a settlement must have at least 10,000 inhabitants in order to be classified as a city, however in other countries, such as Germany, there is no such separation. A city usually consists of residential, industrial and business areas along with administrative buildings and areas, which may cover a wider geographical area (*Πόλη - Βικιπαίδεια*)[1].

The meaning of the word city may seem clear to us, but we can not give a unique and precisely defined definition. This is because the economic, religious, social, ideological and cultural criteria of human coexistence are not always the same. However, it is possible to reach an agreement on some of its features. Initially the city is a permanent settlement, unlike temporary settlements, which are created for

economic and other reasons. A second element of the city is its exterior. The urban landscape is defined in each area by its differences in relation to the rural landscape. It can be the urban organization or the existence of a temple and fortifications. A third and crucial element is the population concentration per unit of built-up area. A fourth element is the definition of the city from specialized urban activities, those that are considered non-agricultural. Care needs to be taken here, because the city is directly dependent on its property status in relation to the surrounding rural areas. Statistics show that it took more than ten farmers to survive in the city during the Middle Ages, let alone in earlier periods of history.

Based on the above we can say that the city in antiquity is a permanent settlement with enough size, structured to serve the collective life. Part of its population - large or small - may be associated with agricultural activities, while its study needs standard reference standards. These standard models are the place and the location, the phases of its development, its functions and urban planning, its sanctuaries, its population, its role in the wider region, its political and economic entity, as well as its role as a metropolis in some cases. In the archaic period the word polis was a special concept that represented the urban area, in contrast to the country that represented the countryside. Its main feature was its political entity, even if it was not suitable to be considered a city, due to its urban planning or lack of public buildings. Thucydides uses the term polis for both the unfortified group of comas and the fortified city. The general use of the word indicates an unbroken development by the primitive rural community as a primary urban center in the city. The parameter of the political entity highlights the role of the influence of the city in the political and social developments of the region (*Πόλις - Βικιπαίδεια*)[2].

Another phrase we meet in ancient Greek times is “city-state”. The term was coined in England in the 19th century and was used especially for the city-states of ancient Greece, Phenicia and ancient Italy, as well as for cities of medieval Italy. The ancient city-states, although showing significant differences in the management policy they follow, present important common features that are mainly based on the existence of:

- Full autonomy

- Administrative and / or religious center, (see citadels or ancient Ziggurats)
- A region that can vary from arable land to secondary cities that serve the commercial-economic interests of the city-state
- Cultivated areas important for the survival of the city

Based on the above, the city-state is an administratively independent city that exercises power in various areas or secondary cities, serving at the same time as a center and guide of political, economic and cultural life (*Πόλη-κράτος - Βικιπαίδεια*)[3].

Going back, Aristotle asserts that all communities aim at some good. The state (polis), by which he means a city-state such as Athens, is the highest kind of community, aiming at the highest of goods. The most primitive communities are families of men and women, masters and slaves. Families combine to make a village, and several villages combine to make a state, which is the first self-sufficient community. The state is no less natural than the family; this is proved by the fact that human beings have the power of speech, the purpose of which is "to set forth the expedient and inexpedient, and therefore likewise the just and the unjust." The foundation of the state was the greatest of benefactions, because only within a state can human beings fulfill their potential.

The good it seeks, which is the well-being of the citizens, is the highest of all the goods of other societies, and with this the "city" pursues the interest of all citizens. On the contrary, other forms of society pursue an individual good in the interest of their members. Aristotle seals the definition of the concept "city" with the characterization of political society, i.e. the state-organized society which has self-sufficiency, autonomy, freedom, institutions and state. It concerns, therefore, the city known as a city-state known to the ancient Greek world. According to Heraclitus and Democritus, the conquest of bliss depends on man himself and his actions. According to Aristotle, bliss is not a state, but a constant energy of the soul with the rules of perfect virtue. Studying the above views, we observe that the term "bliss" refers to the moral life of man. For Aristotle, however, this term has on the one hand a moral content and concerns man as an individual and on the other is the destination of the city, which concerns man as a citizen. In other words, man will

conquer with his moral energies both the individual bliss and the bliss within the city, coexisting harmoniously with the other citizens and acting as a citizen. In this sense, his actions are political acts, as he acts as a member of political society, and have political consequences, as long as they lead to the well-being of the political whole. This view is clearly expressed by Aristotle himself in the seventh book of his "Politics", where he states that the happiness of each person individually coincides with the happiness of the city. Thus, the view is confirmed that moral philosophy is part of political philosophy. Aristotle's position on the construction of the city differs from that of Protagoras and Plato. More specifically, Protagoras's view is that cities were created "law", that is, from the need of humans to be protected from wild beasts and to survive. Plato argued that cities were created because people lacked self-sufficiency and felt the need to help one another. Aristotle, on the other hand, believed that cities were created by the innate tendency of people to coexist with other people in societies organized by state, institutions and laws (man is "by nature a political animal") (*1st Lyceum of Trikala*)[4].

On the other hand the word "smart" has been treated as an adjective, instrumental concept, or a normative concept *(Rasha F. Elgazzar, Rania F. El-Gazzar, 2017)*[5]. As an adjective, smart had several meanings in Oxford and Merriam-Webster dictionaries, such as "mentally alert", "very good at learning or thinking about things", "showing intelligence", "knowledgeable", and "programmed so as to be capable of some independent action". These meanings apply for persons, objects, or places. A smart person is interpreted as either a mentally intelligent and alert or using ICT.

As an instrumental concept, smart means creating "products, services and product-service systems in which ICT plays a major role" *(Höjer & Wangel 2015)*[6], and this concept is more focused on the means, and not the final outcome. As ICT started to reshape our society and "the way we interact with our friends, communities, transportation modalities, homes, offices, and even our bodies" nowadays, smart word is often related to the use of ICT that provides a level of intelligence and coordination of information around us through sensor-based technology *(Stimmel 2015, p.6)*[7]. However, using a smartphone without being connected to the

Internet and interconnected with other mobile devices and/or computers does not mean any smartness; "the novelty is thus not so much the individual technologies, products or services but the interconnection and the synchronization of these and the systems they include, so that they work in concerted action." *(Höjer & Wangel 2015)*[6].

Hence, a smart object (e.g., smart phone) is programmed to act autonomously and intelligently by being connected and interconnected with other objects. A smart place, either a city or a building, is often described as being capable of managing its resources intelligently, and it is often based on the notion of technologically-interconnectedness (i.e., IoT) *(Bonomi et al. 2014; Deloitte 2015)*[8][9].

Doran (1981) has set **SMART** (Specific, Measurable, Achievable, Relevant, and Time-bound) criteria for writing management's goals. SMART criteria model suggests that a goal should be (1) **Specific**: precisely defined, (2) **Measurable**: progress towards the goal can be measured, (3) **Achievable**: realistic and attainable within constraints of available resources, knowledge, and timeframe, (4) **Relevant**: bring the desired social, economic, or environments outcomes, and (5) **Time-bound**: have clearly stated deadlines. From an ICT perspective, the term "smart" in a smart city implies the use of Internet, ICT, IoT, and Big Data. However, from the perspective of urban planning and development, "smart" implies that a city has a key goal to achieve its economic, social, and environmental sustainability and, thus, improve the quality of life *(Albino et al. 2015; Kondepudi & Kondepudi 2015)*[10][11].

There is no universally accepted definition of a smart city. It means different things to different people. The conceptualization of Smart City, therefore, varies from city to city and country to country, depending on the level of development, willingness to change and reform, resources and aspirations of the city residents. Generally, a smart city is a developed urban area that creates sustainable economic development and high quality of life by excelling in multiple key areas; economy, mobility, environment, people, living, and government.

Goals of smart city:

1. Efficiency of services – to optimize the use of public resources and provide a high level of citizen service.

2. Sustainability – to grow and develop the city with strong consideration to environmental impact.

3. Mobility – to make it easy for citizens, workers and visitors to move around in the city, whether by foot, bike, car, public transport etc. (regardless of transportation means).

4. Safety and security – to improve public safety and security in every-day life and at special events, as well as being best possibly prepared for emergencies and disasters.

5. Economic growth – to attract businesses, investors, citizens and visitors.

6. City reputation – to constantly improve the city's image and reputation.

Successful smart city projects, regardless of their core objectives, will help cities get closer to their ultimate goal to improve the overall quality of life, or in smart city terms, "Livability". Next time you hear about a smart city project, it can be helpful to ask yourself which of the six key smart city objectives the project addresses and how it uses sensors, connectivity and data to improve the overall quality-of-life – or livability – in the city *(https://www.axis.com/)*[12].

In general, a smart city is a city that uses technology to provide services and solve city problems. A smart city does things like improve transportation and accessibility, improve social services, promote sustainability, and give its citizens a voice. Though the term "smart cities" is new, the idea isn't. Ancient Roman cities actually used elements of the concept, such as using technology to make their citizens' lives easier. Aqueducts and water drainage systems are just two ways they did that. The main goals of a smart city are to improve policy efficiency, reduce waste and inconvenience, improve social and economic quality, and maximize social inclusion. To understand what a smart city is, it's important to know that "smart" in this context doesn't refer to a characteristic that defines the city, but rather a tool. "Smart" describes the city's ability to create well-being for its citizens. But it's not just about how

citizens benefit from the services the government provides to them. A key element of a smart city is valuing citizen participation. It's centered around the idea that citizens create the city, not the other way round. Cities use this tool to collect data in real time about all kinds of things, including traffic, air and water quality, and solar radiation. With this information, the government can act immediately to solve nearly any problem *(https://blog.bismart.com)*[13].

Smart cities are cities that work. Cities are a confluence of people; places where people live, come to meet, exchange ideas, earn livelihoods, access education, health and other services and enjoy a life of good quality. People are at the core of the city. Therefore, cities should work for their people. Cities that work for their people will continuously become better versions of themselves with each passing day. "We shape cities, and they shape us" (Jan Gehl). Answering the question 'what is a smart city' in another way; it is a city, which is liveable, sustainable and has a thriving economy offering multiple opportunities to its people to pursue their diverse interests *(https://smartcities.gov.in)*[14].

1.2 Historical overview on the smart city concept

The emergence of the smart city concept is narrowly related to the development of city's initiatives to use ICT to solve urban problems. For Kitchin (2013), cities that embrace ICT with management and regulatory purposes have been labeled in different ways. Dutton, Blumler, and Kraemer (1987) called them wired cities, Graham and Marvin (1999) cyber cities, Ishida and Isbister (2000) digital cities, Komninos (2002) intelligent cities, Hollands (2008) smart cities, and Shepard (2009; 2011) sentient cities. While each of these terms is used to conceptualize the relationship between ICT and contemporary urbanism, they share a focus on the effects of ICT on urban form, processes and modes of living, and in recent years have been subsumed within the label smart cities (Kitchin, 2013). The concept of a wired city is blurry. Even if *Dutton et al. (1987)*[15] do not provide a concrete concept of it, a wired city could be related with a concrete set of telecommunications experiments which provides telecommunications services to both households and businesses *(Dutton et al., 1987 in Reese, 1988)*[15]. The concept of cyber cities is focused on the

complex interdependence between transport and telecommunication, the broad links between urban economies and information economy, the relations between urban and cyber cultures based on IT systems, and the ways in which urban communities and virtual—IT-based—communities are interdependently linked *(Graham & Marvin, 1999)*[16]. The digital city "is defined as a city that integrates urban information (both achievable and real time) and creates public spaces for people living in the cities" *(Ishida & Isbister, 2000)*[17]. Intelligent cities refer to places "where the innovation processes meet the digital world and the applications of the information society", which generate digital environments that provide to citizens additional capabilities in handling knowledge and new tools for problem solving, and increases the community's intelligence *(Komninos, 2002)*[18]. A sentient city is a city that is able to hear and feel things happening within it, but doesn't necessarily know anything in particular about them; sentient cities can remember, correlate, and anticipate through the use of technologies such as sensors and algorithms *(Shepard, 2009, 2011)*[19].

In the same vein, *J. H. Lee et al. (2013, p. 2)*[20] posit that the smart city concept originated from various definitions including those of the information city, ubiquitous city, and knowledge city. The information city collects information from localities and delivers it to the public via the Internet *(Chourabi, Taewoo, et al., 2012 in Lee et al. 2013, p. 2)*[21]. The ubiquitous city has been understood as a further extension of the digital or information city in making data ubiquitously available through an embedded urban infrastructure (e.g., through equipment embedded in streets, bridges and buildings) *(S. H. Lee, Han, Leem, & Yigitcanlar, 2008)*[20]. A knowledge city is a city that aims a knowledge-based development, by continuously encouraging knowledge management processes through ICT *(Ergazakis, Metaxiotis, & Psarras, 2004)*[22].

Albino et al. (2015)[10] posit that most of the concepts stated above could fall under the definition of a smart city, which, as I have shown, has several dimensions that cover many areas of urban contexts (e.g., economy, transport). However, one of the first academic works that mention the notion of a smart city was written by Mahizhnan (1999). His article analyses how Singapore was using ICT with economic

and social purposes but he does not posit a definition of a smart city. It was not until 2008 that *Hollands (2008)*[23] wrote a journal article that compiles cases of cities that use ICT with managerial and assessment purposes (smart cities) and summarizes the many labels that up to 2008 have been used to describe these kinds of cities. Moreover, the author describes common elements and debates regarding smart cities.

The literature review related to the smart cities history shows that they emerged as a response of four forces. First, the need for better tools to govern and control urban areas that started to get larger and became overpopulated. This population growth augmented both the demand for superior and efficient public services, safer places, and healthier and environmentally friendly urban centers as well as cities' complexity. Second, the increasing development of computing technologies and ICT. At the begining, these technologies were used for research and military purposes, but as they improved, they started to be used first by technology enthusiasts and pioneer governments (e.g., Los Angeles and Singapore) and then by dynamic and innovative cities (e.g., Bangalore and San Diego). The third force was the growing interest of big IT companies such as IBM, Cisco, Siemens, and General Electric to employ their technology and expertise to improve the cities' management and at the same time gain a new unexploited market. The fourth force was the citizen interest to develop and deploy digital-based applications to make cities more livable. The citizens' willingness to improve the places where they live is not new. However, the Internet, the smartphones, and the mounting availability of data online facilitated the emergence of bottom-up smart city initiatives. In other words, pioneer city managers viewed ICT as a tool to improve and control cities and solve their problems, and at the same time, ICT developed and adapted sufficiently to be useful solving urban problems from the citizens side and IT companies side, which gave rise to smart cities *Montes, 2020*[24].

The major milestones in the smart cities theme, as identified by GlobalData *(https://www.verdict.co.uk/smart-cities-timeline/)*[25]:

- 1974 – Los Angeles created the first urban big data project: "A Cluster Analysis of Los Angeles" report.

- 1994 – Amsterdam created a virtual 'digital city' – De Digital Stad (DDS) – to promote Internet usage.
- 2005 – Cisco put up $25m over five years for research into smart cities.
- 2008 – IBM Smarter Planet project investigated applying sensors, networks and analytics to urban issues.
- 2009 – IBM unveiled $50m Smarter Cities campaign to help cities run more efficiently.
- 2009 – American Recovery and Reinvestment Act (ARRA) provided funding for US smart grid projects.
- 2009 – EU Electricity Directive required EU states to roll out smart meters to 80% of consumers by 2020.
- 2010 – Japanese government named Yokohama as a smart city demonstrator project.
- 2011 – IBM named 24 cities as Smarter Cities winners from 200 applicants.
- 2011 – 6000 visitors from over 50 countries attended first Smart City Expo World Congress in Barcelona.
- 2012 – Barcelona deployed data-drive urban systems, including public transit, parking, and street lighting.
- 2013 – China announced first batch of pilot smart cities, comprising 90 cities, districts and towns.
- 2013 – Mayor of London created Smart London Board to shape London's digital technology strategy.
- 2014 – China launched second batch of 103 pilot smart cities.
- 2014 – Vienna City Council launched Smart City Wien Framework Strategy until 2025.

- 2015 – China announced third batch of 84 smart cities, comprising 277 in all.
- 2015 – India's Prime Minister Narendra Modi launched "Smart Cities Mission" for 100 Indian cities.
- 2016 – Columbus won US Dept of Transportation's $50m Smart Cities Challenge.
- 2017 – UK government launched 5G testbeds and trials programme.
- 2017 – Hong Kong launched smart city blueprint.
- 2018 – Toronto and Google offshoot Sidewalk Labs announced plan to develop smart waterfront area.
- 2018 – London updated 2013 plans with launch of 'Smarter London Together' roadmap.
- 2018 – IESE Business School Cities in Motion Index ranked New York, London and Paris as its top 3 cities.
- 2018 – Singapore won Smart City of 2018 award at the Smart City Expo World Congress.
- 2019 – Ford committed to support Cellular Vehicle to Everything (C-V2X) standard.
- 2019 – Sidewalk Labs' Toronto planning document fiercely criticised over data privacy implications.
- 2019 – G20 nations picked World Economic Forum as secretariat for a G20 Global Smart Cities Alliance.
- 2019 – US Federal Communications Commission picked New York and Salt Lake City as 5G testbeds.
- 2020 – Vietnam to start work on new $4.2bn smart city close to Hanoi, with completion target of 2028.

- 2030 – By 2030, the number of cities in the world with a population of more than 10 million will grow to 43.
- 2050 – By 2050, up to 70% of the world's population is expected to live in cities.

1.3 Problem description - components

So, now we have defined the main terms, we can see clearly what is the "problem" and what are its components. Growing smart cities raise ethical challenges, people should be in the center of investment, fulfilling the purpose of the smart city itself.

We can set the following key principles *(https://www.arup.com)*[26]:

1. Invest in governance
2. Make privacy a priority
3. Be honest about benefits and risks
4. Incorporate ethical considerations into commercial partnerships
5. Use algorithms responsibly
6. Smart city as a means towards freedom or equality or both

Invest in governance. For cities, ethical digital governance will require investing in new skills and leadership, resourcing a team. As it stands, few cities are fully resourced to manage and control the new data gathered from the citizens they serve. Cities need to define a top-level strategy that includes policies on privacy and the ethical use of data.

Make privacy a priority. 'Privacy by design' as well as 'security by design' should be embedded in all services delivered by city government. The public should have the ability to give explicit and informed consent to data collection in the public realm.

Be honest about benefits and risks. When implementing new digital or data-driven services, be clear about the benefits... but also the risks. Eindhoven in the

Netherlands deployed a raft of digital tools – WiFi trackers, microphones, cameras – to try to improve public safety in a city district, but the collection of personal data caused pushback from residents and visitors. There's no trust without honesty about the data collected and used.

Incorporate ethical considerations into commercial partnerships. Cities do need to experiment and work with the private sector, as long as they share data in a fair way that respects ownership, privacy and the wider public good. New models of sharing data between public and private sectors are developing—the City Operating System in Barcelona is one such model, the Alphabet Sidewalk Civic Trust in Toronto is another. Cities will need to evaluate what might work for them in partnership with their partner ecosystems. They'll also need to evaluate supply chain risks associated with data. Some companies may offer services where their business model relies partly or wholly on capturing citizen data. But as data sets get commoditised, or new regulations are introduced, maybe that service provider will no longer be capable of keeping the service going. And advertising-driven business models also might not be sustainable in the long-term. What happens if a service provider suddenly fails?

Use algorithms responsibly. As data-driven services grow, algorithms will play a larger role in decision making, picking winners and losers in new contexts. But placing this responsibility in mathematical rather than human hands poses new dilemmas. What are the algorithm's biases? We can already see the pitfalls of these data-driven tools in the world of recruitment, where recruiters have been accused of automating bias, for example, by not rating candidates in a gender-neutral way. City authorities will face similar ethical challenges soon enough.

Smart city as a means towards freedom or equality or both. Smart city is not a prison for its citizens, observing their lives, making data and leading to conclusions. It's a mean to raise its people, guide them to a better life, to do things for themselves, freely and equally.

Data-driven services and algorithm-powered decision making will usher in many exciting new possibilities for cities. But without 'data trust', advances in services are likely to stir new resentments and reduce faith in political leaders. Faith in political

leaders depends on developing these ideas in ways the public understand and can engage with. The digital revolution will continue. The Internet of Things will grow deeper, more interconnected roots, generating more insights from infrastructure and services. Appealing devices may seduce us into giving up more personal information. The public needs to consider both what it wants and will tolerate.

Chapter 2

Sustainability and Ethical issues

2.1 Sustainability

The rapid urbanization of recent years has brought to the fore the vital concept of the smart city. Since the 1980s, sustainability and the importance given to it have played a major role in the design of smart cities. Modern cities are constantly developing and using more and more natural resources. Minimizing the use of non-renewable energy sources is crucial, as is the preservation of natural heritage and energy sources for the design and maintenance of a sustainable smart city *(De Jong, Joss, Schraven, Zhan & Weijnen, 2015)* [27].

Urban sustainability signals balance within the city. The concept of sustainability refers to the socio-ecological background that ensures the coverage of the basic needs of the population worldwide over the years, in constant balance with long-term ecological stability. In terms of policies to be pursued, the various social, environmental and economic dimensions need to be understood and respected and integrated into the various strategic initiatives worldwide. Natural systems must maintain their quality and be able to continue to provide everything they provide so far without alterations and interventions, thus ensuring the continuity of the human species *(Ferrara, 2015)* [28].

Because of human influence, *Barnosky et al. (2012)* warned that the impending global crisis is considered irreversible. They predict a "turning point", which will

be caused by humans and the biological changes they cause and which threaten the earth's ability to sustain humans and other species. The natural wealth inherited from generation to generation should remain the same without fluctuations that can play a catalytic role in its prevalence and development. In addition, when we talk about sustainability, we are talking about equal access to the resources provided to generations, providing all people with water, shelter, food, work, a sewer system. *(Barnosky, Hadly, Bascompte, Berlow, Brown, Fortelius, 2012)* [29].

The above are taken for granted in developed countries, but unfortunately they are not an acquis of many regions that are still under development. These inequalities must be taken into account and addressed as soon as possible. Once they are gone, the dialogue on the sustainability of cities worldwide and the equality of peoples in terms of their viability can continue.

2.1.1 Pillars of the Smart City

A basic condition for the evidence of the smart city is the coexistence of four pillars, which are supported in the first phase by the participation of society and the further financial support of the project by private and public bodies. Institutional, material, social and economic infrastructure, are considered as the four pillars of development of a smart city *(Silva, Khan & Han, 2018)* [30]. The existence of the Smart City is based on them and through them the possibility of its development is provided. The partnership of public power (institutional infrastructure), with society as a whole (social infrastructure), with the use of investment capital (financial infrastructure) and the utilization of physical structures (material infrastructure), create the starting point for the integration of specialized technological features of smart cities in this proposed ecosystem.

Institutional infrastructure. The institutional infrastructure concerns the governance of the city as well as the services it offers to its citizens, aiming at the best and most reliable service. Refers to uses related to the administration and executives of a city. Governance structures must therefore be citizen-centered.

Physical infrastructure. Physical infrastructure is related to natural resources

and facilities and is responsible for ensuring the sustainability of these resources. It mainly concerns transport and connectivity. ICT infrastructures play an important role, as their quality utilizes the performance of the Smart City. In addition, due to severe environmental pollution, physical infrastructure is turning to green buildings and renewable energy sources (smart energy) to solve this problem.

Social infrastructure. Social infrastructure concerns all those elements which are responsible for the development of human and social capital. These elements are health care, education and the provision of amenities and entertainment. These determine the quality of life in a city. Therefore, social infrastructure is perhaps the most important pillar, due to the vital importance for the development and sustainability of the city.

Economic infrastructure. Developing a smart city that can create opportunities and attract investment requires a basic economic infrastructure. Financial infrastructure is linked to the integration and use of advanced technologies, which enhance the efficiency of financial management. The goal is to create a high quality living environment using the right design and the right investments. In addition, the use of e-commerce and e-business contribute to increasing the productivity of the city's economy *(Lea, 2017)* [31].

2.1.2 Characteristics of Smart Cities

The characteristics of Smart Cities or otherwise, the architectural composition, are the essence of such a city. Specifically, these are projects that specialize and integrate technologies in such a way as to make a city smart *(Negara & Emanuel, 2019)* [32].

These characteristics of Smart Cities, according to the report of the European Union 2014 *(Manville, Cochrane, Jonathan, Millard, Pederson, Thaarup et al., 2014)* [33], are divided into 6 categories and determine the model of Smart Cities:

- Smart economy
- Smart people
- Smart mobility

- Smart living
- Smart governance
- Smart environment

Smart economy. By "smart economy" we mean e-business and e-commerce, increased productivity, advanced production and services through ICT and advanced technology, innovation with ICT technologies, and new products, new services and business models. This form of economy also installs intelligent clusters and ecosystems (e.g. digital business and entrepreneurship). The smart economy also implies local and global interconnection and international integration with natural and virtual flows of goods, services and knowledge *(Appio, Lima & Paroutis, 2019)* [34].

Smart people. By "smart people" we mean e-skills, access to education and training, human resources and skills management, in an inclusive society that fosters creativity and promotes innovation. As a feature it can also allow people and communities to enter, use and personalize data. For example, through appropriate data analysis tools and dashboards, people make decisions and create products and services *(Bawany, & Shamsi, 2015)* [35].

Smart mobility. The term "smart mobility" refers to integrated and ICT-supported transportation and logistics systems, including buses, trains, subways, cars and bicycles, providing a sustainable, innovative and secure transportation system. Smart mobility prioritizes clean and largely non-motorized options. Stakeholders can access relevant information in real time, in order to save time and improve travel efficiency, save costs and reduce CO2 emissions. Mobility users may also provide their own real-time data and contribute to long-term planning.

Smart living. By "smart living" we mean the forms of living, behaviour and consumption that ICT allows. "Smart Living" is also a healthy and safe way of living in a culturally vibrant city with a variety of cultural facilities that incorporates superior quality housing and accommodation. It is also associated with high levels of social cohesion in aspects such as culture and education, health conditions and healthcare, security and housing *(Appio et al., 2019)* [34].

Smart governance. The term "smart governance" describes governance inside and outside the city, including services and interactions that connect and, where appropriate, integrate public, private, civil and European organizations so that the city can function effectively as an organization. The main tool for achieving this goal is ICT (infrastructure, hardware and software), which are assisted by intelligent processes and interoperability and powered by data. International, national and local connections are also important as a smart city could be described as a global web hub. This involves public, private and urban partnerships and cooperation with various bodies working together to pursue smart goals at the city level. Smart goals include transparency and open data through the use of ICT and e-government in participatory decision-making processes and e-services *(Walravens & Mechant, 2018)* [36].

Smart environment. The term "smart environment" refers to smart energy, including renewable energy sources (RES), ICT-backed energy networks, the measurement, control and monitoring of pollution, the renovation of buildings and amenities, green buildings, green urban planning, as well as efficiency of the use of resources, reuse and replacement of resources that serve the above objectives. Implemented examples of the above are municipal services such as street lighting, waste management, drainage systems and water resources systems monitored to evaluate the system, reduce pollution and improve water quality *(Bawany, & Shamsi, 2015)* [35].

The term urban sustainability is a term that is understood as a concept that concerns the social, economic and physical organization of the cities and the populations living in them in such a way as to meet the needs of the current generation, but also of the next ones, in a way that the environment and its functions will not be affected as the years go by. The sustainability of cities presupposes the promotion of global sustainability, the cooperation of countries with respect for the environment and man. Actions will obviously differ from region to region and will be influenced by the culture and particular characteristics of each population, but this also creates a background of mutual respect and fruitful cooperation with a view to adopting common policies *(Barro, Degila, Zennaro). & Wamba, 2018)* [37]. Governments are not only local, but their influence extends far beyond their borders and this

Figure 2.1: Interdependent dimensions in a sustainable smart city

marks the beginning of a new era in which peoples will have set other priorities for the future at a time when the world economy has reached the point where to cause urban change (especially in the richest countries) and thus marginalize the various environmental factors *(Castelnovo, Misuraca & Savoldelli, 2016)* [38].

From the above, it follows that the sustainability of cities is not an element that necessarily coexists with the characteristic of "intelligence" of cities. Sustainability and intelligence are two different elements, which need to be reconciled in order to say that a city has a future and possibilities in terms of its development. A smart city that relies solely on its technological and economic achievements could not survive without the natural world and its people. The essence of the creation of cities is man and his quality of life, therefore cities must functionally meet the needs of citizens and citizens in turn must respect the environment around them *(Ferrara, 2015)* [28].

2.2 Ethical challenges

Fostering the development and applications of data science while ensuring the respect of human rights and of the values shaping open, pluralistic and tolerant information societies is a great opportunity of which we can and must take advantage *Floridi, 2016*[39]. Social acceptability or, even better, social preferability must be the guiding principles for any data science project with even a remote impact on human life, to ensure that opportunities will not be missed. On the other hand, overemphasizing the protection of individual rights in the wrong contexts may lead to regulations that are too rigid, and this in turn can cripple the chances to harness the social value of data science.

In a few decades, we have come to understand that it is not a specific technology (computers, tablets, mobile phones, online platforms, cloud computing and so forth), but what any digital technology manipulates that represents the correct focus of our ethical strategies. The shift from information ethics to data ethics is probably more semantic than conceptual, but it does highlight the need to concentrate on what is being handled as the true invariant of our concerns. It is not the hardware that causes ethical problems, it is what the hardware does with the software and the data that represents the source of our new difficulties. Data-centric level of abstraction (LoAD) brings into focus the different moral dimensions of data. In doing so, it highlights the fact that, before concerning information, ethical problems such as privacy, anonymity, transparency, trust and responsibility concern data collection, curation, analysis and use, and hence they are better understood at that level.

In the light of this change of LoA, data ethics can be defined as the branch of ethics that studies and evaluates moral problems related to data (including generation, recording, curation, processing, dissemination, sharing and use), algorithms (including artificial intelligence, artificial agents, machine learning and robots) and corresponding practices (including responsible innovation, programming, hacking and professional codes), in order to formulate and support morally good solutions (e.g. right conducts or right values). This means that the ethical challenges posed by data science can be mapped within the conceptual space delineated by three axes

of research: the ethics of data, the ethics of algorithms and the ethics of practices.

- The **ethics of data** focuses on ethical problems posed by the collection and analysis of large datasets and on issues ranging from the use of big data in biomedical research and social sciences, to profiling, advertising and data philanthropy as well as open data. In this context, key issues concern possible re-identification of individuals through data-mining, -linking, -merging and re-using of large datasets, as well as risks for so-called 'group privacy', when the identification of types of individuals, independently of the de-identification of each of them, may lead to serious ethical problems, from group discrimination (e.g. ageism, ethnicism, sexism) to group-targeted forms of violence. Trust and transparency are also crucial topics in the ethics of data, in connection with an acknowledged lack of public awareness of the benefits, opportunities, risks and challenges associated with data science. For example, transparency is often advocated as one of the measures that may foster trust. However, it is unclear what information should be made transparent and to whom information should be disclosed.

- The **ethics of algorithms** addresses issues posed by the increasing complexity and autonomy of algorithms broadly understood (e.g. including artificial intelligence and artificial agents such as Internet bots), especially in the case of machine learning applications. In this case, some crucial challenges include moral responsibility and accountability of both designers and data scientists with respect to unforeseen and undesired consequences as well as missed opportunities. Unsurprisingly, the ethical design and auditing of algorithms' requirements and the assessment of potential, undesirable outcomes (e.g. discrimination or the promotion of antisocial content) is attracting increasing research.

- Finally, the **ethics of practices** (including professional ethics and deontology) addresses the pressing questions concerning the responsibilities and liabilities of people and organizations in charge of data processes, strategies and policies, including data scientists, with the goal to define an ethical framework to shape

professional codes about responsible innovation, development and usage, which may ensure ethical practices fostering both the progress of data science and the protection of the rights of individuals and groups. Three issues are central in this line of analysis: consent, user privacy and secondary use.

Data ethics must address the whole conceptual space and hence all three axes of research together, even if with different priorities and focus. And for this reason, data ethics needs to be developed from the start as a macroethics, that is, as an overall 'geometry' of the ethical space that avoids narrow, ad hoc approaches but rather addresses the diverse set of ethical implications of data science within a consistent, holistic and inclusive framework.

2.2.1 Ethical issues in smart cities

Considering the smart city from the perspective of public ethics, social ethics and ethics of computing systems, it is possible to immediately highlight some ethical issues that should receive due attention.

In principle, there is a gap between the intended goals of smart cities and the means used. In the commercial context of the smart city, the means can quickly become an end in themselves. Also, digital devices make it possible to collect a large number of digital traces and associate them with the physical space. This growing integration between the physical and digital worlds is modifying their relationship and raising the issue of respect for privacy (Venkataramanan, 2014). Furthermore, it is necessary to distinguish "narrow" issues, concerning the consequences of individual applications, from more general issues. This concerns the social consequences arising from the aggregation of applications and components of a system. In addition, the very definition of a smart city and the design of related applications are still heavily controlled by the private sector. Therefore, important issues will need to be resolved, especially regarding the private sector's control over data and public services. Finally, the smart city generally aims to leave more space for the citizens and, consequently, to be more democratic. However, this is not self-evident. On the one hand, new forms of participation or consultation are based on parameters

that do not necessarily ensure the inclusion of all stakeholders. The very definition of these parameters is a political issue. On the other hand, the smart city is often accompanied by a more technocratic model of governance, which stands in contrast to other participatory and deliberative modes *(Batty, Axhausen, Giannotti, Pozdnoukhov, Bazzani, Wachowicz, & Portugali, 2012)* [40].

2.2.2 The gap between means and resources

The smart city mobilizes a set of rather ambitious goals in relation to the applications offered today: optimization of resources, improvement of the quality of life, citizen participation, transparency, sustainable and open governance, increased accessibility to public services, smart mobility, etc. These goals, which remain relatively abstract, signal both the ideals to be pursued and the possibilities offered by technologies, when used properly.

However, setting more precise goals and operational alignment is often overlooked. High-tech companies focus on promoting the applications they produce, without always having a critical counterweight. The danger that lurks is the eventual legalization of large investments in the future, without actually realizing the expected benefits for citizens (Venkataramanan, 2014). There is also a gap between two distinct concepts or dimensions of the smart city: the social city and the digital city (Batty et al., 2012). The first case refers to a city that listens to its citizens, that responds to their requests, that is endowed with a good cultural offer, where every citizen feels safe, moves easily, etc. On the other hand, the digital city refers to the whole digital knowledge, devices and technological innovations that characterize smart cities, such as interdependent urban infrastructures, connected road equipment, data and open access network, data transmission network, etc. Digital city devices are justified only as tools for the social city and as therefore, they should be evaluated according to the purposes of the social city. There is a significant risk of overlooking this duality within the smart city. It is also pointed out, the technological challenge, which consists in achieving a technological feat, ignoring the status of technology as a means and the ends to which it must be subject. This context can quickly be marked by a technological determinism, according to which the appli-

cations on offer determine the scope of cities' possibilities *(Venkataramanan, 2014)* [40].

It is also important to reflect on whether the digital city is really the best vehicle for realizing the smart social city, especially considering the large sums invested in digital and other technological innovations. However, this is not simply a question of whether smart city tools are effective. It is generally easy to demonstrate that they produce concrete results that significantly improve the quality of life in cities. The question is whether better results could not be achieved with the available resources, or whether they could be implemented in a way that would be more in line with today's values and principles *(Batty, 2013)* [40].

For example, one of the principles of the social smart city is sustainable development. However, among the applications that appear most often are those that facilitate road networks and traffic on them, providing solutions to the problem of traffic congestion, parking, etc. More generally, a perception that perhaps should change is that for every urban problem, the best, if not the only, solution is technological. According to Hollands, cities face a myriad of problems, and contrary to prevailing ideology, not all problems offer a technological solution (Hollands, 2015). Furthermore, Sassen (2011) points out that it is important to urbanize technology instead of resorting at all costs to technologies that de-urbanize cities.

2.2.3 Digital traces, law and privacy

The smart city is based on a technological infrastructure consisting of different types of sensors, computer support, wired or wireless information transfer networks, etc. It is also based on the use of software, mobile applications, data processing tools, dashboards, etc.

The dominant smart city model is one that collects a wide variety and large volume of data in order to maintain and analyze it. This "panoptic" way of managing data is not the only one, even if it seems to be the ultimate goal. It currently coexists with other more diffuse and collaborative modes, not directly controlled by municipal authorities (Batty et al, 2012). The questions that will need to be answered in the

future are: a) who should own the technological devices and the data collected and analyzed, and b) how should this data be managed.

These issues are critical, as they can have significant implications, especially regarding the potential for technologies to become a means of tracking and categorizing citizens (Kitchin, 2014). Moreover, all this aggregated information opens the door to multiple potential uses, which cannot be fully predicted at present *(Sadowski & Pasquale, 2015)*[41].

Therefore, an issue of particular concern is that of the digital "traces" that each one leaves everywhere, which digital traces are increasingly collected and completely out of our control. Each citizen's digital identity can no longer be considered a separate part of their personal identity, but this still does not raise concerns. There is now a direct intersection between the digital world and physical spaces, and therefore between the online life and the real life of individuals. Thus, the digital and physical worlds are increasingly intertwined. Smart city environments, generally promoted, are inseparable from this phenomenon. Devices and applications developed in smart cities focus on monitoring, tracking and geo-locating the person, anywhere and anytime. The physical location of the individual is linked to the other traces he leaves in the digital world and there is almost no way for the citizen to control or manage all the details concerning him *(Sadowski & Pasquale, 2015)*[41].

The situation described above has two consequences, which directly concern private life, but also respect for the individual's autonomy. The first consequence concerns the social and spatial sorting that can emerge from the collected data and analyzed traces. The proliferation of surveillance cameras and connected objects, combined with the ability to geolocate people who are in a given place, at a given time, and to monitor their behavior on social networks, opens up unlimited perspectives, if the use of these media is justified, for example, by security reasons. Mass data collection would indeed make it possible to determine patterns of individuals' mobility behaviors. From this point to identifying individuals and sorting them according to whether they are inside or outside the sociospatial normality, there is only one step. Already, a deviation from behavior patterns that are considered normal is quickly perceived as illegal behavior *(Cosgrave & Tryfonas, 2012)*[42]. This trend is

likely to be greatly enhanced by the normative use of patterns from data analysis. Thus, from the standards developed, the temptation would be great to determine in a normative way standard behaviors, to impose standards of behavior according to various places, days of the week, etc.

The second consequence concerns the algorithmic personalization of spaces. Thanks to people's digital footprints, internet spaces learn about them and offer them, with algorithmic personalization, the environments that are closest to their expectations. In successive iterations, the sites each one visits improve what they provide them to see. However, doing so contributes to the gradual narrowing of one's scope and ability to discover new things. In the near future, in urban environments based on so-called smart sensors, communicating connected objects, everyone will be detected and identified, just like on the internet, once they reach a place. The algorithmic personalization of these places - a programmatic of urban places in a way - will then be put into action (Rabari & Storper, 2015): billboards, ambient information (music, advertising, etc.) and notifications on phones or tablets, they can be reshaped at the pace of the evolution of the urban behaviors of the citizens and according to the people present at a given moment.

Finally, all technologies used are at risk of errors or other failures, experiencing compatibility and interoperability problems, and even being subject to cyber-attacks (Kitchin, 2014). Thus, in addition to the already alarming possibilities of surveillance and control mentioned above, there is still a question that needs attention: what consequences could these failures or errors of the technologies used have (consequences related to possible problems in the quality of the data that are also collected in the decisions of municipal authorities or automated algorithms) *(Sadowski & Pasquale, 2015)*[41].

2.2.4 Broader and specific ethical issues

The social and spatial sorting enabled by apps, which collect and process geo-location data of people in public spaces, not only reinforces already existing practices, such as determining what behavior is considered acceptable in a given place

and time. In fact, they risk legitimizing these practices. Considering the potential social consequences of the smart city, it is important to distinguish between the different types of ethical issues raised by the smart city in broader and specific issues.

The smart city is not a complete system or device in itself. Rather, it is a very diverse set of innovations, technologies, knowledge and devices. Nevertheless, the analysis of the ethical issues raised by the innovations and technological devices related to the smart city, should not be based on a narrow understanding of ethics and conduct a piecemeal assessment. This would run the risk of reducing the work of ethical analysis and reflection in the institutional model of project approval or through certain technology assessment mechanisms. However, this model cannot be applied as it is in the field of digital innovation. Indeed, it would be problematic for each new innovation or technology to be individually scrutinized by the ethics committee and therefore validated without considering the consequences arising from their aggregation *(Cosgrave & Tryfonas, 2012)*[42]. However, there is another type of problem, which is related to the systemic dimension of the smart city or the aggregation of its devices. Adopted applications can, together, have extremely significant impacts on citizens' lives without them really having a chance to think about it. For example, each of the devices associated with one's phone, is not just a means to achieve a certain goal, but is additionally, the imposition of a certain way of life. All these devices produce a new way of life (Hollands, 2015), which risks completely escaping a real moral and democratic reflection.

Therefore, it is important that everyone has the means to be informed and to reflect specifically and more generally, to assess the overall consequences of said technological tools, but also to act collectively, regarding the kind of society in which they wish to live.

2.2.5 The potential and impact of the private sector

A serious risk posed by the use of technology in a smart city is the privatization of public services, which would result in undue influence of interested companies on

public policies. For the most part, smart city devices are not only sold or leased by private companies, but their uses are also licensed and managed by these same companies, which raises important questions regarding the ethics of public policy. Indeed, the integration of physical and digital data is often carried out by third parties from the private sector, which can have serious consequences (Batty, 2013).

First, the accumulated information about citizens goes through private settings. There is an important principle that smart city devices often seem to violate: the data generated when citizens use public services is also publicly owned and under public control. The danger here is that this data provides private companies with valuable information about citizens' preferences and behaviors for free, but without their consent. The question of the accessibility of public data and its use for commercial purposes is a broader issue that needs special attention.

Second, access to services may depend on mobile applications whose primary purpose is commercial, which raises a potential conflict between the objectives of the customer - the public - and the objectives of the provider - the private sector. In particular, this enables companies responsible for technological solutions to influence the direction and details of public services. At the various stages of design, development and production, the companies involved make choices that have a political impact and that risk deviating from the needs of the population and the public interest (Kitchin, 2014). Indeed, these companies act rather within their own profit logic. This objective is perfectly legitimate, but it should not weaken or replace the logic of the public sector.

Third, smart cities can quickly become dependent on external providers to provide public services (Cosgrave & Tryfonas, 2012). This leads to two additional risks: obsolescence and technological lock-in (Mason, 2015). Private companies have an interest in ensuring that the technologies provided have a limited level of flexibility and must be updated quickly. Moreover, it is not easy to abandon a technology that was too expensive, which then forces every new technology to adapt to it, allowing the responsible company to make significant profits in the long run, but which also creates a significant block to any innovation. This leads to technological lock-in (Mason, 2015).

Therefore, a reflection on the mode of governance related to the awarding of contracts, the monitoring of projects, the devices themselves and the data produced is necessary from the outset.

2.2.6 Societal inclusion & human centric design

One of the great promises of the smart city is that of more transparent management of public affairs, which will respond better and faster to citizens' requests and needs. Thus, for many, the very legitimacy of the smart city rests on a genuine openness to citizen participation. Some initiatives related to the smart city model seek to include citizens' perspective and expertise in decision-making and joint problem-solving (Sadowski & Pasquale, 2015).

The democratic dimension of the smart city, as promoted today, generally includes two basic principles:

(A) the accessibility and availability of data for different users (open data)

(B) public participation in decision-making through digital platforms.

A typical example of the application of these principles are the initiatives in the city of Montreal. An open data portal has been brought online there that can be reused by individuals, organizations and businesses to learn more about their city and its governance, and to design applications for other citizens to use (Simard, 2015). Also, several Montreal municipalities used the Budget citoyen application to conduct a new form of public consultation. On the one hand, this application offers an opportunity to educate citizens about the reality of city or municipality budget planning by asking the citizen to make choices within a given budget and seeing the effects of their choices on the various funds of the budget. On the other hand, it allows the administration to better understand the needs and preferences of its citizens by examining the choices made by the participants (Simard, 2015).

This change in the decision-making mechanism and the exercise of power itself would give more power to citizens. However, this aspect of the smart city is more demanding for public authorities and may lead to some resistance on their part due

to the fear of losing power.

In addition to the risk of private control over public affairs, which directly concerns the issue of the risk of democratic diversion of the smart city, there are other issues. First of all, the question arises whether the participatory methods of the smart city really promote the representation of the population and the participation of citizens, or whether a first division is caused between citizens who have the technological tools to participate in the various forms of consultation and those who do not have the ability to do so. The same applies to decision-making mechanisms (Hollands, 2015). The users of the technologies and services being evaluated are not necessarily the same, just as the citizens who tend to participate in consultations, whether online or more traditional, are not always representative of the general population. In addition to the issue of access to tools, there is thus the issue of agreement between the group the city is targeting and the one it will actually join. Finally, another concern concerns the gap between the demands or needs of real people and the data collected by cities, which are limited to quantified parameters. Thus, the citizen as an individual is removed from the public debate, while administrations focus on a set of parameters, measured quantitatively (Sadowski & Pasquale, 2015).

Hence, a second set of concerns about the democratization of the smart city arises: there is a fear that the smart city will give too much space to a technocratic style of management, based on objective information, at the expense of other more political and participatory modes of governance. It can also create a political environment where the various issues within a city are seen as technical problems that technology can solve. This is done at the risk of overlooking their deeper causes and political and social tensions, which are not necessarily manifested by the data collected (Kitchin, 2014). One can then ask whether the citizen really participates in the decisions, in a democratic process, or whether the relationship remains one-way and the citizen is in fact only an additional source of information for the public administration. Advancing this collective, one can wonder if the citizen does not ultimately become an obstacle or limitation in the implementation of the smart city (Hollands, 2015).

Chapter 3

Smart city across space and time

3.1 Smart cities history

Looking at the evolution of the smart city phenomenon to date, different models are identified, each reflecting different ideals for the smart city (Mueller, 2017). The three major models and the corresponding generations of smart cities are:

(A) Smart Cities 1.0 (”techno-city”): a technology-centric vision for smart cities led by major technology companies, aiming to create efficient and innovative cities.

(B) Smart Cities 2.0 (”Contributing City”): a government-led vision for using technological solutions to improve the quality of life.

(C) Smart Cities 3.0 (”e-city”): a people-centric vision of smart cities based on co-creation with citizens, aiming to improve quality of life and well-being *(Zhao, Fashola, Olarewaju & Onwumere 2021)* [43].

(A) Smart Cities 1.0: ”techno-city” or the smart city of technical systems

A key principle of this smart city model, defined by technical systems, is that infrastructure defines the capabilities and drives the smart city. In the ”techno-city” are grouped all models produced by technical systems: city of sense, city of sensors, city of network systems, ubiquitous city, etc. *(Katz & Bradley, 2013)* [44]. The

techno-city is first chronological smart city, produced by equipment manufacturers. It is this dimension that largely establishes the very possibility of the smart city, because without technical systems and sensors, the construction of data and the circulation of information is impossible. Many models of the smart city thus highlight sensors as structural tools. Thanks to them, the entire urban environment is monitored. Measuring car flows, measuring energy consumption flows, measuring the number of travelers waiting for subway, bus, etc. *(Lee, Hancock & Hu, 2014)*[20].

These smart city models are high-tech community models and are being developed in Songdo (Korea), Masdar (United Arab Emirates), Putrajaya (Malaysia) or even PlanIT Valley (Portugal). New neighborhoods in kit form, and even entire cities, designed around the necessary monitoring infrastructure, are currently being designed as prototypes *(Brown, 2008)*[45].

A prime example of Smart City 1.0. is the city of Songdo, the city that sees everything. Sondgo, Korea, is a business center developed by a private consortium led by Gale International. The entire area is monitored in order to optimize its operation, especially in terms of energy, because Songdo wants to be the greenest city in the world *(Baek, 2015)*[46]. Built by equipment manufacturer Cisco, Songdo offers solutions for all aspects of daily life. An operations center gathers information and manages city operations. From there, for example, energy networks are managed according to consumption analysis in real time. Since the vehicles are equipped with RFID chips, the center provides reliable information on traffic conditions and optimizes the operation of traffic lights. On the streets, cameras detect the flow of pedestrians and adjust public lighting accordingly *(Baek, 2015)*[46].

This type of city is also called the "ubiquitous city" or U-city, because it is based on ubiquitous computing characterized by a constant presence of information, which is produced by the interaction between mobile terminals (smartphone, pad, etc.) and objects that they communicate. It is a centralized model, as it is designed around one or more control points, depending on what is at stake (transportation, security, etc.). These urban control centers gather information to embody a new dream of governmental utopia, in the sense that decision-making becomes essentially technical and no longer political *(Komninos, 2019)*[47].

Figure 3.1: Songdo Smart City

Source: https://www.bmw.com/en/innovation/smart-cities.html

Several criticisms have been leveled against this model of a hyper-technological and centralized city, which are summarized below:

- Gated tech communities, effectively excluding those who don't connect.
- "Big brother" cities, which violate the principles of individual liberties, since everyone's activities are tracked.
- Rigid models whose over-design hinders urban development. The technologies developed in the city must be adaptable in order to respond to its complexity, while it is pointed out that people prefer an open and undefined city, allowing them to make their own mark.
- Cities that limit people's experiences. This information-rich city may do nothing to help people think for themselves or communicate well with each other, who develop a passive attitude, since everything is planned and they do what is planned. These are smooth cities where nothing breaks the predictability *(Kitchin, 2014)*[48].

(B) Smart City 2.0: The "contributing city"

Smart City 2.0 emphasizes public administration and uses modern technologies starting from local authorities and introducing new solutions, with the aim of improving the quality of life of citizens.

In this second model, the infrastructures are as neutral as possible, in the sense that they do not cause a specific use: they are open and interoperable, allowing actors an easy appropriation to retrieve the data produced and propose applications. This model is characterized by a smaller institutional presence, be it public bodies or large digital companies *(Mezher, 2011)*[49]. This is a collaborative model that differs from the more passive contributory form, often cited by operators who limit user participation to the exclusive retrieval of the data they produce (geolocation, markets, etc.).

This version of the smart city is based on two types of factors:

1. people who contribute to the production of data and services

   Users/residents, individually or gathered in associations, produce or co-produce the services, even the common goods, from the available data. This form of smart city makes its inhabitants more resourceful by giving them access to more reliable, personalized and real-time information *(Swilling, 2011)*[50]. This is what will allow them to become more creative and at the same time claim their position as co-creators of the city (Kitchin, 2014). Bureaucratic versions of the smart city do not recognize the contribution of very accessible and low-cost technologies, already in people's hands: open-source solutions to monitor air quality, open data tools to improve transparency in public policy, hacking processes in social innovation workshops, digital co-creation projects in public services, media interfaces and other connected objects that promote social interaction in public spaces, digital construction, etc. *(Kitchin, 2014)*[48]. In this model, the city dweller can become one of the tools that document the smart city. Citizens act as "citizen-sensors" who generate the data. Either the person is passive but agrees to share the data they produce (e.g. their car trip data, etc.), or they actively participate (e.g. flagging specific urban problems). Many applications have been developed around the world, whether it is to fight air pollution (CitizenAir, Citypulse, etc.), or to fight corruption and insecurity (Reportes en Distrito Federal, México, RETiO) or to monitor the environment *(Lee et al., 2014)*[20].

2. middlemen, who connect the collaborative economy

   These users take advantage of the business opportunities created by infrastructure (broadband network coverage, open data, etc.) to offer new services. There is talk of peer-to-peer (p2p), a "horizontal" economy, with or without currency exchange. The common point is that people, who are not professionals, do things together, resort to each other, often through digital platforms (Kitchin, 2014). These connected users contribute to the production of open solutions, either free or paid, for established classical service companies. Typical examples are Airbnb, an alternative platform for offering accommodation in private homes or even Uber, a platform for urban transportation (taxi).

Various criticisms have been leveled against this model, listed below:

- Limited participation and generation of solutions by users. Indeed, there is little original among the smartphone apps offered in the cities that publish their data. Apart from a large number of applications dedicated to mobility (bus, metro, bicycle), almost nothing comes from the users themselves, while institutions (tourist offices, museums, airports, theaters, etc.) or private companies have caught up and they now produce most of the content. The "contributor" of the urban system is a marginal reality related to the mass of users, who are however unable to produce a program, while on the other hand they require applications that are easy to use and increasingly efficient *(Swilling, 2011)*[50].

- The trap of overestimating participation. Placing too much importance on participation may overestimate the time citizens will have to spend in the city. Only people familiar with technologies will adhere to this techno-participation, while urban citizens, maintaining a utilitarian approach, may mobilize only occasionally *(Swilling, 2011)*[50].

Based on the above, if the smart city refers to the utopia of a technical solution that answers all the issues posed by common life in the narrow space of urban complexes, the "contributing city" model refers to a double utopia. First, that of

generalized participation as a mode of organization. Then, that of the extent of joint appropriation of know-how *(Mezher, 2011)*[49]. While it is possible to stimulate technical collaboration, the average user today produces very little software or applications.

Other caveats are aimed at the sharing economy. Its large-scale development by large companies causes some concerns. Some see in this the triumph of neoliberal ideology *(Mezher, 2011)*[49]. This smart city model centered on the collaborative economy brings to the fore forms that disrupt the traditional economic ecosystem and raise serious questions.

(C) Smart City 3.0: The "electronic city" (e-city)

This city model is equipped to enhance governance with open platforms and participatory forms, from the bottom up. The "electronic city" brings together all the concepts that give the public body the driving role in organizing the digital tool for the benefit of the "smart governance" of the city. With this understanding, the digital medium is a tool in the service of urban management, even the production of the city, connecting public bodies and residents. It is no longer a question, as in the first model, to entrust the management of the flows to a central control unit, nor, as in Smart City 2.0, can users co-produce a solution. In Smart City 3.0 the goal is to create the conditions for joint management. So, the smart city is the one that will manage the creation of a digital public space *(Katz & Bradley, 2013)*[44].

While the system is driven by institutions, it relies on open formats and public data, as it aims for citizen participation. In this sense, the e-city is the city that is digitally equipped to enhance the power of citizens to act. The role of the institution is changing, it is less one that plans, decides and produces, and more one that sets a direction and connects, directs, advises *(Ranchordás & Klop, 2018)*[51].

In this model, the principle of open government prevails, including the open government partnership approach. The aim is to strengthen the use of new technologies to modernize public action and improve citizen participation. The concept of open government, based on the notion that if data is public, it better benefits the effectiveness of public management, this can be applied at the national scale and locally *(Lee et al., 2014)*[20].

The "electronic city" (e-city) is the open city with open data. Behind the problem of data governance (integrated model vs. open approach), a political question arises: what is the role of the public actor in the era of the smart city and how can the emerging dynamics be harnessed without recapturing the (digital) dominance of users exploitation of the smart city. In this sense, the "open" city model seems to offer an alternative for the future *(Katz & Bradley, 2013)*[44]. The purpose of open data analytics is to profoundly transform the effectiveness of public policy. However, efforts should be made to give meaning to big data in order to find levers to improve the effectiveness of public policies: defining and monitoring important indicators, evaluations of interventions, etc.

Criticisms leveled against this model relate to:

- Equal access: the question that arises is how to ensure that every citizen has access to the digital tools and know-how that will allow them to appropriate the standards used.
- Data confidentiality: it raises the question of how the public body can guarantee users that the data they collect will not be used for purposes they do not want, nor will it be diverted or sold.
- Lack of interoperability of different systems and platforms.
- The complexity of big data: the question arises as to how the masses of collected data can gain meaning. In particular, two risks are identified: a) the difficulty of choosing the right indicators and b) the attachment of interest to the indicators may not allow the identification of other issues that may arise *(Kitchin, 2014)*[48].

To summarize, the three types of smart cities mentioned above reveal three dominant operators:

- In the first model (Smart City 1.0), it is the equipment supplier that directs the use of the smart city, designing the city's instruments and data collection and management systems.

- In the second version, (Smart City 2.0), the emphasis is on the user-resident. The city either organizes itself, individually or collectively, or thanks to third parties promoting links, being one of the hubs of the network.

- Finally, Smart City 3.0 is based on the public agent that organizes the digital tool for the benefit of intelligent city governance *(Zhao et al., 2021)*[43].

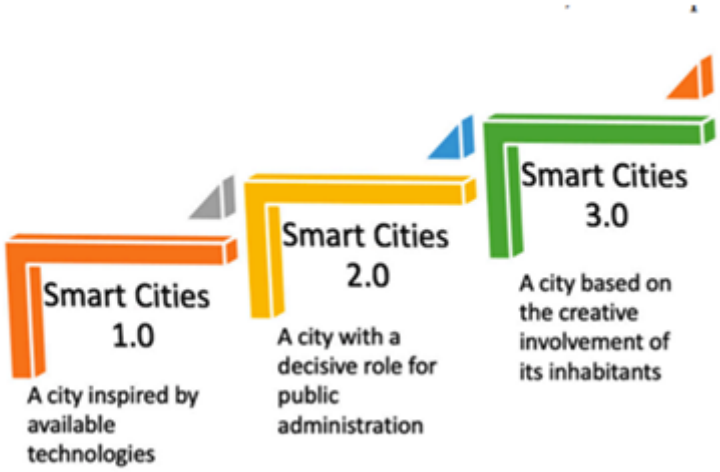


Figure 3.2: Levels of Smart City development

Source: Cliche, Roche & Turmel, 2016[52]

Looking at the previous three generations of smart cities, it appears that the direction of a smart city is not determined solely by a technological partnership or only by a government-led master plan. It is necessary to combine intelligent initiatives and solutions, which are developed and implemented by many different private and public users across the city and in various strategic areas of action. Over-focusing on technology and neglecting the human factor leads to a failure to connect and activate the collective intelligence of a city *(Mueller, 2017)*[53]. Human-inclusive approaches are those that move from the bottom up, where the human factor acts as a means to activate and connect various factors. Regarding the human element, it seems that the first two generations of smart cities (Smart City 1.0 and 2.0) have significantly neglected it, while in the third generation (Smart City 3.0), the importance of citizens has been recognized, in order to create customized solutions *(Cliche, Roche & Turmel, 2016)*[52].

Many of the world's biggest cities are already embracing the changes that are being brought about by the adoption of smart technology (5 examples of smart cities from around the world - NEC New Zealand). Whilst some of the changes are things you might not necessarily notice, many of the improvements brought about by smart technology are having a positive impact on the way people that live in these cities around the world live their lives.

Singapore, Zurich, and Oslo topped the list as the world's smartest cities in the 2021 Smart City Index. The annual report, conducted by the Institute for Management Development with Singapore University for Technology and Design (SUTD), ranks cities based on economic and technological data, along with their citizens' perceptions of how "smart" their cities are.

Each year, more and more cities are added to the study, with Lausanne in Switzerland entering for the first time in 2021 and jumping straight in at number five on the list of smart cities. Other new cities on the list include Leeds and Glasgow in the UK, Bordeaux and Lille in France, Kiel in Germany, Medina in Saudi Arabia, Istanbul in Turkey, and San Jose in Costa Rica.

Auckland continues to be New Zealand's only entry in the 118-strong list of smart cities, placing ninth in 2021, down from fourth in 2020. The City of Sails continues to score well across the board, achieving A ratings for Structure and Technology as well as an overall rating of A. The highest rating is AAA and Singapore achieved this rating across all three aspects included in the study, the only city to achieve a AAA overall rating.

Whilst this is an important guide to smart cities around the world, more anecdotal evidence suggests some cities are doing more to embrace the potential of smart technology, particularly the power of the IoT, although this is not necessarily reflected in this particular study. London, ranked 22nd on the 2021 list, Barcelona (number 58) and Tokyo (number 84) are all widely regarded as some of the leading lights in terms of the way they have implemented smart city technology, however, they are not ranked as high as some other cities around the world.

Below, we take a look at five examples of leading smart cities around the world and the ways in which they have embraced smart technology.

Singapore

Singapore consistently tops the list of the world's smartest cities no matter how they are rated. It was the only city in the top ten of the IMD's rankings not to move position from 2020 to 2021 – an indication of the city's commitment to smart technology.

Singapore is widely regarded as being ahead of the curve when it comes to smart technology. The country has an ageing population, and the government is focused on digital technologies and initiatives to raise productivity in the country's advanced economy. This has included a move to a digital healthcare system – normalising video consultations as well as introducing wearable IoT devices to monitor patients remotely.

Singapore is the second-most densely populated city in the world and their Smart Nation vision aims to digitally collect information throughout the city using sensors. The sensors collect a massive amount of information about what citizens do on a daily basis and they can measure everything from how clean a certain area is to how crowded an event is.

Singapore is also aiming to be the first country to develop a new eco-smart city that is entirely vehicle-free. To be located in Tengah in the western region of Singapore, the planned forest city will be home to five residential districts with 42,000 houses, as well as safe zones for both pedestrians and cyclists.

Oslo

Oslo is a smart city that is focused on creating a sustainable, eco-friendly environment. Whilst sustainable cities and smart cities often share a lot of common goals, there is a difference between the two. A city can be sustainable without necessarily being smart. In this case, however, Oslo ticks both boxes.

The city has over 650,000 LED lights that are all connected to processing stations and these lights can intelligently adjust the amount of lighting based on current needs.

Oslo has also gone all-in on electric vehicles, committing for all vehicles in the city to be electric by 2025. Oslo is not a small city. With 670,000 citizens, that

is a huge commitment to both smart technology and sustainability and they are currently on track to achieve that goal.

They already have incentives in place for zero-emission cars including free parking, the use of bus lanes and lower taxes and toll prices.

Traffic is an area the city is working hard to improve. As well as introducing all-electric vehicles by 2025, they also currently monitor cars using small licence plate detectors to understand traffic flow around the city and develop a data-driven way to improve traffic congestion.

New York

Whilst New York does not feature as high as you might expect on the IMD list of smart cities, it is widely regarded as one of the smartest cities in the world. Hundreds of smart sensors have been placed throughout the different districts of New York City as part of its smart city pilot project in 2020.

The programme collects huge amounts of data to help manage essential services around the city including waste management and collection more efficiently.

The city is also improving connectivity for citizens, replacing phone booths with charging stations that are also WiFi-enabled.

Car sharing has been popular in the city for a number of years, and this continues to grow and evolve. Car sharing helps to reduce emissions in and around the city as well as helping to manage traffic congestion.

The police department has tested web-based software from HunchLab that uses historical crime data, terrain modelling, and other information to predict and respond to crime. The test produced a marked decrease in violent crime, and now other city agencies are interested.

London

London is another city that surprises people when it comes to the adoption of smart city technology. The city has set up a number of smart city initiatives over the past decade and this is driven by the Office of Technology which is committed to making sure London is a smart city.

Their Civic Innovation Challenge is one example. The challenge is aimed at

helping entrepreneurs and start-ups to develop solutions to the growing number of urban issues experience throughout the city.

Connect London is another smart city project that aims to provide 5G connectivity and fibre-optic coverage throughout the whole city. The iconic lamp posts that dominate the skyline will also be fitted with sensors and electric vehicle charging points as London also aims to reduce emissions and cut traffic congestion.

To achieve their goals, London has a Smart City Plan that includes strategies for how to implement technology in a city that's expected to grow to 10 million people in the next decade or so. The plan includes key areas including healthcare, transportation, and energy management, all of which could benefit from smart city solutions.

Copenhagen

The Danish capital, Copenhagen, came seventh in the IMD's list of smart cities in 2021, down one place from sixth in 2020. Like Oslo, Copenhagen is taking a sustainable approach to its smart city developments.

In 2017, the Copenhagen Solutions Lab received an award for its system which monitors air quality, energy consumption, traffic, and waste management. The system also connects parking systems, traffic lights, buildings, smart metering, and charging systems for electric vehicles to direct traffic in real-time.

The city is working towards bringing all these smart technologies into a single platform to deliver a more efficient automotive experience in the city as well as being able to collect all that data in one place. In addition, the city is working with the Massachusetts Institute of Technology (MIT) to develop an intelligent bike system in the city.

3.2 Smart Cities 4.0

Smart cities, as mentioned above, have been developed in three phases. At the current time, the formulation of the Smart City 4.0 phase is underway. In the context of Smart City 4.0 development, a challenge facing local governments is to base city development on the creative engagement of citizens *(Morawski & Warszawskiej,*

2021) [54]. Now, citizens are starting to co-create their cities and projects of a social nature play an important role: equality, social inclusion, cheap housing, etc.

Every modern city is a complex ecosystem that includes many elements including all those that connect people, environment and technology. What is a distinguishing factor of dynamically developing cities is definitely the smart municipal infrastructure that serves both citizens and administration. When creating a Smart City 4.0, the complex network of interconnections that produce real benefits is taken into account *(Lee et al., 2014)*[20]. For example, blockchain technology may be used to encrypt and distribute data.

Blockchain is the technological foundation of cryptocurrency systems. Before one can make a transaction with the chosen cryptocurrency, the transaction must be sent to the blockchain community *(Pal, Alam, Thakur & Singh, 2021)*[55]. Transaction data contains public passwords, which strictly correspond to private passwords. The transaction completed through the blockchain is both anonymous and encrypted. When transaction data is made public, community members can collect and verify that data. It is a highly secure tool and due to the fact that individual components are stored in an extensive network, it cannot be counterfeited *(Atlam, Azad, Alzahrani & Wills, 2020)*[56]. Thanks to this level of security, blockchain can be used in concepts such as the Internet of Things (IoT) or a Smart City. The implementation and use of a network of IoT devices in smart city environments has resulted in a very large amount of data. In cities and metropolitan areas, this data is maintained by multiple sources that use independent systems to collect, store, and use data. Such dispersion makes it difficult to fully exploit their value. Blockchains, as distributed ledgers, can be used, for example, to develop a universal data collection and distribution system. Smart contracts can be used to automate all the processes of such a network *(Moniruzzaman, Khezr, Yassine & Benlamri, 2020)*[57].

Shaping a Smart City 4.0 is closely related to other industrial revolutions, dominated by robots, artificial intelligence, nanotechnology, the Internet of Things (IoT) and autonomous vehicles. Profound technological changes with significant social and economic consequences for cities and the natural environment are integrated into the process of sustainable development, which sets high standards for citizens

(Makiela, Stuss, Mucha-Kuś, Kinelski, Budziński & Michalek, 2021)[58]. One of the many foundations of the Smart City concept is well thought out and properly implemented smart municipal infrastructure. Simply put, it aims to use the integrated infrastructure of the Internet of Things to increase the efficiency of operations carried out by municipal services and companies, and finally to improve the lives of citizens *(Meekaewkunchorn, Szczepańska-Woszczyna, Muangmee, Kassakorn & Khalid, 2021)*[59].

Solutions that include the holistic concept of a Smart City also have an impact on increasing the efficiency of municipal investments and greater sustainable development of the city (*Mucha-Kuś, Sołtysik, Zamasz & Szczepańska-Woszczyna, 2021)*[60]. This results in changes visible to everyone. A common Smart IoT system implemented in a growing number of cities covers many basic services available to every citizen *(Makiela et al., 2021)*[58].

In particular, the Smart IoT system controls water supply and consumption metering, energy-saving LED lighting with a management system, city bicycle systems, intelligent parking monitoring and management, waste collection and recycling and/or electricity supply. The above list can be extended to air and water quality sensors and so-called smart benches, located in the urban space to provide Internet access and charge mobile devices, smartphones and tablets, drawing energy produced by solar panels *(Firmino, van Amstel & Gonzatto, 2018)*[61]. In order for all of the above to be possible, the consistent activities of the municipal authorities and their cooperation with the suppliers of Smart systems that have the relevant knowledge, experience and technologies are necessary.

In the ESI ThoughtLab survey conducted in 2019, twenty global cities were referred to as "Cities 4.0". These are cities that have advanced both in terms of progress in implementing the UN Sustainable Development Goals and in the effective application of digital technologies and data. Some of these cities are: Athens, Baltimore, Barcelona, Berlin, Birmingham, Boston, Copenhagen, Helsinki, London, Los Angeles, Madrid, Moscow, New York, Orlando, Paris, Philadelphia, Singapore, Tallinn and Vienna *(Firmino, van Amstel & Gonzatto, 2018)*[61].

The benchmark research on 'Smart City Solutions for a More Dangerous World',

conducted by ESI ThoughtLab, was based on research conducted in 167 leading cities from 82 countries around the world, combined with data on municipal services and quality of life from the World Bank. Numbeo, IESE and other sources *(Makiela et al., 2021)*[58].

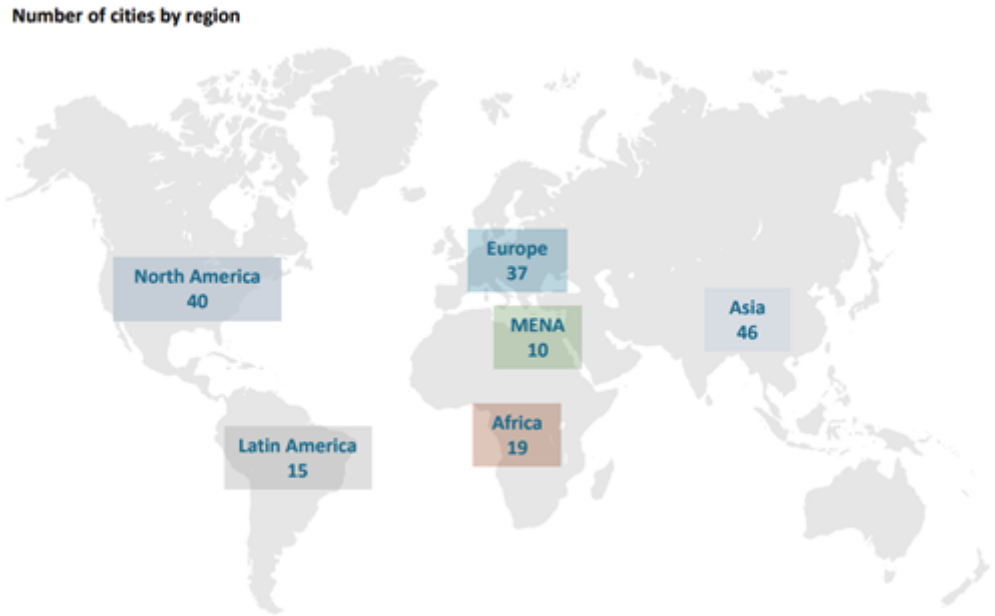


Figure 3.3: The countries that took part in the ESI ThoughtLab survey

Source: Smart City Solutions for a Riskier World[62]

The report said that Cities 4.0 typically implement 14 smart city projects on average and have better infrastructure, public transport, roads, parks, healthcare and digital communication. In addition, Cities 4.0 has made the most progress towards achieving the Sustainable Development Goals, achieving 86% progress across all 17 goals *(Burke & Zvarikova, 2021)*[63]. The share of capital for technology investment across urban areas, particularly in digital infrastructure, mobility and transport, public safety, health, education, sustainable development, as well as energy and water, has increased (econsultsolutions.com). Smart Cities 4.0 is hyperconnected, as it uses technology, data and citizen participation, but is additionally used to achieve the goals of sustainable development *(Burke & Zvarikova, 2021)*[63]. The main principle that dominates Smart Cities 4.0 is that it is not enough for a city to be "smart", it should also be sustainable. Sustainable development goals are the priority of the future.

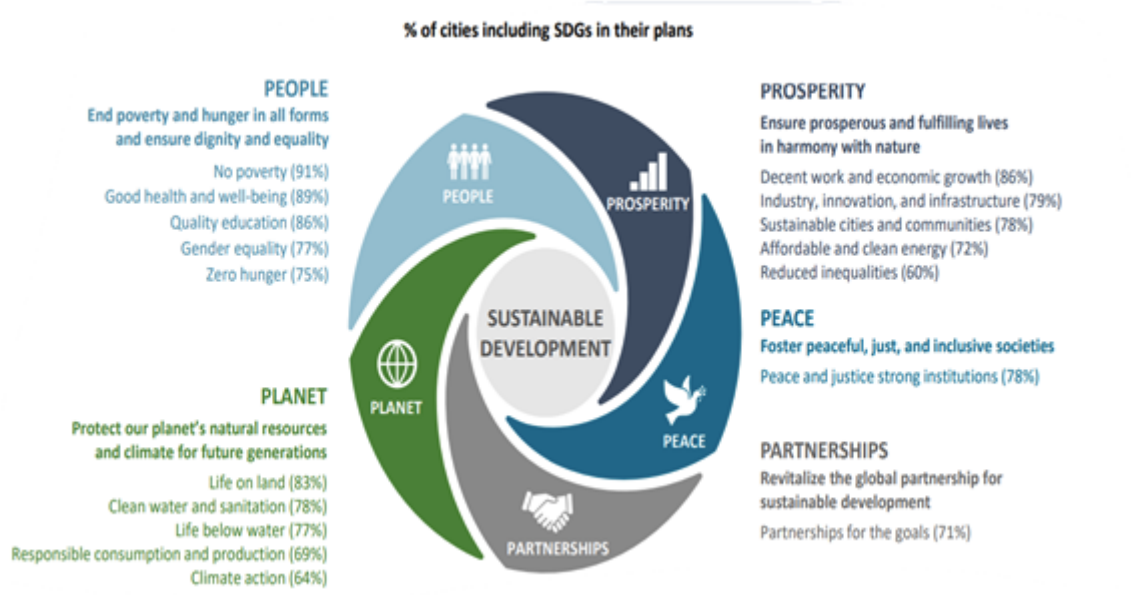


Figure 3.4: The goals of today's smart cities

Source: Smart City Solutions for a Riskier World[62]

ESI Thought Lab researchers reported that during the pandemic many cities achieved most of the people-related Sustainable Development Goals, including no urban poverty (91%), good health and well-being (89%), decent work (86%) and good education (86%) *(Makiela et al., 2021)*[58]. But at the same time, the survey identified barriers to achieving sustainable development goals over the next three years, including complex city policies and regulations (52%), finding a suitable partner or supplier (50%), as well as managing data security and of privacy (44%) *(Atlam et al., 2020)*[56].

The steps that have been taken by Cities 4.0 in order to develop their program for the Sustainable Development Goals are:

1. regularly monitor and evaluate efforts towards the Sustainable Development Goals;
2. ensure broad support for Sustainable Development programs across government;
3. appoint a department to lead efforts on the Sustainable Development Goals;
4. conduct a voluntary local review of progress in implementing programs for the

Sustainable Development Goals *(Makiela et al., 2021)*[58].

In addition, the research showed that these cities invested in a range of smart technologies. The biggest investments are in cloud (87%), mobile (85%), IoT (81%), biometrics (72%) and artificial intelligence (66%). Over the next three years, the technologies that will generate the largest increase in investment will be digital twins (+164%), 3D printing (+125%) and augmented reality/virtual reality (+63%), as well as data storage (+ 50%) (econsultsolutions.com). Cities are becoming more and more complex and multidimensional urban systems, which are of crucial importance for human life on the planet. In addition to advanced technologies, the importance of soft capabilities, including technology, talent, tolerance and trust, is increasing. From the point of view of the Smart City Concept, it is crucial to build on these four pillars/capabilities (4T): Technology, Talent, Tolerance and Trust (Popescu, 2020).

The advancement of these capabilities in a city determines its intelligence, entrepreneurship and innovation. An advanced 4T share in smart city management determines the quality of life of its citizens and its competitive position *(Popescu, 2020)*[64]. Cities treat their urban innovative systems as a priority, moving from the traditional urban character to an innovative "green", "smart" and "open" city, striving for sustainable environmental and social development *(Zygiaris, 2013)*[65].

The greatest potential resource of an innovative, entrepreneurial, attractive and competitive city, which determines its economic development, is knowledge, while innovation (which is an outcome of knowledge) is the main driving force of economic development *(Popescu, 2020)*[64]. The implementation of innovation results in modernization, increasing efficiency and competitiveness and, consequently, the amount of revenue generated *(Makiela et al., 2021)*[58].

3.3 Introduce promising smart city applications and architecture

3.3.1 Internet of Things and Smart Cities

Smart city has become an "umbrella" term for many technologies, aiming to improve the efficiency of future cities and the quality of life of their inhabitants, not only by introducing new applications but also by leveraging existing processes. There are now policy efforts aimed at encouraging the development of smart cities *(Khatoun & Zeadally, 2016)*[66]. While it is generally argued that there cannot be an absolute definition, as the term smart city does not describe a static concept but rather a process towards more vibrant and resilient cities *(Gubbi, Buyya, Marusic & Palaniswami, 2013)*[67], there seems to be agreement that some new technologies and applications amount to creating smarter cities *(Zhou, 2012)*[68].

The number of smart city applications is large. The primary goals of smart cities are to improve the quality of life of citizens and generate economic growth. These two goals can be achieved by increasing efficiency and sustainability, allowing citizens to participate and improving decision-making through increased availability of information. To this end, many smart city applications have been proposed or already developed in nine key areas: Mobility, Assistive Devices, Buildings, Environment, Public Services, Governance, Economy, Health and Citizens *(Atzori, Iera & Morabito, 2010)*[69], such as are presented in the following image.

These nine regions are by no means isolated from each other. Instead, services in different areas can interact and are often developed in conjunction. For example, smart buildings are often combined with smart utility solutions to facilitate the management of electricity demand from the grid *(Harrison, Eckman, Hamilton, Hartswick, Kalagnanam, Paraszczak & Williams, 2010)*[70].

A smart city is defined as a city that connects physical infrastructure, ICT infrastructure, social infrastructure and business infrastructure to harness the collective intelligence of the city *(Harrison et al, 2010)*[70]. A city can be smart through a

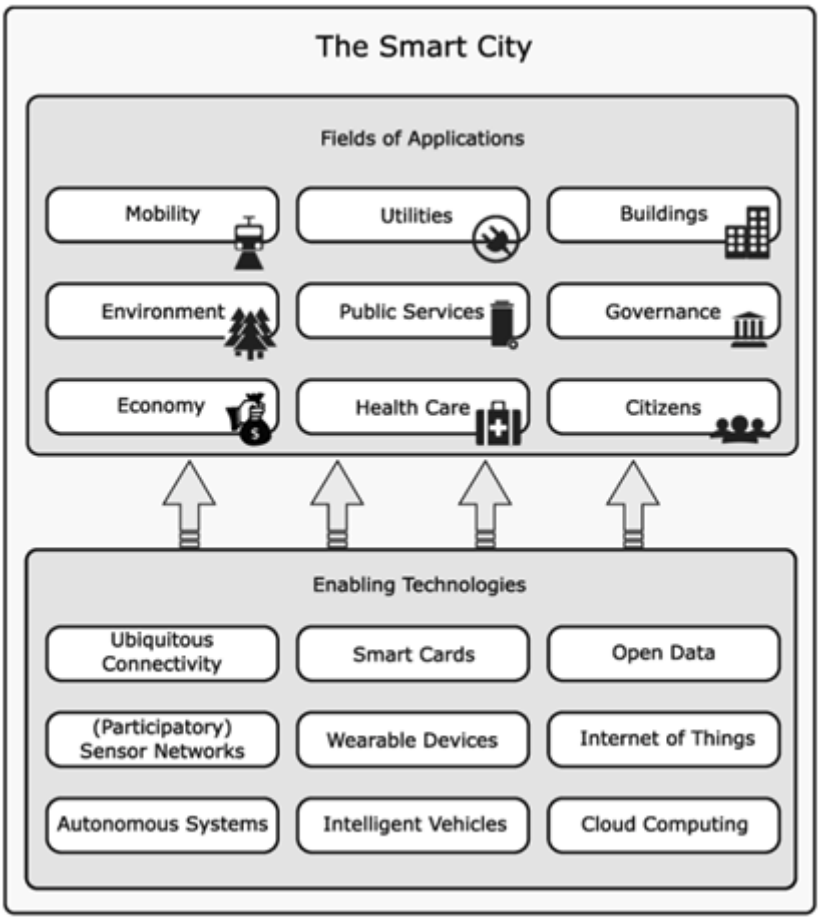


Figure 3.5: The key areas of smart city applications and widely applicable technologies

Source: Atzori et al., 2012[69]

large deployment of IoT. Wireless Sensor Networks (WSNs), the sensor enablement arm of the IoT, integrate seamlessly into urban infrastructure forming a "digital skin" around it. The information generated is shared across various platforms and applications to develop a common operational picture (COP) of the city *(Jin, Gubbi, Marusic & Palaniswami, 2014)*[71].

The IoT philosophy leverages various ubiquitous services to facilitate Smart City development. IoT introduces new opportunities such as the ability to monitor and manage devices remotely, analyze and take action based on information obtained from various traffic data streams in real time. As a result, IoT products are changing cities by enhancing infrastructure, creating more effective and efficient municipal services, improving transportation services by reducing traffic congestion, and improving citizen safety. To realize the full potential of the Internet, smart city

architects and providers recognize that cities should not be a distinct feature of smart cities, but produce scalable and secure IoT solutions that include efficient IoT systems *(Jin et al., 2014)*[71].

3.3.2 Internet of Things (IoT) technologies for smart cities

As cities develop and expand, smart and innovative solutions are vital to improve productivity, increase operational efficiency and reduce management costs *(Khatoun & Zeadally, 2016)*[66]. Citizens are gradually equipping their homes with IoT devices, such as TVs and Internet boxes. In real estate, connected objects include thermostats, smart alarms, smart door locks, and other systems and devices. At the United Nations Climate Change Conference (Cop21) held in Paris in 2016, the items linked were discussed extensively and gave many local communities the opportunity to review their environmental goals in order to reduce their CO2 emissions through of IoT use. The latter can play a vital role in the context of smart cities *(Haddud, DeSouza, Khare & Lee, 2017)*[72]. For example, smart waste containers can bring real benefits to citizens, they will be able to indicate that it will soon be full and they will have to evacuate. Citizens can check through a smart phone app whether the waste containers on the street are full or not. Also, spaces can be equipped with sensors and monitor environmental conditions, cyclists or athletes can find the «healthiest» trips, and the city can respond by adjusting traffic or planting more trees in certain areas. The data will be accessible to all citizens to promote the creation of applications using real-time information about residents. Cities have become hubs for knowledge sharing *(Khatoun & Zeadally, 2016)*[66]. The image below gives an example of a smart city.

Investing in IoT will be crucial to building smart cities and services, as the use of data will generate the most revenue *(Haddud et al., 2017)*[72].

Several definitions have been given for the term Internet of Things (IoT). It can be defined as “Objects that have identities and virtual personalities in smart spaces, using smart interfaces to connect and communicate within social and medical environments and users” *(He & Zeadally, 2014)*[73]. Today, huge investments

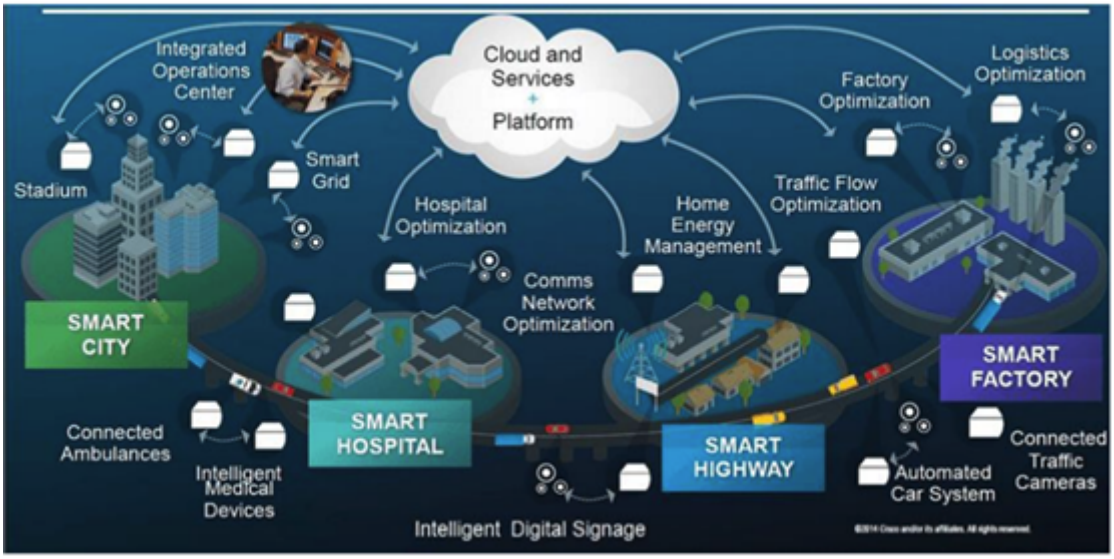


Figure 3.6: Developing smart cities

Source: Khatoun & Zeadally, 2016[66]

are being made in the area of IoT to support the provision of large-scale services, and in this context, various aspects of social and economic life are being considered. IoT development requires communication standards that work seamlessly between various objects. Several international organizations are involved in standardizing these communications. These include the International Telecommunication Union (ITU), Institute of Electrical and Electronics Engineers (IEEE), Internet Engineering Task Force (IETF), Global Standard1 (GS1), Organization for the Advancement of Structured Information Standards (OASIS) Industrial Internet Consortium (IIC), and many more *(Haddud et al., 2017)*[72].

Some of these IoT standards and initiatives are presented in the following Table:

Various standards have been proposed by the IEEE and IETF at different levels for Internet Protocol (IP)-based sensor networks. For example, at the link layer, the IEEE 802.15.4 standard is more suitable than Ethernet in industrial environments. At the network level, the IPv6 over Low Power Wireless Personal Area Networks (6LoWPAN) standard can adapt the IPv6 protocol for wireless communications *(Bello, Zeadally & Badra, 2017)*[74]. In 2011, the IETF published the standard IPv6 routing protocol (RPL) for low-power networks. The IETF also launched a working group to standardize an application-layer oriented protocol for

	802.11a	802.11b	802.11g	802.11n	802.11 ac	802.11 ad	802.15.1	802.15.3	802.15.4	802.15.6	NFC
Network Type	WLAN	WLAN	WLAN	WLAN	WLAN	WLAN	WPAN	WPAN	WPAN	WBAN	Point-to-Point
Date	1999	1999	2003	2009	2014	2012	2002/2005	2003	2007	2011	2011
Network Size	30	30	30	30			7	245	65535	250	-
Bit Rate	54 Mbps	11Mbps	54 Mbps	248 Mbps	3.2 Gbps	≥ 7Gbps	3 Mbps	55 Mbps	250 Kbps	10 Mbps	424 Kbps
Frequency	5 GHz	2.4 GHz	2.4 GHz	2.4/5 GHz	5 GHz	2.4/5/60GHz	2.4 GHz	2.4 GHz	868-915 MHz 2.4 GHz	402-405 MHz	13.56 Mhz
Range	120 m	140 m	140 m	50 m indoor 250 m outdoor	30 m	5 m	100 m	100 m	75 m	2-5 m	0.2 m
Modulation	BPSK, QPSK 16-QAM 64-QAM OFDM	DBPSK DQPSK CCK DSSS	DBPSK DQPSK 16-QAM 64-QAM OFDM	OFDM	OFDM	QAM-256	8DPSK DQPSK PIDQPSK GFSK AFM	QPSK DQPSK 16-QAM 32-QAM 64-QAM	ASK DSSS PSSS		Manschester and Modified Miller
Application	WiFi	WiFi	WiFi	WiFi			Bluetooth		ZigBee		

Figure 3.7: Main communication standards in the Internet of Things

Source: Haddud et al., 2017[72]

connected objects. The reference protocol is called the Constrained Application Protocol (CoAP). CoAP provides methods and commands (such as HTTP Get) to look up an object and change its state. CoAP is based on UDP and can optionally use Datagram Transport Layer Security (DTLS) to provide communication security. Operating systems used in IoT include: TinyOS, Contiki OS, MantisOS, Nano-RK, Android, Brillo (Google), Windows 10 IoT Core, LiteOS (Huawei). In addition, several platforms have been developed for IoT: Arrayent, California CoAP Java framework, Erbium, CoAP framework for Contiki, and XMesh networking stack. At the application level, a large number of applications were developed: Iobridge Thingspeak, Nimbits, Evrythng, Open.Sen.se, NanoService, exosite One, HP supposedly, Isidorey, SensorCloud, Manybots *(Okkonen, Mazhelis, Ahokangas, Pussinen, Rajahonka, Siuruainen & Warma, 2013)*[75].

The image below compares the 6lowPAN communication stack with other popular communication stacks.

The initiative of Global Standard 1 (GS1) of the Global Electronic Code Code (Global Product Code) defines a unique individual identifier for the identification of an electronic product and the general EPC network architecture, which defines the organization of information systems designed to exchange information in a EPC network *(Li, Liu, Sheng, Zeadally & Zhong, 2011)*[76]. One of its main components is the Object Naming Service (ONS), which is based on the Domain Name System (DNS). In fact, the European Article Numbering (EAN) standard for product

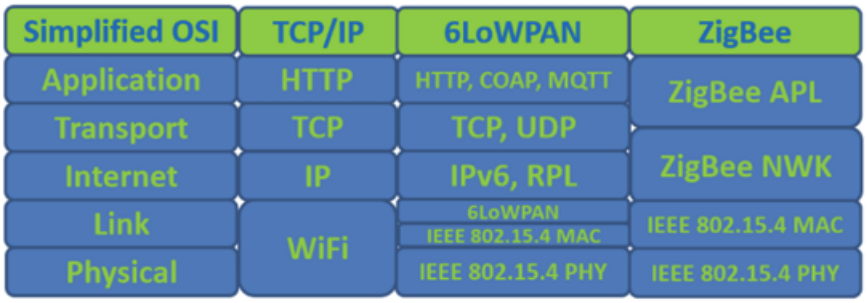


Figure 3.8: Comparison of the 6LowPAN stack with other stacks

Source: Okkonen et al., 2011[75]

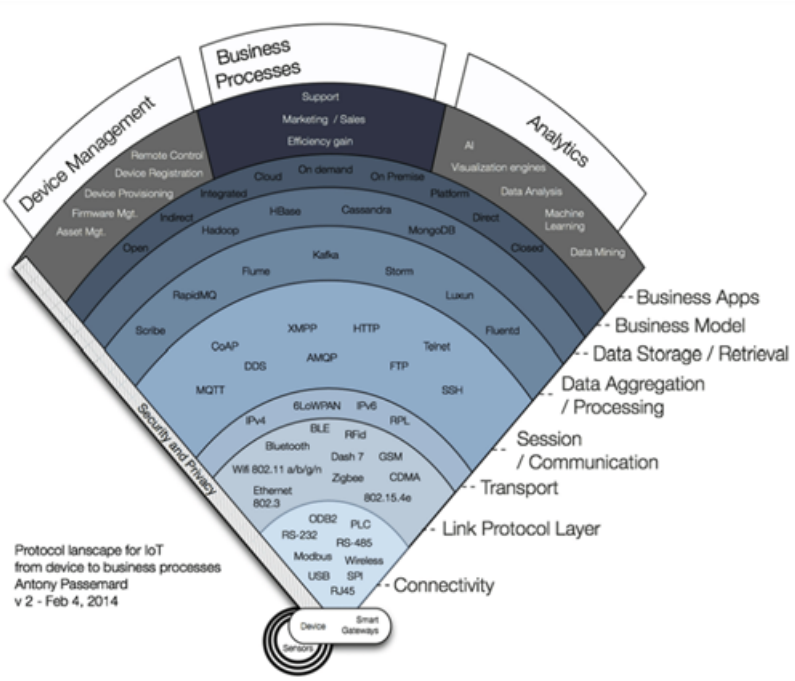
identification emerged in 1970. However, this EAN barcode is actually used to identify a category of products, not individual cases within that category *(Sheng, Li & Zeadally, 2008)*[77]. Additionally, on the internet, a unique IP address is required for each connection. This is why EPC was proposed by GS1 as a new standard *(Li et al., 2011)*[76].

Meanwhile, OASIS issued several recommendations on network technologies in communication and messaging technologies, such as Message Transfer Telemetry (MQTT), Advanced Message Queuing Protocol (AMQP), and Data Distribution Service for Real-Time Systems (DDS). A new Industrial Internet Consortium (ICC) was launched in 2014 to coordinate and establish the priorities and technologies that enable the Industrial Internet. There are thousands of ICC founding and contributing members and they include: Bosh, Intel, IBM, Schneider, Huawei, Cisco and many others. There are currently 19 working groups working in various areas: Business Strategy and Solution Lifecycle, Legal, Interfacing, Security, Technology Testing, Marketing and Synthesis etc. *(Jin, Gubbi, Marusic & Palaniswami, 2014)*[71].

The following image summarizes some IoT protocols and standards and the Table below details the acronyms used:

3.3.3 IoT applications in smart cities

It is interesting to consider the application of the IoT paradigm in an urban environment. Many national governments are investigating and planning how they



Acronym	Description	Acronym	Description
HBase	Hadoop Database	RapidMQ	Rapid Message Queuing
MQTT	Message Queuing Telemetry Transport	DDS	Data Distribution Service
XMPP	Extensible Messaging and Presence Protocol	AMQP	Advanced Message Queuing Protocol
HTTP	HyperText Transfer Protocol	FTP	File Transfer Protocol
Telnet	Telecommunication Network	SSH	Secure SHell
IPv4	Internet Protocol Version 4	IPv6	Internet Protocol version 6
6LowPan	IPv6 over Low power Wireless Personal Area Networks	RPL	IPv6 Routing Protocol for Low-Power and Lossy Networks
BLE	Bluetooth Low Energy	RFID	radio frequency identification
GSM	Global System for Mobile Communications	CDMA	Code division multiple access
OBD2	On-board diagnostics 2	PLC	Power-line communication
RS-232	Recommended Standard 232	Modbus	Modicon Communication Bus
USB	Universal Serial Bus	SPI	Serial Peripheral Interface
AES	Advanced Encryption Standard	SSL	Secure Sockets Layer

Figure 3.9: Internet of Things Protocol

Source: Jin et al., 2014 [71]

can adopt ICT solutions in the management of public services in order to realize the Smart City concept *(Sanchez López, Ranasinghe, Harrison & McFarlane, 2012)*[78].

- Building maintenance

  To properly preserve the historical buildings of a city, the actual conditions of each building must be continuously monitored and the areas most affected by various external factors must be identified *(Zanella, Bui, Castellani, Van-*

gelista & Zorzi, 2014)[79]. The city contains many structures, which are of different sizes and different ages. In general, most structures are very old (such as buildings, dams or bridges). To assess the conditions of a building, passive WSNs can be embedded inside a concrete structure and periodically send a radio signal with appropriate amplitude and phase characteristic, to be informed about the state of the structure *(Zanella et al., 2014)*[79].

- Environmental monitoring

  WSNs process, analyse and disseminate information collected from multiple environments. The various parameters measured by sensors are *(Kafle, Fukushima & Harai, 2016)*[80]:

  1. Water level in lakes, streams, drains.
  2. Concentration of gases in the atmosphere.
  3. Soil moisture and other characteristics.
  4. Slope for static structures (eg bridges, dams).
  5. Changes in location (eg landslides).
  6. Lighting conditions.
  7. Infrared for heat (fire) or animal detection.

- Waste management

  Waste management is becoming a bigger and bigger problem in urban life. It is related to many aspects, including socio-economic and environmental. An important feature in waste management is environmental sustainability. A major advantage of global IoT infrastructures is that they provide the ability to collect data and further help improve the effective management of various issues. Using IoT devices inside the waste containers, they will be able to connect to the computing server using one of the LPWAN technologies, which can collect the information and optimize the way to collect waste from the waste trucks *(Bello et al., 2017)*[74].

- Smart parking

In this use case, there is a wireless sensor at each parking spot. If a parked vehicle leaves a parking spot, the sensor in the parking spot sends a notification to a management server. By collecting parking space occupancy information, the server can provide parking space information to drivers via display platforms such as smart phones, human machine interfaces (HMIs), or vehicle billboards. This information will also allow the city council to issue fines for parking violations *(Jin et al., 2014)*[71]. Furthermore, radio frequency identification (RFID) technology is automated and can be very useful for vehicle identification systems. Vehicles are identified and parking fees are automatically collected through this system. Thus, barriers and parking control can be achieved. In this way, an unmanned, automated vehicle control and identification system can be developed *(Jin et al., 2014)*[71]. The development of vehicular ad hoc networks (VANETs) along with the advancement and widespread deployment of wireless communication technologies, is driving many large automobile factories and industries telecommunications companies to increasingly fit their cars with communication units (OBUs) *(MacGillivray, Torchia, Bisht, Kalal, Leung, Membrila & Torisu, 2020)*[81]. This allows different cars to communicate with each other as well as with the road infrastructure. Thus, applications that provide information about parking spaces are made possible through road communications *(Sheng et al., 2008)*[77].

- Smart health

A Wireless Body Area Network (WBAN), based on a low-cost wireless sensor network technology, could significantly benefit patient monitoring systems in hospital, home and work environments *(Guerrero-Ibanez, Zeadally & Contreras-Castillo, 2015)*[82]. The sensors communicate with medical devices using different WPAN technologies (ZigBee, 6LowPAN, CoAP, etc.). The sensors are also able to measure various information of physiological parameters (e.g. blood flow, respiratory rate, blood pressure, blood PH, body temperature, etc.), which are collected and analysed by remote servers *(Guerrero-Ibanez et al.. 2015)*[82].

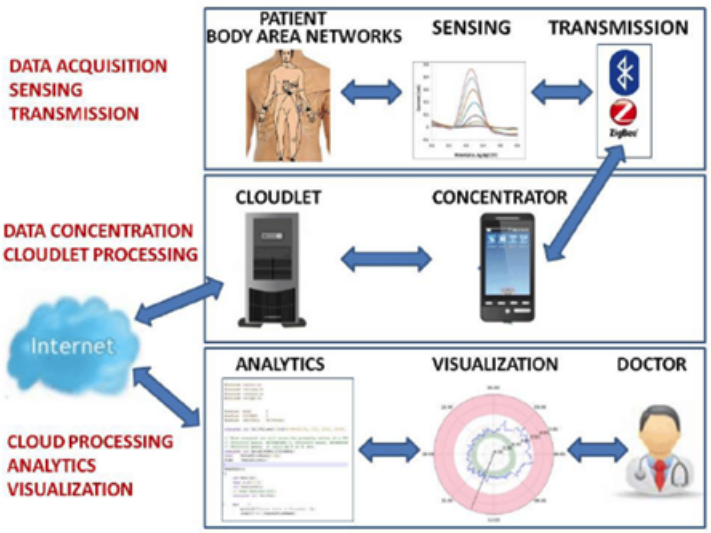


Figure 3.10: Components of a remote patient monitoring system based on an IoT-Cloud architecture

Source: Guerrero-Ibanez et al., 2015[82]

- City bus navigation system

  UBN is based on an IoT architecture, which uses a set of distributed software and hardware components that are tightly integrated into the bus system. The UBN system consists of three main components:

  1. the urban bus system with networks of buses equipped with Wi-Fi
  2. the UBN navigation application for bus passengers
  3. immediate information about the occupancy of buses operating on various routes *(Jin et al., 2014)*[71].

- Smart grid

  The smart grid uses new technologies, such as smart and autonomous controllers, advanced data management software, and two-way communications between energy companies and consumers, to create an automated and distributed advanced energy supply network *(Firdaus, Murti & Alinursafa, 2019)*[83]. Using the infrastructure to sense and transmit information for the smart grid, IoT technology, when applied to the power grid, will play an important role in

the efficient generation, distribution, transmission and consumption of energy *(Firdaus et al., 2019)*[83].

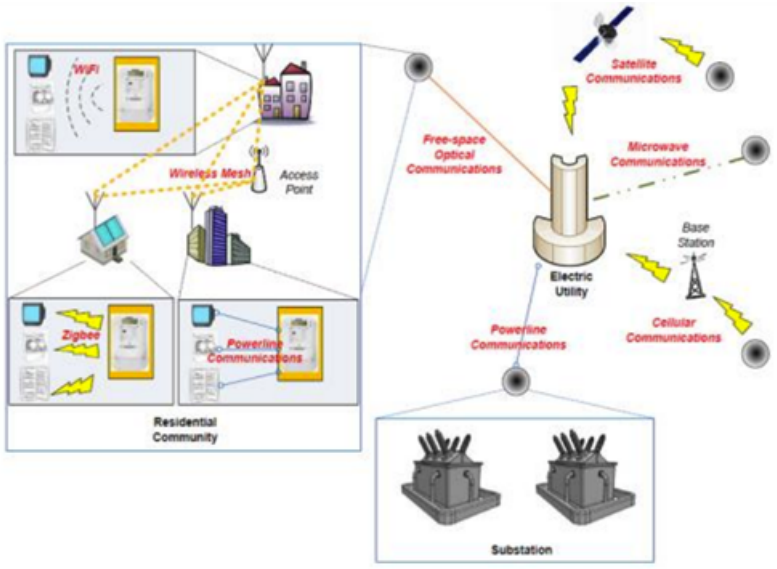


Figure 3.11: Smart grid architecture

Source: Firdaus et al., 2019[83]

- Autonomous driving

  In a smart city, autonomous driving technologies are synonymous with saving time for the user. This technology will help speed up traffic flow in a city and save almost 60% of parking space *(Nolan, Guibene & Kelly, 2016)*[84]. Through a combination of radar, cameras and ultrasonic sensors located around the car, an autonomous car can detect anomalies everywhere and has an alert that automatically activates the emergency brakes to prevent accidents or collisions. The Intelligent Transport System could allow the best route to be calculated in real time, connecting different modes of transport to save time and reduce carbon emissions *(Nolan et al., 2016)*[84].

Chapter 4

Governance

4.1 Smart city technologies

4.1.1 Smart cities assessment indicators

Various smart city performance measurement and evaluation indicators have been developed. Evaluation systems through synthetic quantitative indicators are gaining more and more importance among city leaders and policy makers. Indicators help them decide where to focus time and resources, as well as communicate the city's performance to citizens, visitors and investors *(Berardi, 2013)*[85]. One of the values of these systems is the ability to represent a benchmark, which is much more tangible than a region's self -characterization as a smart city.

The University of Vienna developed an evaluation metric to rank 70 medium-sized European cities *(Giffinger, Fertner, Kramar, Kalasek, Pichler - Milanović & Meijers, 2007)*[86]. This measurement uses specific indicators for each of the identified dimensions of a smart city. For example, smart mobility is divided into local accessibility, international accessibility, availability of ICT infrastructure as well as sustainable and safe transport systems. Another rating system has been developed by the Intelligent Community Forum (ICF), which annually announces cities designated as Smart 21 Communities. This metric is based on a number of factors: broadband connectivity, knowledge of the workforce, digital inclusion, innovation and marketing.

More recently, *Zygiaris (2013)*[65] developed a measurement system, identifying six layers of a smart city:

1. The city layer, emphasizing that smart city concepts must be based in the context of a city.

2. The green layer of the city, inspired by the new urbanization theories of urban environmental sustainability: is the interconnection layer, corresponding to the spread of green economies at the city level.

3. The instrumentation layer highlights that smart cities require real-time responses from smart meters and infrastructure sensors.

4. The open integration layer, pointing out that smart city applications should be able to communicate and share data, content, services and information.

5. The application layer, useful for smart cities to reflect the actions of the city in real time, to new levels of intelligent response.

6. Finally, the innovation layer, emphasizing the fact that smart cities must create a fertile innovation environment for new business opportunities *(Zygiaris, 2013)*[65].

A method to evaluate the "smart city index" was also proposed by *Lazaroiu and Roscia (2012)*[87]. The indicator helped to distribute European funds in the strategic plan 2020. The indicators that contributed are not homogeneous and require a large amount of information. The proposed approach uses a fuzzy procedure that allows defining a set of weights to combine the various indicators according to their relative importance.

A more sophisticated system of measuring the intelligence of a city has been proposed by *Lombardi et al. (2012)*[88]. These authors used a modified version of the triple helix model, a framework for analyzing knowledge-based innovation systems that links the three main knowledge-creating agencies: universities, industry and government *(Lombardi, Giordano, Farouh & Yousef, 2012)*[88]. The authors added a new knowledge creation factor to the previous three, civil society, defining

a quadruple helix model. For the four enablers of innovation, they propose indicators belonging to five clusters *(Lombardi et et al., 2012)*[88]. This analysis framework consists of 60 indicators, selected after a literature review that included EU project reports, the Urban data set Audit, statistics of the European Commission, the European Green Index of City, TISSUE, Trends and Indicators for Monitoring the EU Thematic Strategy for the Sustainable Development of the Urban Environment and the smart city ranking of medium-sized EU cities. Surprisingly, they excluded the smart mobility dimension *(Lombardi et et al., 2012)*[88].

The *Carlis et al. (2013)*[89] recently proposed a framework for analyzing and comparing measurement systems for smart cities. They propose to separate the measurement indicators into two categories: objective and subjective and to examine both physical infrastructure and environmental data together with citizen satisfaction and perceived well-being. These authors also focused on how indicators are measured and revealed that along with traditional tools, new indicators of well-being are increasingly assessed through real-time data detection, such as social network messages *(Carli, Dotoli, Pellegrino & Ranieri, 2013)*[89].

Many of the usual developments determine the importance of fields of practice comparisons with other cities. The Global Index Power City was created by the Institute for Urban Strategies in Japan and was based on the accuracy of the data, supplemented with information about the viewpoint of various agencies. This index maps the strengths and weaknesses of cities and ranks them in a broad comparative analysis, according to their comprehensive economic potential for creators and exceptional companies.

As previously mentioned, the University of Vienna has ranked 70 medium-sized cities *(Giffinger et al., 2007)*[86]. Meanwhile, in the United States, the Natural Resources Defense Council has developed the Smartest Cities Ranking, which is characterized by a strong bias towards environmentally relevant criteria *(IDA, 2012)*[90]. Considering that this ranking encourages a city to be an economic hub, an international trade and a global city, it is not surprising that Singapore was considered the smartest city in this ranking *(IDA, 2012)*[90]. The classification in urban areas, such as IBM Smart City or the McKinsey ranking Global Institute, periodically compare

and classify urban areas *(Arribas - Bel, Kourtit & Nijkamp, 2013)*[91].

Many more ways of categorizing smart cities are observed. A modern practice often found in reports is the classification of cities into leaders and followers, which is based on peer logic effect, i.e. the influence of one city on another. Peer influence, or otherwise peer pressure, is the direct influence on the individual from his peers. In other words, a person is encouraged to follow his peers by changing himself. The effects of peers are important in many social science studies, with particular importance and implications in the life of the individual. The so - called peer effect can be measured through several approaches, with the most important approaches leveraging observational data. More specifically, with regression, the same outcomes (or behavior) are used in the outcomes (or behavior) of the others. Based on the above, smart cities that are considered to be leaders play an important role in charting the course for cities that are considered to be followers. In research conducted by *Liu (2019)*[92], this assumption is modeled by dividing cities into high, medium and low score groups.

Overall, it appears that there are peer group effects in the advancement of smart cities. Analysis of the data shows that the effect of peer effect is an important feature. Also, the coefficient shows a positive value, which means that the effects from the surroundings (in this case, the pioneer smart cities) play a positive role in the progress of smart cities *(Kummitha & Crutzen, 2017)*[93]. There is a lot of evidence that can support this result.

City managers continue to visit other cities, exchange views in urban planning discussions, and then submit proposals for decision-making. All of the above could make their own cities evolve into smarter ones. Also, the media contributes a lot to the effectiveness of smart cities. Many sources rank smart city performance, and many highly ranked cities publish good practices online or in newspapers, which can accelerate smart city progress through competition. Mid-score city groups have stronger peers-effects, compared to the low- and high-scoring groups *(Kostakis, Bauwens & Niaros, 2015)*[94]. The low-scoring group remains in the early stage of smart cities, meaning they focus on smart city infrastructure and other foundational designs. The medium score group has a greater need for smart city improvement. In

this group, the design and installation of the foundation has already been completed. They need to focus on how to improve, so it is a good idea to reach out to other similar cities, because similar cities may have more in common, such as weather, cultural factor, etc. On the other hand, the group of high-scoring cities may have limited room for improvement. They invest more in researching new technologies, which means there is a waiting time. The improvement suggestions they can get from others are very limited *(Kostakis et et al., 2015)*[94].

The prevailing tendency to classify followers and leaders has been extensively examined in the case of the United Kingdom with an even more detailed classification, in four more categories:

1. **Leaders**: These cities have differentiated themselves through the clarity, scope and inclusiveness of their vision and planning at the smart city level. They are also leading the way in the implementation of important projects, both at the pilot and at the most large-scale levels.

2. **Contenders**: These cities have done a lot to establish their own smart city strategy and have implemented some important projects. However, there are some gaps in their strategies and the number of actual projects may lag behind that of smart city leaders.

3. **Challenges**: Challenge cities have set a vision for their smart city efforts and have already started, but the execution is still short on vision. They may have shown strong initiative in a few key areas, but with less scope in their program than the leading cities.

4. **Followers**: These are cities that are at the beginning of their smart journey. They may have made initial statements of intent and moved forward with limited pilot projects, but they need to develop a more comprehensive view of the city's development and stronger leadership for their programs *(Potts & Kastelle, 2010)*[95].

The evaluation of cities with this index is based on two dimensions: a) Strategy and b) Application (execution). The strategy dimension assesses the vision, goals

and objectives of each city in relation to the smart city programme. The execution dimension assesses the actual achievements of the city, from initial projects to the full development of innovative technologies and services. Each dimension is divided into five assessment categories *(Rizzo, Deserti & Cobanli, 2015)*[96].

The assessment categories of the strategy dimension are as follows:

- **Vision**: Assesses the city's smart or future urban planning strategy, including assessing the clarity, completeness and basis of the strategy. Leadership commitment in each city and the level of engagement with all stakeholders is also assessed.

- **Digital Innovation**: Assesses the city's strategy for the development and exploitation of digital technologies and services, including plans for the development of the city's communication infrastructure, open data policy, digital inclusion strategy and plans for the development of the local digital economy.

- **Service Innovation**: Assesses the City's strategy for local service innovation that takes advantage of the improvements offered by smart technologies, including plans in the areas of councils, social care and healthcare, education and skills, transport and urban mobility.

- **Sustainability Plans**: Evaluates a city's sustainability strategy and explicit goals set for energy consumption, greenhouse gas emissions, and related goals in the areas of waste management, transportation programs, air quality, and other environmental initiatives.

- **Stakeholder Involvement**: Considers the range of stakeholders involved in the development of the smart city strategy, including citizen participation programmes, business involvement and the involvement of local universities and other research organizations *(Snow, Håkonsson & Obel, 2016)*[97].

The application dimension are as follows:

- **Implementation**: Assesses the city's overall progress in turning its strategy into action based on the number, scope and extent of projects implemented.

It also assesses the dynamics of ongoing projects and the short-term flow for new projects and programs.

- **Digital delivery**: Assesses progress in implementing the city's digital strategy, including pilot projects, smart city expressions and full-scale projects covering all forms of digital innovation, including IoT projects, open data platforms and other big data programs, and improvements in the city's communications infrastructure.

- **Service Delivery**: Assesses progress in delivering innovative services set out in the smart city strategy, including improving access to essential services, innovative social care and healthcare projects, skills improvements and training in the use of digital technologies, innovations urban mobility, innovations to support local businesses and programs aimed at providing improved information and services for visitors and residents *(Rizzo et et al., 2015)*[96].

- Environmental impact: examines achievements against sustainability goals and environmental sustainability programs, including smart energy projects, transport initiatives low carbon, energy efficiency programs (such as smart street lighting and smart waste projects).

- **Community Approach**: Assesses engagement in multiple communities, involvement of local business and academic communities in smart city projects, and extension of projects to the wider city area and other local bodies. The image below shows the ranking of 10 UK cities based on Huawei 's recent study (2017).

4.1.2 Considerations and examples around the world

So far, more than 1000 smart cities have been launched or built around the world, especially in Europe, North America and Asia *(Deloitte, 2018)*[99]. Inspired by smart city initiatives such as IBM Smart Planet, the i-Japan strategy 2015 and the Europe strategy 2020 *(Cocchia, 2014)*[100], the smart city has become a global phenomenon. Regarding the two knowledge incubators in the smart city field, North America and

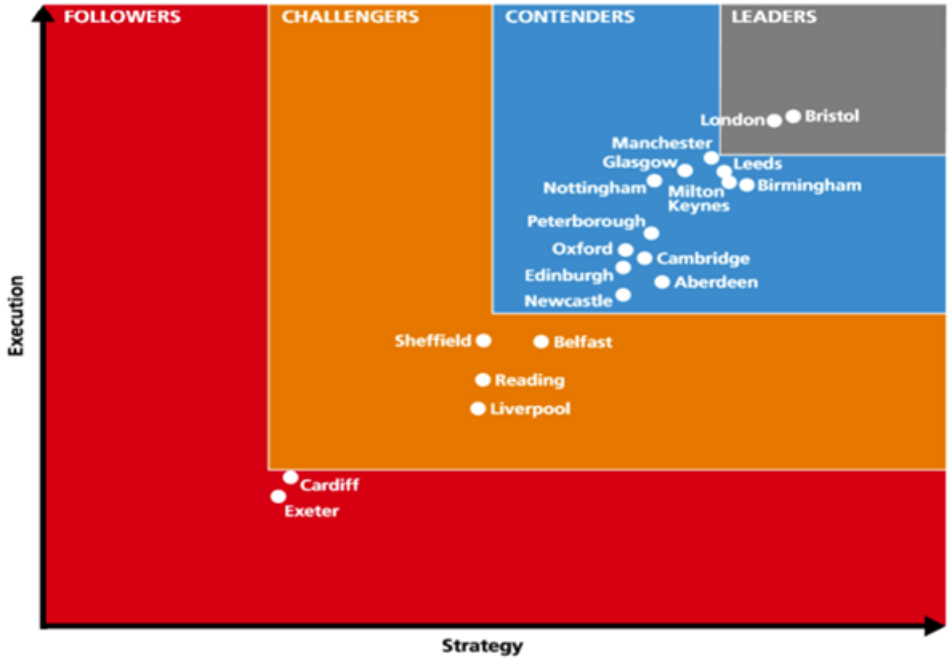


Figure 4.1: Strategy / Implementation relationship of UK cities

Source: Huawei, 2017[98]

Europe *(Mora, Bolici & Deakin, 2017)*[101], they represent divergent development paths in smart development. The first represents a vision with technology promoted by ICT companies, such as IBM, Cisco, etc., while the other reflects the trend towards a low-carbon economy *(Mora, Deakin & Reid, 2019)*[102]. Consequently, the technology-based method and the human-based method are the two general approaches when talking about smart cities *(Kummitha & Crutzen, 2017)*[93].

Then, some examples of smart cities from Greece and abroad are presented.

Example from Greece: Trikala

Trikala is a much-discussed city in the field of smart development in the Greek territory. After 2014, the municipality of Trikala realized the importance of digital transformation and aligned its policies with its environment, as follows *(Anthopoulos, 2019)*[103]:

- **Big Data and digital platforms**: The city has installed a central city monitoring platform (Cisco Connected Digital Platform6,7), which integrates various cyber -physical systems (sensors and controllers regarding smart pub-

lic lighting, Wi - Fi network, smart parking, and smart environment), while planning to install and integrate the smart bins. All aggregated big data streams are made available to the public through the ongoing Cities Data Portal *(Anthopoulos & Fitsilis, 2010)*[103]. The system analyzes all the data collected and visualizes the performance of the smart services. In addition, other platforms collect and analyze data through municipal processes.

- **Digital skills**: The municipality offers several ICT training programs within its organization and cooperates with vocational training schools to support business training in ICT. Recently, it has launched similar efforts with public schools in science, technology, engineering and mathematics (STEM) subjects, which enhance young people's creative and algorithmic thinking, problem solving and teamwork. A side effect of this initiative was that within two months more than ten local robotics academies were supported in the city, which validates the prospects around initiatives of this nature.

- **Cities and regions**: The municipality took a leading role in ICT transformation and defined the following policies: (1) data industry development: defines the open data policy, collects data flows and opens them centrally in the data portal, (2) cooperation with stakeholders in measuring ICT performance, launching training programs and undertaking joint activities (such as the "Elf Mill" and the "Virtual" Open Mall), (3) simplifying government transactions: establishing the call center of the city, launching an automated citizen engine that measures the performance of G2B services. In addition, the municipality became a member city of EU Digital Cities Challenge and thus receives coordinated support in defining the local digital transformation strategy *(Anthopoulos & Fitsilis, 2010)*[103].

- **ICT standardization**: The city of Trikala in collaboration with the Greek standardization organization is trying to standardize the ecosystem of smart cities. The head of the project team of this proposal is also the head of these standardization efforts, who oversees the smart initiatives in Trikala after 2014. In addition, its internal organization has been updated with the

definition of a specific Smart City Department that aims to standardize all of internal processes using ICT, while aiming to standardize processes involving the other stakeholders of the city (i.e. development of construction projects in the city). Standardization will be monitored with ICT, such as open project management tools.

The above initiatives were supported only with municipal funding and in cooperation with suppliers willing to develop and test their products and services under real conditions. In addition, the trade association collaborated with the Municipality and created a virtual open shopping center that operates over municipal Wi - Fi. This "virtual" shopping center communicates the offers available from local retailers to Wi - Fi users and enables the delivery of personalized advertising campaigns. In addition, the municipal water utility developed a smart water system to monitor the network, while participating in an EU-funded collaborative initiative to calculate the city's energy efficiency *(Anthopoulos, 2019)*[103]. The image below shows the fundamental elements that make up the smart city of Trikala.

Figure 4.2: The fundamental elements of the smart city of Trikala

Source: Anthopoulos, 2019[103]

Example from abroad: Barcelona

The urban transformation of Barcelona dates back to the 1980s. The city had such a development that it managed to go from a city with a deep economic crisis and a lack of infrastructure to becoming one of the leading metropolises in Europe. Barcelona has some unique characteristics that affect its urbanization plan. It is

a highly urban and densely populated environment with very close partnerships between the state and companies. As there were urban planning and social problems, the Smart initiative City was necessary to cover obvious deficiencies that existed in the previous strategic planning in terms of housing, environmental issues, water, transport and energy *(Bakici, Almirall & Wareham, 2013)*[104].

In order for a significant transformation to take place in these sectors by applying modern ICT, the Local Government recognized that a common course of action was necessary from all the city's stakeholders. This is the reason why the City Authorities together with its other organizations, as well as the institutions, organized the strategic plan of the smart city in the 1990s. Barcelona aims to become one of the smartest cities in Europe. It is important to mention that the city model revolves around a collaborative movement between companies and the market, academic institutions, government authorities and the inhabitants of Barcelona, with the aim of becoming a reference program in the field of economy and urban development. All the agencies involved are developing smart projects to promote the city's competitive profile. The overall objective of the model is to use ICT to transform the business processes of public administration both at home and abroad into more accessible, effective, efficient and transparent. For example, through the provision of smart services, Barcelona intends to strengthen the cooperation between the council, the political layer and the professional arena. There are several goals for the Barcelona model but the promotion of the competitiveness of the city's top goal. The city is organized to promote innovation, create new communication channels, facilitate access both locally and internationally and improve the efficiency of public services *(Bakici, Almirall & Wareham, 2013)*[104].

In the case of Barcelona, the smart city consists of a complex conceptual model, as it moves around the natural environment which provides infrastructure and urban planning based on historical heritage. This interaction of citizens with the city and companies ultimately creates a knowledge society. The key elements of the city model are summarized in the figure below.

The practice is grouped into four main themes: (1) smart governance, (2) smart economy, (3) smart living, and (4) smart people. In addition to tools such as kiosks

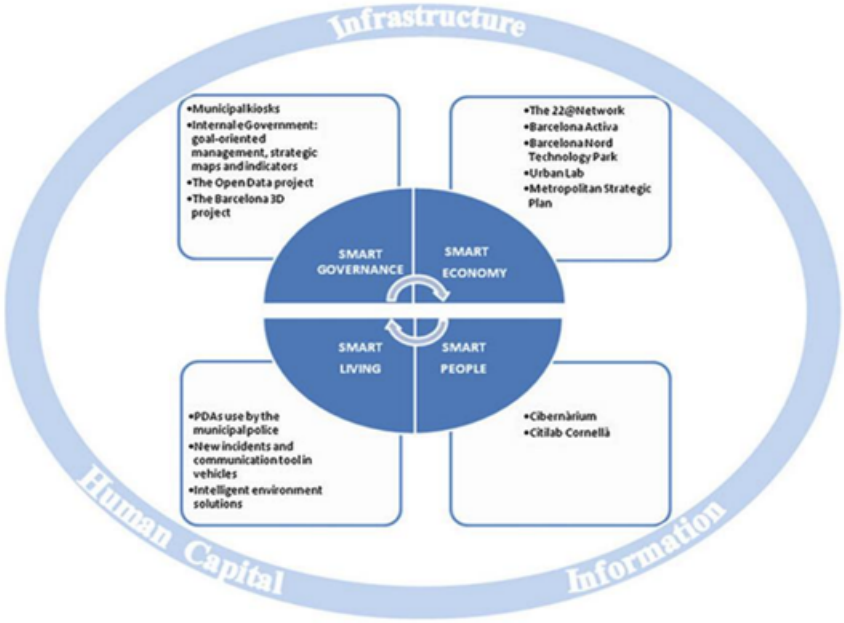


Figure 4.3: Barcelona smart city model

and maps, smart governance includes a number of important initiatives such as Open Data. However, the main objective remains to provide optimal access to government information. The smart economy involves the creation of innovation clusters and the triple helix concept where businesses, schools and citizens can interact and collaborate. To promote innovation, smart living initiatives are mainly aimed at adoptions of new technologies that initially started with application in the police and the development of tools for public transport. Finally, the smart people sector mainly includes digital education training programs of Barcelona City Hall *(Bakici et et al., 2013)*[104].

To support these initiatives in the city, existing as well as new infrastructures have been developed and used. The key components of Barcelona's strategy include the following *(Bakici et al., 2013)*[104]:

- **Smart regions**. In some areas, Barcelona has pushed the boundaries towards an efficient and sustainable city by transforming it from an industrial area to an area of innovative companies. This, in particular, is the project of district 22 Barcelona, which provides a city knowledge model that covers the standards of smart with economy, green infrastructure, science and technology, housing, mobility, quality of life and identity. The Barcelona program also operates in

this context Urban Innovation Lab & Dev (BUILD) and aims to encourage the participation of the private sector in the development of innovative products and services related to the improvement of urban space management *(Bakici et al., 2013)*[104]:

- **Living initiatives Labs**. As mentioned above, 22 Barcelona, also known as 22 Urban Lab, is also part of the BUILD program. The BUILD program uses 22 district as a leading laboratory for new infrastructure and services, inspiring companies to test an d develop innovative solutions as products or services in any field: urban planning, mobility, education, etc. The Living Labs are used as tools and processes to create collaborative user innovation in real-life environments. The Living Labs not only provide benefits, such as product improvements, but also encourage innovation and offer knowledge for future markets by reducing risk. Except 22 @ Urban Lab, Barcelona has many more Living Labs, such as LIVE, BDigital Custer Living Lab, i2Cat LivingLab (associated with UPC), FABLab (associated with IAAC), HANGAR and CITILAB-CORNELLÀ *(Bakici et al., 2013)*[104]:

- **Infrastructure**. This major transformation includes infrastructure such as companies, institutions, specific spaces, universities, technology centers, housing, and other services. The backbone of the smart city includes dedicated publicly owned infrastructure projects. These are Wi - Fi and fiber optics, a new mobility plan, new heating and cooling systems and new energy networks.

- **Innovative services for the citizens**. The model provides several new services: corporate fiber optic network to connect the main municipal buildings, Wi - Fi network mesh to provide a wireless connection to these municipal services and to the employees working in the municipality, sensor networks to manage a network as well as a public Wi - Fi network. There are also services created by citizens for citizens with Citizen Services that promote collaboration.

- **Open Data**. Barcelona City Hall participated in the Open movement Data whose objective is to make government information available to the public.

These data concern indicators of land, population, management and processes, urban environment and document data *(Bakici et et al., 2013)*[104].

4.2 How smart cities address crisis

Adapting Smart Cities to the COVID-19 Pandemic

The Covid -19 pandemic has brought about serious changes in lifestyles and accelerated digital transformation processes. The new reality due to the pandemic has led to the adoption of new technologies that help solve problems and deal with similar crises.

The mission of the smart city is to make the lives of its residents better and safer, to offer modern infrastructure and transportation services, as well as digital services that improve citizens' daily lives and make their interaction with public services easier and safer. Especially with the pandemic crisis, the smart city aims to ensure social distancing, early diagnosis and immediate treatment of cases (Faturotti, 2021).

In the new reality of the coexistence of the digital world with the physical, technologies such as drones, artificial intelligence (AI), autonomous vehicles, blockchain, the Internet of Things (IoT), Big Data, come to solve basic problems arising due to the pandemic. Technological innovations of smart cities increase their ability to detect, treat and control outbreaks of infection accurately and efficiently, which can lead to faster responses to contain outbreaks *(Wyrwa, Zaraś & Wolak, 2021)*[105]. However, in order to implement some of the solutions promoted, access to personal data is required, which means that measures must be taken to secure sensitive information.

Next, some solutions that large smart cities are successfully implementing to deal with COVID -19 are presented.

- South Korea is implementing the Smart program City Data Hub, which allows the government to perform advanced case contact tracing, using data it receives from cameras and sensors. This enables the government to intervene early and limit the spread of the virus without having to implement a blanket lockdown *(Allam & Jones, 2020)*[106].

- Singapore, on the other hand, is an example of effective use of social media (social media), such as WhatsApp, Facebook, Twitter, Instagram and Telegram, through which it shares information about COVID-19 with citizens.

- The city of Ho Chi Minh, in Vietnam, has presented an application (app) to control the citizens who have fallen ill, but also those who are in quarantine. Through this control system, as well as other strict measures, Vietnam has managed to drastically limit the spread of the coronavirus *(Costa & Peixoto, 2020)*[107].

- In China, new technologies are emerging as tools to contain the epidemic. In many cases, private companies are working with the government and offering free tools and services to stop the spread of the virus. Aircraft are one of the tools used to maintain isolation restrictions. They are often equipped with loudspeakers to communicate with citizens when they break the rules or fail to follow government orders for precautionary measures. In Chinese cities and rural areas, aircraft cameras track these people while government officials give specific instructions over the loudspeaker. Chinese authorities are also using electronic surveillance and facial recognition technology to detect quarantine violators and issue warnings to enforce epidemic regulations. Surveillance includes cameras in public places, reading license plates and mobile phone data collected by telecommunications companies *(Wyrwa, Zaraś & Wolak, 2021)*[105].

The above techniques are quite limited in America, due to the legal barriers imposed by the protection of privacy. For example, a growing number of US cities (Oakland, Portland, San Francisco, etc.) have banned or are considering banning facial recognition technology. However, less invasive measures to mitigate the coronavirus could prove useful for cities during a public health crisis *(Abusaada & Elshater, 2020)*[108].

For example, Beijing has used wireless artificial intelligence (AI) technology at transportation hubs to check travelers' temperatures and identify people who may be infected. In the US, the Centers for Disease Control and Prevention (CDC)

conducted similar applications at three major international airports. In Shanghai, voice-recognition devices communicate with citizens in danger to provide treatment instructions. Private companies and the Chinese government have released apps to allow citizens to check if they have been in close contact with a person who may be infected with the coronavirus *(Allam & Jones, 2020)*[106]. The apps serve as sources of information distribution and provide care recommendations, but they also collect data to help the government update its records on the spread of the virus.

A simpler application used in the US. It is the "Flu Near You", which uses information from citizens to inform the public about the spread of infectious diseases. Analytics technology also provides a variety of benefits, from enabling cities to assess the risk of contagion in their population, to tracking the spread of an outbreak to deciding where to allocate resources. Many private companies offer AI-based software, analytics and mapping applications. Nonprofit organizations, such as HealthMap and OpenStreetMap, also offer data-driven epidemic "trackers" *(Azoulay & Jones, 2020)*[109].

The health and technology communities have turned more of their attention in recent years to creating and improving data analysis software for zoonotic diseases, which account for 60% of infectious diseases. While mapping and geographic information system platforms are typically used to detect an existing outbreak, they can also be used for preventative measures, indicating where a zoonotic outbreak might occur and how it might spread.

Also, multimodality prevents citizens from being cut off from communication if one mode is exceeded during a crisis. 5G technology is expected to further increase the bandwidth and speed of crisis communication *(Allam & Jones, 2020)*[106]. Some US cities have already partnered with communications companies on systems that enable two-way interactions between local government and citizens. The city government sends a mass mail message or app notification to citizens, who respond to a template saying they are fine or need help *(Azoulay & Jones, 2020)*[109]. Citizens can choose to share their location through the device.

Citizens must trust government institutions to make the response to a health crisis work. But technology can create barriers to that trust if misused.

Another key element is for city departments to fully understand the technology and its capabilities. This often comes from building strong and lasting partnerships with technology manufacturers or service providers for ongoing system support and oversight. (Faturotti, 2021).

Security and privacy are also a primary concern whenever a government collects and analyzes citizens' data, let alone when sensitive information about citizens' health is collected. Digital tools should be able to cover individuals' personally identifiable information, while providing cities with their valuable and actionable knowledge. Analytics software and other technologies are most robust when aligned with federal security and encryption standards.

Smart European cities are responding to the ongoing COVID-19 pandemic in a variety of ways by providing smart, socially inclusive and energy efficient solutions through the European program "Smart Cities and Communities Lighthouse" of the EU *(Costa & Peixoto, 2020)*[107]. During the quarantine, the 46 cities participating in 17 projects of the European Smart Cities Program are using different smart technology applications in the fields of energy management and data exchange in urban areas, with the aim of restoring normalcy as quickly as possible post-Covid -19 era.

The Sharing program Cities looks at the role that the technologies implemented in the cities of London, Lisbon and Milan can play in dealing with COVID-19 *(Wyrwa et al., 2021)*[105]. As citizens drastically change the way they move around cities and spend more time in their homes, housing quality and energy consumption become even more important. The addition of sustainable energy management systems to energy- intensive buildings, through the relevant program, ensures that they will become energetically "smarter" with a low energy footprint. The bottom - up solutions developed by Sharing Cities, like the Digital Social Market, motivate citizens for positive behavioral change, further increase the resilience of energy systems, create vibrant communities, encourage energy-neutral lifestyles and continuously pursue sustainability goals *(Wyrwa et al., 2021)*[105].

4.3 The smart city business opportunity

4.3.1 The economy in the context of the smart city

In the context of intelligent development, the concept of smart economy is becoming more and more popular. The smart economy, a key building block of the smart city system, has been defined in many ways. The literature review reveals different definitions of the smart economy, some of which are summarized below:

- The smart economy includes the knowledge economy, where innovation and technologies are considered as the most important driving force *(Torres, Pina & Royo, 2005)*[110].
- The smart economy implies the creation of innovation clusters and mutual cooperation between businesses, research institutions and citizens in order to develop, implement and promote innovation through these networks *(Bakici et al., 2013)*[104].
- The smart economy combines the business economy and the innovation or 'ideas' economy. A characteristic of the smart economy is the use of human capital, i.e. knowledge, skills and creativity, turning ideas into valuable processes, products and services. The smart economy also focuses on creating the "green economy" by developing "green companies" (promoting the employment of renewable energy sources, increasing energy efficiency, based on needs and reducing costs) *(Zygiaris, 2013)*[65].
- Smart economy is the ability to use existing resources to develop and implement innovative solutions. It is a networking economy, which develops new models of cooperation in production, distribution and consumption *(Anttiroiko, Valkama & Bailey, 2013)*[111].
- The economy of a smart city emphasizes its ability to overcome economic challenges, create new jobs, create new businesses and increase the attractiveness and competitiveness of the area *(Alawadhi, 2012)*[112].

- Urban efficiency is identified with the intelligence of the city, as an efficient city attracts and retains a skilled workforce, new businesses, students, tourists and residents *(Auci & Mundula, 2012)*[113].

The objectives as well as the characteristics of the smart economy in the smart city are *(Kumar & Bharat, 2017)*[114]:

- The smart economy shows a high capacity to transform the smart city with the effective use of ICT in every aspect of its economic activities. Therefore, the smart city with a smart economy has a clear long-term economic vision, which is accepted by civil society, the public and private sectors and other relevant stakeholders.
- The smart economy builds on and fosters a knowledge-based economy through the active sharing of knowledge for the economic benefit of all people.
- The creation of an innovative spirit seeks a newer approach to economic activities. Innovation is stimulated through competition, cooperation and clustering of economic units and activities.
- Entrepreneurship is created by individual effort and nurtured through positive business climate, capacity building, institutional strengthening and openness to unforeseen opportunities.
- The smart city economy acts as a force that enhances international economic deepening so that the city and its residents benefit from the process of economic globalization.
- The smart economy has high productivity of land, labor and capital.
- A good quality of life for all is essential for the development of the smart economy. This entails effective provision and management of urban infrastructure, services and amenities, and effective management of the urban environment, natural resources and urban life.
- Valuing, preserving and promoting local culture and heritage is central to the smart economy, which effectively manages and facilitates creative development

in culture and heritage, and links it to the development and promotion of sustainable tourism *(Kumar & Bharat, 2017)*[114].

A prerequisite for the smart economy in smart cities is universal access to high-speed Internet. Smart city citizens tend to use the Internet for all areas of life be it shopping, recreation, education, or participatory democratic governance. Delving deeper into the relationship between the smart city and the economy, we can see another way in which they are connected. An interesting aspect is the consideration of the smart city as a "platform economy" *(Nieto - Mengotti, López -Arranz & Novo - Corti, 2019)*[115].

Technologies have made possible new forms of socialization, the main exponent of which are digital social networks that form the basis for the initiation and development of new ways of consumption. The rapid penetration of new telecommunications technologies, combined with increasing access to networked devices and the growth of social media, has led to structural changes in consumer behavior and consumption habits. Recent years have seen significant growth in this new reality that is revolutionizing the entire industry, fundamentally transforming the way consumers and users relate to industries *(Auci & Mundula, 2012)*[113].

This has been the basis for the launch of countless new business models based on services and products that already existed, but are now offered in a more accessible and efficient way. Platforms create value through the contact between suppliers and consumers of a product or service, always based on a technological support, which would not be possible without technological developments. These include cloud storage, virtual servers, virtual reality, artificial intelligence, the development of big data and, most importantly, the increase in connectivity, which has enabled the Internet of Things. This connectivity would not be possible without the development of a broad and efficient telecommunications infrastructure in urban areas *(Bakici et al., 2013)*[104]. The superiority of the platform economy over the traditional economy is based on a number of factors that make a company succeed in building an innovative platform with one common feature: they are all structured as networks, connecting people, companies, information and goods to each other. Connections and information have become the most valuable assets a company can

own. Multilayered compared to the classic economy, the network economy has its own rules and market mechanisms *(Kumar & Bharat, 2017)*[114].

This network structure provides companies with four superpowers, the cornerstones of their competitiveness. First, the power to detect and organize units of very little value, creating value for the user. Second, an excellent ability to operate in real-time, using real -time data to instantly adjust the market and improve the value of products. Third, the endless ability to grow. Fourth, the ability to personalize products or services, using customer information and tailoring the experiences provided to each customer *(Zygiaris, 2013)*[65]. By targeting and personalizing products to each individual user, intimate and solid relationships are created.

The model developed by "start - ups" is the one that best exploits the scalability and flexibility of this environment offered by technological platforms. This helps businesses grow rapidly with limited infrastructure. Creating smart cities requires political will, decision-making, negotiations and government decision-making power. Citizen participation can have a favorable impact on citizens' quality of life, covering such broad options as e-commerce forums, online or telecommuting, telemedicine, open government enterprises, and democratic practices. Having a city that functions as a platform full of options is only valuable if its citizens know how to integrate it into their daily lives.

A smart city is the sum of different efforts from many sectors, forming an intelligent system. The connectivity that has developed in recent years, mainly in the industrial and technological sector, has focused on the business use of new connectivity solutions, closely linked to their digital transformation processes. However, apart from the project or collective fields, there is already a continuous presence of the Internet of Things (IoT) and in other aspects of personal life. In the context of IoT, the smart city as a platform enables a collaborative economy to flourish. There are five key features that favor the development of the collaborative economy in cities:

1. The collaborative economy creates markets for goods or services.

2. The collaborative economy opens up opportunities for the efficient use of ca-

pabilities and capacities that are not used in housing, time or money.

3. Community-based networks are created, rather than centralized institutions or hierarchical structures.

4. In these platforms, the personal and professional level of the employees is diffused.

5. In the new economy, the boundaries between full-time work and casual work, between employment and self-employment, and between work and leisure, are blurred *(Lombardi et al., 2012)*[88].

Yet, there are two types of transactions called B2C (Business that Consumer) and C2C (Consumer that Consumer), depending on whether the exchange is between individuals or between companies and individuals. The types differ according to the economic sector in which they operate. Thus, in the transport sector, there are cases of car-sharing platforms such as Uber, Zipcar, Lyft or BlaBlaCar, which connect drivers and cars of any type with passengers. Another factor that points to the great potential of smart cities in terms of economy is to address inequalities, both within the city itself and between different cities. *(Shahrestani, 2018)*[116].

Another critical factor is ensuring that the entire city can benefit from technology-driven economic growth. Poor and insecure areas, which are often excluded from this kind of technological progress, need to be seen as part of a broader strategy of "levelling" the digital and financial inclusion of poorer minorities and communities. An example is the collaboration of local authorities with private ride - sharing service providers, such as Uber, to improve mobility in more remote suburbs of a city. The productivity and economic benefits that could come through these new technologies can exceed the potential of more traditional infrastructure investments, such as building new railways, both in terms of cost and difficulty *(Susanti, Soetomo, Buchori & Brotosunaryo, 2016)*[117].

The other big growth opportunity offered to the most forward-thinking local authorities is attracting business and investment to the fledgling smart cities ahead of the competition. This may include offering favorable tax incentives to encourage

businesses to relocate there. This is a particularly attractive prospect for smaller cities, where local authorities are disadvantaged by limited financial resources and a lack of relevant technical expertise. Already, coalitions are starting to form, especially among smaller cities and communities, allowing participants to share benefits and apply best practices. Also, competition between municipalities brings its own benefits, accelerating interest, advocacy, and ultimately development of the required technology *(Rizzo et et al., 2015)*[96].

4.3.2 Business Models in Smart Cities

Technological development has changed the approach of business practices in urban infrastructure development. Thus, significant new opportunities are constantly emerging through these developments. More specifically, smart technology now allows accurate and reliable measurement of socio-economic and environmental impacts. It is therefore possible to quantify and price the externalities created by investment in urban infrastructure. This fact opens up new sources of revenue for projects, new business models for value recovery and collection as well as new investment opportunities. This is the context in which smart city solutions arise *(Osterwalder, 2004)*[118].

The term "business model" gained popularity in the late 1980s and, while originating from e-commerce, has been incorporated into a variety of empirical contexts *(Amit and Zott, 2012)*[119]. Essentially, it is designed as a conceptual tool or model capable of understanding how companies create and deliver value to customers and capable of enticing customers to pay for that value and converting those payments into profit *(Teece, 2010)*[120]. Although technology is the key factor in the development of new business models, data indicates that without a coherent approach to new business opportunities, proposed solutions are likely to fail. Local stakeholders need to think and act beyond the technological point of view and be realistic about the planning area, required inputs and sustainability of initiatives, as well as governance and funding issues. City decision-makers need to define a rigorous business approach and encourage the engagement of investors and stakeholders from the earliest stages of the project, such as the planning stage *(Teece, 2010)*[120].

The key dimensions that characterize successful implementation in the underlying business models are:

- Governance: Governance relates to the mechanisms, relationships and approaches to directly manage integrated smart city solutions. As smart city solutions tend to include public units, they are often the ones that determine the approach and interaction between other units, levels of cooperation between departments or different agencies, data management, etc. *(Osterwalder, 2004)*[118].

- Funding: Funding represents a key element in creating a smart city. Current budget limits and constraints force public authorities to seek the appropriate financial and financing mechanisms to support strategic planning and integration between municipal services, as well as the procurement processes necessary to deploy smart solutions at scale. Similarly, financial constraints affect the private sector (especially small innovative companies and start-ups growing with high-risk projects and products), limiting both their ability to develop innovative solutions and their ability to bring their products to market *(Amit and Zott, 2012)*[119].

- Procurement: The complexity of cities, in terms of parties and processes involved, including procurement, is one of the main barriers to the adoption of integrated smart solutions. This complexity appears in many areas (politics, governance, economy, etc.) of local governments and may create difficulties for city leaders and stakeholders to agree on methodologies for implementing smart city solutions. It seems that a critical factor that can accelerate the development of solutions is an open and cooperative market, which can bring to the city the largest number of solutions and which ensures lower implementation costs. Procurement, and more specifically, innovation procurement, is one factor that can create this type of open and collaborative market *(Teece, 2010)*[120].

- The role of citizens: More and more stakeholders practicing smart cities, as well as policy makers, recognize that the change required to achieve sustain-

able solutions that are able to produce results (such as higher resilience of cities, increased regional sustainability and lower resource consumption), the role of citizens, local businesses and communities is critical in developing, implementing and sustaining high-impact sustainable solutions. Many evidences that have emerged from cases of both successful and failed smart city initiatives highlight the importance of structuring the approach to solutions. This structuring starts from the definition of a coherent and shared strategic vision and ends with the definition of the needs of the city, through a specific business plan *(Teece, 2010)*[120].

IoT technology platforms, the overall architecture can be considered to consist of three different layers (perception layer, network layer and application layer), each of which is complemented by companies and individuals, who provide the system with specialized resources and capabilities *(Domingo, 2012)*[121]. Specifically, the perception level is concerned with evaluating the physical properties of things, and gathers information about them and their environment. The network layer transmits information, collected from the previous layer, to the next layer through a network consisting of a number of actors, information storage and processing systems. Finally, the application layer transforms information previously collected and processed with high-value digital services offered to end customers, belonging to a variety of application domains *(Domingo, 2012)*[121]. These three levels are differentiated from each other according to the activities they perform and the technical solutions they adopt to achieve their specific goals.

In addition, differences were observed in the business models adopted by companies belonging to each of the three levels mentioned above. Indeed, businesses operating within the application layer are expected to deliver value through the design and delivery of new services based on IoT solutions. In contrast, companies operating at the network layer seek to connect the application layer with the perception layer. Accordingly, the value of the service provided by such companies depends on their ability to create fruitful relationships with stakeholders belonging to the other two levels. Finally, companies belonging to the perception layer focus their efforts on designing "smart objects", i.e. smart products that can interact

with the environment and gather information about specific aspects related to it *(Domingo, 2012)*[121].

Following such an approach, management scholars have attempted to identify the characteristics of business models for companies operating in an IoT context *(Wirtz, Pistoia, Ullrich & Göttel*[122], 2016). Most of the attention has been devoted to how the theoretical frameworks used to describe the business models of enterprises need to be modified to capture the specificities of the IoT. Specifically, a theoretical framework that has been examined it's the Business Model Canvas (BMC) *(Dijkman, Sprenkels, Peeters & Janssen, 2015)*[123]. *Dijkman et al. (2015)*[123] suggest the integration of the "value proposition" construct, which includes aspects related to convenience and the possibility of updates, the "customer relationship" component, which includes aspects related to co-creation and communities, and the element "collaborations - key a".

Since the technological platforms of smart cities are indeed IoT technological platforms, in the case of smart cities it is possible to identify the three different levels of the architecture (perception, networking and application levels) *(Shahrestani, 2018)*[116]. In particular, special attention should be paid to the analysis of the differences of the companies' business models in relation to the business models adopted by companies belonging to other sectors. However, it has been argued that the analysis should not only focus on modifying differences in BMC structural elements. This approach, in fact, would underestimate the connections that exist between the various components of the business model, overlooking the fact that the competitive advantage of companies comes from a coherent and harmonious organization of activities *(Olson, Slater & Hult, 2005)*[124].

4.3.3 Entrepreneurship in smart cities

As urban populations grow, consumption and production habits are also changing significantly and are constantly evolving. Among other things, companies are invited to produce and deliver material related to home technologies, advanced security and sensors. The networked development of cities at the infrastructure level and their

shift to a smarter and more sustainable reality not only helps cities in their social, cultural and urban development, but also opens up new market and exploitation opportunities by businessmen. This is because sensors collect massive amounts of data which are then available to businesses to use to market their goods and services. The collected data further enable the dynamic analysis of city life and provide material for the businesses, which can be used in new and innovative ways *(Bakici et al., 2013)*[104].

It is supported that smart cities promote the "neoliberal ethos" that prioritizes market-driven technological solutions *(Kitchin, 2014)*[48]. In order to produce new technologies necessary for cities, firms are able to propose new ideas and benefit from the exploitation of these ideas *(Munoz & Cohen, 2016)*[125]. Entrepreneurs are able to create new areas, pioneer and radical differentiation, and have the ability to transform existing organizations, leveraging corporate entrepreneurship, individual entrepreneurship or social entrepreneurship.

A classic example of corporate entrepreneurship is IBM's smart city. IBM began exploring and capitalizing on smart city business opportunities shortly after the 2008 economic recession *(Paroutis, Bennett & Heracleous, 2014)*[126]. The potential is such that both developed and developing countries are adopting smart city vision and inviting global companies to participate in corporate entrepreneurship. Given the huge prospects, software companies that are considered giants, such as IBM, Cisco et al., have begun to move into the field of civil services and consulting businesses *(Kummitha & Crutzen, 2019)*[93].

In addition, point out that citizens can play an important role in the development of smart cities by creating new technologies. Often citizens start small and medium enterprises or social enterprises to tackle local problems by inventing new technologies. In particular, *Kummitha and Crutzen (2019)*[93] argue that citizens act as entrepreneurs to create IoT interventions based on smart cities. Cities typically adopt two types of approaches to encourage entrepreneurs to participate in smart city interventions: (a) promote public - private collaboration and (b) play regulatory roles.

City governments work directly with companies, SMEs and citizens. In this

context, *Munoz and Cohen (2016)*[125] state that cities need to create a dynamic environment for the three main factors, the private sector, citizens and policy makers to work together. While the companies are actively involved in the creation of technological innovations within the framework of strategic corporate entrepreneurship, *Almirall et al. (2016)*[127] argue that governments also need to ensure that people at the grassroots level are excited about creating smart city-driven technologies that are relevant to basic needs. The technologies adopted to improve the efficiency of cities generate a huge amount of data, which when collected can be used to create certain business opportunities. Data is collected by monitoring and evaluating people's movements and activities, thus aiming for better city-level planning *(Almirall et al., 2016)*[127].

Open data can enhance political and civic debate among citizens. In addition, open data can promote economic progress by enhancing business activity and encouraging the development of new products and services. By allowing citizens to access data, governments can thus encourage innovative businesses and services that offer social and economic value *(Berrone, Ricart & Carrasco, 2016)*[128].

How cities offer various business opportunities is summarized in the following figure:

Figure 4.4: Smart cities and business opportunities

As part of the regulatory role, several cities are redefining their ecosystems, allowing for greater involvement of the private sector. Policymakers create a supportive environment for entrepreneurs to benefit. The change in government behavior reflects the enriched role of corporate entrepreneurship and citizen-led businesses *(Kummitha & Crutzen, 2019)*[93] in the context of the smart city. Such an enabling environment offered by the state through its supportive policy enables corporate companies to innovate and offer advanced smart city solutions. The state can actually offer tax benefits to encourage environmentally friendly technologies *(Oberg & Graham, 2016)*[129].

Given the potential to create and promote technological innovations and promote smart living throughout the city, companies are investing huge resources in smart city initiatives *(Sweet, 2011)*[130]. For example, Cisco has invested around $100 million in smart cities in India and France, while it has committed to investing around $500 million as part of the project "Deutschland Digital" to turn Berlin into a smart city. IBM has committed to invest around $3 billion in smart city projects. In fact, developed countries have chosen the smart city as a sustainable strategy and therefore invested in promoting cities in emerging economies *(Deloitte, 2018)*[99].

While helping cities keep up with necessary technological advances, companies also benefit greatly when such technologies are implemented. First, they can tap into the technology market. Second, IoT devices installed in cities help generate huge volumes of data. Data has so far been used by companies to improve their inventory, improve forecasting, reduce lead time and understand order frequency. In this context, Big Data helps businesses create value *(Roden, Nucciarelli, Li & Graham, 2017)*[131]. Cities show interest in sharing big data with citizens and start-ups in order to enable them to create IoT interventions to deliver public services more efficiently and sustainably *(Cocchia, 2014)*[100].

Several smart cities around the world have started to promote small and medium-sized and social enterprises *(McFarlane & Sö derström, 2017)*[132]. In order to create a supportive environment for those interested in bringing about technological developments, cities must provide profitable infrastructure. Consequently, municipalities have begun to establish special departments or offices to negotiate with various stakeholders to create infrastructure, including formulating the necessary policies, in order to encourage entrepreneurship *(Cohen, Almirall & Chesbrough, 2016)*[133]. Creating an enabling environment at the city level encourages citizens to establish social enterprises that not only contribute to addressing social problems but also create local employment opportunities *(Caragliu & Del Bo, 2019)*[134].

Chapter 5

Human Smart Cities

In recent years, Smart Cities have been developing and focusing on the introduction of technology into the daily lives of residents, with the aim of development and sustainability at all levels of a modern society.

People and systems are increasingly 'integrated', and this has led to the development of 'human-centric' services. These services become personalized, intelligent, reliable and aim to transform data into real value for citizens. For example, in a smart city citizens will be able to be informed about available parking spaces near their home or about alternative modes of transportation and routes, which reduce air pollution and traffic congestion.

Despite the benefits that these cities present, many times, due to the emphasis placed on technological progress, other problems associated with human activity in the city may arise or be maximized *(Schuler, 2016)*[135]. Quite often, technological solutions ignore the human factor, completely neglecting the fact that cities are made by and for people *(Oliveira, 2016)*[136]. Technological solutions draw all attention away from the real problems of people, such as social exclusion and isolation of individuals, putting citizens in a subordinate fate *(Schuler, 2016)*[135].

The above situation has created the need to adopt a different kind of "smart" approach, in which citizens and their well-being will always be the number one priority. Human Smart Cities are called upon to provide solutions to existing problems by offering new perspectives and possibilities. They respond to people's needs for

a quality, technologically advanced urban environment, with safe living conditions *(Depine, Eleutheriou & Macedo, 2017)*[137]. They are cities that provide their citizens with the active participation and utilization of smart solutions, in order to improve the standard of living and realize urban sustainability. They are cities that enable citizens to use "smart" technology to contribute to the urban planning and management of their city *(Yigitcanlar, Foth & Kamruzzaman, 2015)*[138]. Applying bottom-up planning in these cities, solutions come from the harmonious collaboration of all the actors involved *(Rizzo, Deserti & Cobanli, 2015)*[96]. Bottom-up innovations and the involvement of citizens and various organizations has become a dominant driver in the planning of these cities, especially when looking for solutions not based on central planning and control by the state *(Komninos, Bratsas, Kakderi & Tsarchopoulos, 2016)*[139].

5.1 Definitions of Human Smart Cities

Human Smart Cities present a new paradigm of urban planning, which combines utopian visions and practical solutions to achieve a sustainable, democratic and limitless future. In recent years, various attempts to formulate the term "Human Smart Cities" have been observed in the scientific community. According to *Oliveira and Campolargo (2015)*[140], *"Human Smart Cities are those in which society as a whole participates in shaping the urban environment through an ecosystem of innovation, interaction, synergy and collaborative planning"*. Also, *Depine, Eleutheriou and Macedo (2017)*[137], define Human Smart Cities as *"an ecosystem where physical and digital infrastructures coexist in a systematic relationship with the human capital of the city"*. The same researchers argue that "Human Smart Cities are the new generation of smart cities, which balance technological infrastructure with factors such as social engagement, citizen empowerment, and the interaction of individuals in physical and virtual environments". In addition, *Rizzo, Concilio, Marsh and Molinari (2013)*[141], claim that "Human Smart Cities are a place where citizen-centered planning approaches and increasing their participation are applied, in order to implement a collaborative design and a developing smart applications and services that will balance the technical intelligence of various sensors, meters

and infrastructure with simpler features such as social interaction, collaboration and citizen empowerment in physical urban environments".

5.2 Human Smart Cities practices

From the above, it can be seen that the concept of Human Smart Cities does not come into conflict with the traditional concept of smart cities, but frames their development more coherently towards the interests and real needs of citizens. People should be the real protagonists in a city, and in this sense, the development and transformation of a city that seeks to become "smarter" should start by meeting the desires and current needs of its citizens. Having as a vision the creation and promotion of Human Smart Cities, some practices are then presented which are estimated to contribute to this purpose.

- In terms of vitality:

  The urban green spaces will add color and beauty to the public spaces, offering aesthetic pleasure to the residents and visitors of the area. Through the use of smart technologies, visitors to these spaces will be able to connect to the internet, charge their electrical devices and stay informed about what is happening in the city. On the other hand, public bodies will be able to collect information on the levels of air pollution, noise, humidity and heat, while at the same time they will be given the opportunity for a more efficient waste management. In addition, through the promotion of the city's attractions on social media media, in applications and websites, the city will gain readability and attract new visitors *(Rizzo et et al., 2015)*[96].

- In terms of sustainability:

  Enhancing cycling in the city will help reduce the environmental footprint and save resources. The upgrading of traditional Mass Transportation to electric and automated vehicles will bring about similar results. Also, real-time information on the arrivals and estimated departure times of the various Mass Transportation lines, combined with their priority at traffic lights, will give citizens the opportunity to reduce their travel times.

- In terms of accessibility:

  Through problem reporting websites and apps, citizens will increase their participation, contributing to the governance of public space. Taking into account the relevant requests, the competent bodies will be able to act in a timely manner ensuring a quality and safe environment. In addition, through the transformation of conventional traffic signals into intelligent systems that offer visual and audio indications, citizens with hearing and visual impairments will be able to cross roads/crossings more easily and safely *(Rizzo et et al., 2015)*[96]. The design of an integrated routing network for the blind will also contribute to the above, at the same time as the development of applications oriented to their needs. Furthermore, automated Mass Transportation with respect to the special needs of the disabled will offer comfortable and safe road travel, while at the same time saving energy and resources. Finally, the specially configured parking spaces for the disabled that utilize parking-finding applications will facilitate their access to various buildings and infrastructures.

- In terms of security:

  Traffic safety: The transformation of the exclusive traffic roads into light traffic roads and their monitoring through intelligent systems and sensors, will lead to lower speeds on the road helping to reduce the chances of an accident. In addition, the collection of data from the environmental sensors will help the relevant agencies to take further measures to limit air and noise pollution. In addition, smart road equipment, apart from helping to reduce speeds, will provide information on the number of vehicles crossing the road. Crime prevention: Enhancing the brightness in public spaces through smart lighting bulbs will contribute not only to crime prevention, but also to saving energy. On the other hand, the installation of surveillance cameras in public places will give the police authorities the ability to identify criminals, which will act as a deterrent to their desire to commit criminal acts. The utilization of crime maps will also contribute to the above *(Oliveira & Campolargo, 2015)*[140].

- In terms of durability:

  Urban green spaces and open public spaces are ideal points of evacuation, es-

cape and assistance in natural disaster situations. By equipping these spaces with modern digital technologies, citizens will be able to inform and be informed in real time about the events taking place in the city. The empty ceilings, if equipped with energy production systems, will be able to offer this energy to citizens even in situations of collapse of the city's central energy supply network. Furthermore, the placement of sensors in the drainage networks will contribute to the fight against flooding phenomena, as the collection of data will allow a more effective maintenance and cleaning of the networks. In addition, the construction and utilization of risk maps will contribute not only to the protection of human lives but also assets *(Oliveira & Campolargo, 2015)*[140].

The "smart" building materials will also agree to the above. In addition, the integration of an intelligent and flexible transport system will offer more opportunities to escape from danger. Finally, informing citizens via the internet about the natural risks their city is facing will develop their preparedness against emergency situations.

Summarizing, it is observed that the Smart cities and the Human ones, each separately present certain practices, which contribute positively to the achievement of a sustainable urban environment oriented towards the well-being of their inhabitants *(Schuler, 2016)*[135]. Also, it is observed that when the human-centered planning approach comes in harmony with smart practices, the results presented are ideal for the creation of human smart cities *(Gehl, 2013)*[142]. It is realized that the two dimensions complement each other, multiplying the benefits they would present if taken separately.

Chapter 6

The Security aspect

Many IT safety mechanisms were created in order to protect people and businesses from being exposed due to security leaks.

ISO/IEC 27001

The ISO 27001 standard was published in 2005 under the title "Information technology Security techniques - Information security management systems - Requirements". the ISO/IEC 27001 standard specifies the requirements for the establishment, operation, monitoring, review, maintenance and improvement of standardized information security in the context of the organization's overall business risks. It specifies requirements for the implementation of information security controls tailored to the needs of organizations or individual departments thereof. As a framework, the standard is aimed at companies of all sectors and of all sizes *(ISO 27001, 2005)*[143].

The requirement to design, implement, operate and continuously monitor and improve a process-oriented ISMS is the focus of the 27001 standards. The coverage and scope of an ISMS must be defined for planning and implementation. Risks must be identified and assessed and control objectives for information and information systems must be defined so that appropriate measures to protect businesses are taken from them *(Qusef & Alkilani, 2022)*[144].

Anti-phishing hardware and software

Phishing is considered the attempt to deceive PC users through any network (intranet, internet, etc.), in which the "attacker" impersonates a reliable entity (natural or legal person), in order to obtain personal data in an unfair manner of the "victim" such as passwords, sensitive personal data (such as medical history), exploiting existing deficiencies in protection and authentication *(Khonji, Iraqi & Jones, 2013)*[145]. This particular form of cyber-attack happens frequently and is a significant challenge in terms of the security of personal data both for individuals in their private lives and for the companies - organizations where these individuals work.

Cryptographic controls

By using encryption, organizations and critical infrastructure organizations seek to protect the confidentiality, integrity and authenticity of data-information in the information systems they use and in general in the IT infrastructure. The information that is traded is not readable by anyone except by the users - authorities who also possess the corresponding encryption-decryption process. Thus, the risk of interception of information - data is immediately limited, since even if it eventually happens, the information will not be readable by the one who intercepted it *(Roberts & Al-Hamdani, 2011)*[146].

Privacy - Protection of personally identifiable information

The personal data protection policy is a field that concerns the managers of information systems in collaboration with the IT managers of an organization, as the protection of personal data also carries criminal responsibilities in cases of violation of the relevant provisions that protect personal data. Especially with the introduction of the relevant legislation that will be based on the European GDPR Regulation, certain parameters related to personal data are changing. The personal data protection policy refers to the ways in which the organization (or company) uses, manages and processes the personal data of the users - customers of the information system *(Choi, 2021)*[147]. The personal data protection policy is a legal statement aimed

at protecting the customers/users of an organization/company, whether it concerns the private sector or the public sector. IS managers in collaboration with the organization's IT infrastructure managers should take into account the three main properties of personal data when drawing up the personal data protection policy. The properties are as follows: a) Confidentiality, b) Integrity, c) Availability.

All three of the above situations must be provided for in the organization's privacy policy and managed accordingly by the administrators of the software and the IT infrastructure. Administrators must first:

- Identify the personal identifiable information that the organization is managing and is required to secure
- Prioritize personal identifiable information according to their properties, states and the degree of impact they have on the organization in the event of a security incident.
- Identify the points of "entry", storage, processing and "exit" of personal identifiable information *(Stringer, 2011)*[148].

Network Security

An information system usually consists of a number of computers and servers that are connected to a network, whether it is internal within the critical infrastructure, whether it is located in the cloud or otherwise on the intranet. Access to this network must be ensured by mechanisms that will ensure that users gain access to it in accordance with what is defined by the access control policy we saw above and their requests will be routed through the necessary ports. Also, the data to which they have access via the internet for reading - modification - deletion must be done in accordance with the information classification policy that is applied *(Marin, 2005)*[149].

The primary objective of an Information System administrator in a critical infrastructure organization is to protect system information, which may be "traversed" both on the organization's internal network and on the intranet that may be available or available via the Internet to third parties. (e.g. partners, citizens, suppliers,

etc.). A secondary but equally important goal is to prevent unauthorized access to the network by third parties (and possibly malicious users). That is why the design of the network security policy must be done taking into account some basic security principles such as the following *(Marin, 2005)*[149]:

1. Principle of easiest penetration. According to this principle, IT managers must expect that the attacker will try to gain access to the organization's network using any suitable means without moral barriers.

2. Principle of adequate protection. The assets of the organization and in this case its network must be protected to the extent that is proportional to the value (of the asset) and for as long as this is necessary. There is no need to waste the organization's resources by overprotecting an asset more than necessary.

3. Principle of effectiveness. The choice of methods and mechanisms that managers will use to protect the network must be done correctly and according to safety standards so that they are also effective.

4. Principle of the weakest link. A security policy - especially in networks - is only as strong as its weakest component. In this case (and mostly in cyber security in general) the weakest "link" is the human factor that can be influenced by third parties (manipulation) as we saw above in phishing.

5. Principle of proof of authenticity. Information exchanged on the network (internal, intranet, internet) must come from real users who have been certified to use the organization's resources. Also, the content of the information must be genuine – not falsified, delayed or replaced with other information *(Marin, 2005)*[149].

Chapter 7

The MyData Network

7.1 The Project

In recent years, a network of activists, organizations, entrepreneurs, companies, etc. has been created, with a common goal: to create a human-centered approach to personal data. This network, MyData, aims to inform individuals and communities about their personal data, so that they are empowered to make informed decisions and interact more consciously and effectively, both with each other and with organizations *(www.mydata.org)*[150].

As the importance of personal data in today's society continues to grow, it becomes increasingly imperative to ensure that individuals are able to know and control their personal data, share it securely and with their terms, but also to gain personal knowledge from the combination of these data and to claim a share of the benefits of this process *(Oliveira, 2016)*[136]. Today, the tide is clearly tipped in favor of those organizations that have the power to collect, trade and make decisions based on personal data, while individuals can only hope, begrudgingly, that we can gain control, at some level, about what happens to their data *(www.mydata.org)*[150].

The changes in relation to the current situation and the principles formulated by the MyData network, aim to restore balance and move towards a human-centric vision for personal data. These principles, it is argued, constitute the conditions for a fair, sustainable and prosperous digital society, whose foundations are:

- Trust and confidence, based on balanced and fair relationships between people, but also between people and organizations;
- Self-determination, achieved not only by legal protection, but also by proactive actions to share the power of data with individuals themselves;
- Maximizing the collective benefit of personal data, by sharing it fairly among organizations, individuals and society *(www.mydata.org)*[150].

The elements that, according to MyData, should be modified to implement a human-centered approach in modern environments, are the following:

- From the formal to the practical rights
  In many countries, individuals were afforded legal protection regarding their data, yet their rights remained, for the most part, at a very formal level: they were not widely known, difficult to enforce and often obscured by corporate practices. It seeks to make true transparency and real, informed consent the new standard for when people and organizations interact with each other. Access and restoration of personal data, portability and the right to be forgotten should become rights that everyone can access with a click.
- From data protection to data empowerment
  Data protection regulations and corporate codes of conduct are designed to protect individuals from the abuse and misuse of their personal data by organisations. Common practices need to change in a direction where individuals are protected and empowered to use the data that various organizations hold about them. Examples of such uses are the simplification of administrative bureaucracy, the processing of data from multiple sources to improve the self-awareness of the individual, personalized artificial intelligence (AI) assistants, decision-making and data exchange on the individual's own terms *(Oliveira, 2016)*[136].
- From closed to open ecosystems
  Today's data economy is creating online data that favors platforms that are capable of mass collecting and processing large amounts of personal data.

These platforms "lock" markets, not only for their competitors but also for most businesses that risk losing direct access to their customers. By letting individuals be in control of what happens to their data, it seeks to create a truly free flow of data based on balance and justice *(www.mydata.org)*[150].

7.2 MyData principles

In order to create the shifts necessary for a human-centered approach to personal data, the MyData network makes collective efforts based on the following principles:

1. Human-centric control of personal data:
   Individuals should be empowered to manage their personal lives, both online and offline. They should be provided with all those practical means to understand and effectively control who has access to their data, how they use it and how they share it.

   Target is:

   - privacy, security and data minimization become common practice in application design;
   - organizations enable individuals to understand privacy policies and know how to activate them;
   - individuals to give, refuse or withdraw their consent to share their data, having first clearly understood why, how and when they will use their data.

   Ultimately, it is intended that the terms and conditions for the use of personal data become negotiable in a fair way between individuals and organizations.

2. Individual as the point of integration:
   The value of personal data grows exponentially with its diversity. However, so is the threat to one's privacy. This contradiction can be solved if individuals become the "nodes" through which personal data is crossed *(Oliveira,*

2016)[136]. By empowering individuals to have a complete view of their data and act as a "point of integration", a new generation of tools and services can provide deep personalization, generating new knowledge from databases, but without compromising on privacy issues of person.

3. Empowerment of the individual:

   In a data-driven society, individuals should not be seen simply as customers or users of predefined services and applications. They should be considered free and autonomous entities, capable of setting and pursuing their own goals. They should have the ability to take action and initiative. The aim is for individuals to be able to manage their personal data securely, in their own preferred way, to have the tools, skills and assistance to turn their personal data into useful information and knowledge, and to be able to make autonomous decisions. These conditions are necessary for fair and beneficial relationships based on data *(www.mydata.org)*[150].

4. Portability: access and reuse:

   Personal data portability, allowing individuals to obtain and reuse their personal data for their own purposes and across services, is key to making the transition from data that is kept "closed" to data that functions as reusable sources. Data portability should not just be a legal right, but should be combined with practical means. The goal is to empower individuals to effectively transfer their personal data, both by downloading it to their personal devices and transferring it to other services. Helping Data Sources to make this data available safely and easily in a structured, commonly used format is also necessary.

5. Transparency and accountability:

   Organizations using an individual's data must spell out what they are doing with it and why, and must do exactly what they describe. They should take responsibility for the intended and unintended consequences of owning and using personal data, including security incidents, and allow individuals to hold them accountable. should be ensured to reflect reality, in ways that allow people to

make informed choices in advance and can be verified during and after operations. People should understand how and why decisions are based on their data. The goal is to create easy-to-use and secure channels for people to see and control what's happening with their data, warn them of potential problems, and be able to challenge any algorithmic decisions *(www.mydata.org)*[150].

6. Interoperability:

   The purpose of interoperability is to reduce friction in the flow of data from data sources to services that use data, eliminating data lock-in possibilities. This should be achieved by following a steady course towards normal business practices and technical standards. In order to maximize the positive effects of open ecosystems, the role of interoperability of data, open APIs, protocols, applications and infrastructure is critical so that all personal data is portable and reusable, without losing control of users *(www.mydata.org)*[150].

Chapter 8

The Elliniko complex as a smart city

The goal of LAMDA Development is to create a smart city in the Elliniko area for the benefit of residents, visitors and businesses operating in the area. Through this project, the company is building a global example of a smart city: "a smart urban area with the latest technology that will pioneer the areas of housing, work and leisure through the use of methodologies aimed at creating conditions for stable service." *(https://en.rua.gr)*[151]

Getting started

The case of The Ellinikon in Athens is one of the largest European investments in urban infrastructure. It is a multidimensional project that provides many investment opportunities in different sectors, such as culture, tourism, entertainment, sports, as well as business and innovative business activities. The implementation of the project, which concerns the design of the strategy for the development of the so-called "smart city" for Elliniko and Lamda Development, was undertaken by Deloitte, in collaboration with AFRY. Deloitte is active worldwide in a number of projects related to the design and implementation of smart city strategies, including "The NEOM" in Saudi Arabia and "Porto Nuova Development" in Milan. The internationally recognized engineering consulting company AFRY, also

has extensive experience having implemented relevant projects in Northern Europe, such as in Nyhamnen, Malmö in Sweden, and the Red Sea Development project in Qatar (www.ot.gr). The project will be implemented in collaboration with highly specialized consulting companies in the fields of energy, technology and telecommunications, such as CIGA Energy, CIMA Data Analytics and ENOMIX. The project will be implemented in collaboration with highly specialized consulting companies in the fields of energy, technology and telecommunications such as CIGA Energy, CIMA Data Analytics and ENOMIX. The goal of LAMDA Development is the creation of a Smart City in the area of Elliniko for the benefit of residents, visitors and businesses operating in the area. With this project, the company achieves the emergence of a global example of a smart city and more specifically a smart latest technology urban area that pioneers the future of housing, work and leisure through the use of technology aimed at creating conditions of sustainability and serving the needs of tomorrow *(www.newsit.gr)*[152].

Figure 8.1: Elliniko project

According to Mr. Odysseas Athanassiou, CEO of LAMDA Development "Our vision is to highlight Elliniko in a "beacon" of foreign direct investment and strategic partnerships. Elliniko will be the first smart city in Greece with the application of advanced technologies and innovations that start from design. It will be fully equipped, in its entirety, with sensors and control systems that will analyze data and control energy consumption and carbon dioxide emissions" *(www.lamdadev.com)*[153].

It is noted that Elliniko's project is in the design phase (greenfield) and for this reason, LAMDA Development intends to investigate early on how smart city solutions (smart infrastructure, networks, technologies and software) could be applied to create of "Ellinikon Smart City", as well as how they could be used to support business initiatives in the energy and ICT sectors.

According to Mr. Sotiris Batzias, Director of Deloitte's Strategy Department in Greece and coordinator of the project, LAMDA's development planning and vision for Elliniko are inextricably linked to its ability to create a sustainable city by providing smart services, but and further increase its value from the development project. At the same time, LAMDA Development, utilizing its position in the development of the project in Elliniko, has the opportunity to diversify its portfolio, entering new business sectors and exploring investment and cooperation opportunities. This project, as a leading project for the Greek - and not only - data, is an important challenge for the participants in this and the culmination of their strong know-how and experience *(www.lamdadev.com)*[153].

With the project in Elliniko, Lamda Development expands the international presence of the Greek real estate development market, as during its full operation Elliniko will attract investors and buyers of real estate from all over the world and will increase the foreign direct investment (FDI) in the Greek real estate market. At the same time it will encourage the development of similar projects by investors along the Athenian Riviera *(www.lamdadev.com)*[153].

Figure 8.2: Elliniko project

Project design and progress

Elliniko will be the first smart city in Greece, with application of advanced tech-

nologies and innovations that start from the design. The first strategic cooperation with TEMES has already been announced, while it is pointed out that the project is capitally covered for the first five years of the investment, already having at its side two large banks, Eurobank and Piraeus (www.naftemporiki.gr).

The project design includes infrastructure projects over 500 million Euros and green at 70% of the total area. Also, the coastal front will become a global destination with a 1 km long beach. This is an investment that in its full development will bring 85,000 new jobs, while Greek scientists working in the works of Elliniko have already returned from abroad.

Elliniko changes the architectural and urban philosophy of Athens, designing a series of infrastructure projects of public benefit, which will serve the residents of Elliniko and the neighboring areas. In fact, these are "smart" infrastructure projects, which can be an example to be imitated for the whole of Greece.

In summary, the basic design principles are as follows:

- dominance of green and open spaces,
- access to modern infrastructure including schools, sports facilities, health and welfare services as well as places of entertainment and leisure,
- adoption of strict environmental planning principles,
- connection with the surrounding areas, so that Elliniko is easily accessible by everyone.

Respectively, in terms of the environment, according to the plan over 70% of the total area of 6.2 million sq.m., will be covered by parks, lakes, gardens, public and outdoor areas, while in residential areas the public spaces will exceed 50%. This is a complete reversal of the current picture, as until recently the corresponding ratio was 30% versus 70% *(www.lamdadev.com)*[153].

Regarding the use of BIM (Building Information Modeling) technology for risk forecasting and management, during construction and later in the project, the fol-

lowing is stated: The research is evolving and will be presented in the BIM environment at all stages of the project. This methodology, which complies with international standards, allows the certification of the production of fully coordinated projects, reducing the overall budget and implementation time by 20-30%. In addition, due to the complexity of the project, the use of all modern technological tools is required to automate the design and construction processes, avoiding any obstacles and delays. BIM digital models will include all the necessary information *(www.lamdadev.com)*[153].

Figure 8.3: Elliniko coastal front

Regarding the timing of the project, the works for the reconstruction of Elliniko have started and are proceeding with the highest standards internationally, at all stages of their development. By 2025, much of it will be ready so that all citizens can experience it *(www.lamdadev.com)*[153]. An area that today is difficult to access and cut off from the urban fabric, will be transformed in the coming years, into a modern green city that everyone can visit and enjoy.

Preliminary work has already begun with the demolition and at the same time the first studies have been done, architecture and studies for the tall buildings and shopping malls. Within the first five years, a 3.5 km coastline will be developed. The Elliniko coastal front is expected to be developed by the end of 2024 or the beginning of 2025. A road will be constructed that will connect Poseidonos Avenue with Vouliagmeni Avenue. In 2022, the works started for the new Building for the Relocation of Associations for the Disabled, a complex of 11,000 sq.m., where four care associations for the disabled will be co-located. This project is expected to be completed in the first quarter of 2023.

Figure 8.4: The progress of Elliniko project

Figure 8.5: The building that will house the unions and associations for the disabled

By 2025, the Elliniko Park is expected to be completed, which will cover over 2 million sq.m., being one of the largest coastal parks in the world, and will be open to the public. The park has been designed with the biodiversity of the area in mind and, through advanced technological solutions, will fully cover its needs for irrigation and electricity.

Inside the Park, a state-of-the-art Sports Center will be created, which will be open to all residents of Attica, while it will have the opportunity to host important sports events. The center has facilities for athletics, swimming, football and gymnastics, a stadium for throwing sports, but also an indoor gym, hostels for hosting athletes and academies for football, basketball, tennis, beach volleyball and instru-

mental gymnastics. In addition, and in order to ensure full transparency, a special environmental unit has already been set up to monitor compliance with the terms and commitments throughout the project *(theellinikon.com.gr)*[154].

Figure 8.6: Elliniko Park

In Elliniko, hotels and houses on the coastal front will be developed, among others. Within 2022, the upgrade works of the marina of Agios Kosmas and the beach will begin, as well as the construction of the Marina Tower, while in 2023 the construction of the Marina Galleria and the seaside settlement of houses and complexes in front of the Park is planned to begin.

Marina Tower is the project that has been discussed the most and has sparked discussions about the urban landscape of Athens, as it is the first green skyscraper in Greece, 200m high. It will have 200 apartments on 45 floors and will be the tallest building in Greece, but also the tallest seaside building in the Mediterranean. All houses will have balconies or terraces and unobstructed views of the sea, the beach, the park and the mountain, while some penthouses will have a private pool. Made from environmentally friendly materials, they will provide all modern comforts and will have easy access to the beach and the marina. Next to this building a large beach of 1.3 km will be developed. In general, the coastal front of Elliniko aims to become a global destination, aiming to attract over 1 million visitors annually and for the 12 months of each year *(theellinikon.com.gr)*[154].

Regarding the seismic forecasts of the tower, the international designers of the tower, in collaboration with the Greeks, will take into account all the necessary data for its static solution, based on domestic and international seismic studies and

regulations, in combination with the use of specialized software, providing the best earthquake resistance *(www.lamdadev.com)*[153].

Figure 8.7: Marina Tower

Gastronomy, shopping and entertainment will be found at Marina Galleria, at 22.000 sq.m. which will host more than 70 leading fashion houses, Greek and internationally recognized designers. There will be "next generation" spaces, with Augmented and Virtual Reality capabilities, such as interactive showcases, smart mirrors and test rooms and personalized shopping suggestions. On the first floor of the building there will be about 30 cafes and recognized restaurants of international and Greek renowned chefs, on the terraces that will offer unobstructed views of the sea and the sunset. A variety of cultural and entertainment events will take place there, such as concerts, exhibitions, music performances *(theellinikon.com.gr)*[154].

Also, a research and development center (R&D Hub) will be created in Elliniko. The Commercial Hub will become the largest shopping center in Greece, a new generation shopping park with large stores and state-of-the-art office space. The design incorporates smart and green solutions with lighting and temperature controls. Using natural materials, the impact of the building complex on the environment is minimized, making it the "pioneer" in this field. At the same time, green dominates outdoors as well as patios and terraces. The extensive environmental conditions set out in the legal framework will be fully complied with during the design, construction

Figure 8.8: Marina Galleria

and operation of the mall.

Figure 8.9: The Commercial Hub

Special attention has been paid to the advanced technological solutions that will cover the needs of the park in irrigation and electricity. There will be an underground network for the collection, treatment and safe channeling of rainwater into the public network, as well as a sewage treatment plant for the irrigation needs of the Park, the common areas in Elliniko and the surrounding areas. At the same time, the park will have smart parking and smart lighting 5G, as well as connection to the coastal front via a footbridge *(theellinikon.com.gr)*[154]. Already, the Experience Center in Elliniko is in operation, which can be visited by anyone with easy access and free entrance and to learn more about the history of the site and the

renovation project. This is a unique exhibition of its kind, in a renovated hangar of the former Athens International Airport. Through five thematic zones with impressive facilities and interactive experiences for young and old, one can learn the main goals, philosophy and features of The Ellinikon. In the same area is the Ellinikon Collection, where guests can shop for selected items, as well as the Cafe for moments of relaxation.

Financial data

CAPEX (Capital Expenditure) for the first years of the investment amounts to 1.5 billion euros, not including CAPEX for the development of the integrated tourist complex with casino (Integrated Resort and Casino - (IRC).

Regarding the net profits of Lamda Development in the first half of 2021, they have jumped to 224.6 million Euros, which is due to the integration of the assets of Elliniko SA. The integration of Elliniko SA in Lamda Development, after the acquisition of 100% of its share capital, has already increased the value of the Company by 26%. The result was an improvement in the company's results by 306 million euros, the absorption of any losses from the lockdown due to the pandemic and the return to profitability, given that in the first half of 2020 the company had recorded losses of 5.7 million euros. *(www.moneyreview.gr)*[155].

In terms of operating profitability, the consolidated EBITDA results (before valuations) amounted to 15.9 million euros, showing an increase of 4% compared to the corresponding period in 2020. In terms of house and apartment bookings, they have exceeded all expectations, with potential future Revenue corresponding to existing customer advances is already close to 700 million euros.

The emblematic work of Elliniko is progressing at a fast pace and with the best omens. An area that today is difficult to access and cut off from the urban fabric will be transformed in the coming years, into a modern green city, changing the architectural and urban philosophy of Athens.

As we can see, all goals of a smart city as described above are fulfilled: Efficiency of services, Sustainability, Mobility, Safety & security, Economic growth,

Figure 8.10: The Ellinikon

City reputation.

Despite the paradigm of Toronto and the opaque procedures used, the above paradigm of Elliniko is a great chance all the above analysis to be implemented and turn it into a real human-centric smart city.

Chapter 9

Conclusion

9.1 Conclusions

The Smart City phenomenon is a new way of urban governance and management, which responds to development challenges, contributes to the sustainable development and sustainability of cities, while at the same time improving the quality of life of their residents. The establishment of this new model of city planning, which essentially posits the city as a living laboratory, is a resource for the solution of global problems. Cities should adopt "smart city" strategies in their urban planning practices, to address key problems, such as the fight against climate change, poverty, unemployment, social exclusion, etc., and to also become more attractive and competitive. However, for the development of this "Smart City" model, correct policies are needed, which will lead to its successful implementation and bring positive results.

In addition, a big issue that plagues scientists, entrepreneurs and politicians is whether the city that is smart implies that it is also sustainable. The practices found in modern smart cities are not necessarily sustainable nor will they lead to growth. Technology and economy are promoted and new data is arbitrarily baptized as sustainable. The biggest challenge of today's time is to change the mindset of the citizens, so that the line followed by the politicians regarding society, the environment and the cities can be changed. The harmonious coexistence of natural

and human capital will lead to their sustainability and the creation of cities that will be able to resist deterioration and will more easily integrate within themselves the great changes that the future will bring.

The benefits of smart elements in the everyday lives of citizens far outweigh the negatives and risks that arise. Rights and freedoms are protected in a society based on democratic principles. The creation of smart cities can offer a lot, but it is necessary to define their concept as comprehensively as possible so that the lines between the limits placed on machines, systems, whatever form technology takes and human freedoms are clear. The dialogue on these issues is certainly difficult and requires the cooperation of many scientists coming from different scientific fields with all agencies, society, entrepreneurs.

Finally, the creation and development of sustainable smart cities is imperative at a time when the global environmental data is changing day by day and this model of urban sustainability is the only one that can be followed immediately. The existence of a balance is necessary and can be achieved through dialogue and good organization of all interested parties. Since technology affects our lives, our society, and even people's morals, technological innovations cannot be left to engineers and managers. New technologies require public debate and democratic control. Smart technologies offer opportunities to improve the quality of life in cities, reduce their ecological footprint and create new urban commons. But they can also pose a threat to civil liberties and social justice, especially when smart city solutions are promoted by big tech companies. In conclusion, the smart city is not a utopian plan, on the contrary, it is a plan that can be implemented and desired by all.

9.2 Open issues for future research

Smart cities can create a new type of digital urban commons and enhance social connectedness. Although community connectedness is difficult to quantify, surveys of urban residents have been conducted to determine whether digital channels of communication with local officials as well as digital platforms that facilitate real-world interactions (e.g., Meetup and Nextdoor) can have impact *(Mutiara, Yuniarti & Pratama, 2018)*[156]. The use of these types of apps could almost double the

share of residents who feel connected to the local community and triple the feeling of connection to local government. Creating two-way communication channels between the public and local bodies could make local city governments more responsive. Many city services maintain an active presence on social networks and others have developed their own interactive citizen applications. In addition to disseminating information, these channels create opportunities for residents to raise concerns, collect data, or weigh in on planning issues. *(Mutiara et al., 2018)*[156].

9.3 Concerns

Challenges and perspectives of the smart era

The new "smart" era, with the speed with which it is galloping, cannot help but create the impression that the world it knew until now no longer exists. New inventions appear on an almost daily basis and promise to further tighten the bonds of an already technologically interconnected world. The new "smart" universe, however, at least because of the speed with which it is "settling" into our lives, raises reasonable questions about the nature and stability of its foundations, as well as the impact of its operation at the individual level *(Haddud et al., 2017)*[72]. Especially with regard to the individual, it must be emphasized that he wants to make his presence more visible and calculable within the larger framework of the intended social and collective harmony; it is now accepted that the human factor is the main component of the success of the new smart environment *(Gubbi et al., 2013)*[67]. The question is, if today's citizen can "bear" being under constant surveillance and recording, if he accepts and "sacrifices" part of his privacy for the benefit of the whole *(Hollands, 2015)*[23].

- Citizens' privacy issues

  Developing 'smart city' innovations has largely been a matter for the private sector. Most city councils, at least initially, rely on private companies to develop and implement their "smart city" construction projects. As such, these programs are usually designed to serve the motives of "surveillance capitalism," that is, to accumulate a wealth of data about people's activities and analyze

the data to predict and influence behavior so as to extract as many benefits as possible *(Kitchin, 2014)*[48]. It is not possible to interpret smart cities without talking about the business models of the Internet giants (eg Google, Amazon, Alibaba, Tencent, etc.). These companies are already global entities that largely escape government control. The question that arises is to what extent can state policy control the above digital giants. Public-private partnerships are often bound by confidentiality agreements imposed for reasons related to the inherent nature of the technology. This clearly makes it difficult for citizens to carefully control the systems adapted to their cities and used by and for them (Lee et al., 2014). The illegibility of these proprietary models raises serious concerns about accountability and transparency regarding the use of this technology. Similarly, the issue of Artificial Intelligence – the fact that the decision-making process behind new algorithmic technologies is often untraceable by and for those who develop it, nor those affected by it – further obscures the processes of shaping 'smart cities' and creates a trust deficit *(Komninos, 2019)*[47].

- A human rights-based approach

  Human rights must be put at the heart of "smart city" development plans. Municipal officials must have a deep understanding of the technologies they use and enforce public procurement standards that protect against abuse or misuse of the technologies. Technology must have safeguards to ensure that its use is in line with human rights standards. Ultimately, the people whose rights will be affected by these technologies should be in control of whether and how these new technologies are used through meaningful public oversight, consultation and control *(Hollands, 2015)*[23].

  A human rights-based approach combines citizen participation with new governance infrastructures and emerging technologies. All generated data is available to citizens, private companies and stakeholders alike, but the city together with its people jointly decide the parameters of appropriate access that respect privacy and therefore retain ultimate collective access in city data *(Mason, 2015)*[157]. However, it has yet to be established whether this model can be

effective in protecting against risks to human rights. Private companies often still drive contractual terms and dictate regulatory processes, while municipal officials often lack the necessary knowledge and expertise to challenge them *(McCallister, 2010)*[158].

Ultimately, the only way "smart cities" can live up to their utopian promise is to be designed from the ground up in a way that enhances rights and freedoms while also being accountable.

- Responsible "smart" cities

  In order for a smart city to be considered responsible, it should have the following characteristics *(McFarlane & Söderström, 2017)*[132]:

  1. In a smart city, technological innovations are preceded by public debate and informed democratic decisions. Decision-making is supported by impact assessments, which document the consequences of new technologies for fundamental rights, including data protection and public values.
  2. A responsible smart city sets clear, value-based design requirements for technology. These requirements include open source, interoperability, security, privacy, user-friendliness, accountability, energy efficiency, data frugality, circularity and involvement of all stakeholders in a process. inclusive *(Van Est, Gerritsen & Kool, 2017)*[159].
  3. A smart city uses technology to connect and empower people. It supports citizen detection: citizens make their own measurements around their living environment to report problems, such as air pollution, etc. It promotes new urban commons, such as collaborative platforms that enable the pooling and sharing of clean energy and vehicles.
  4. A smart city organizes resilience. It aims for the diversity and modularity of its systems and resources. It invests in cyber security and enlists the help of ethical hackers. It uses open standards, open-source free software and open hardware *(Henley & Booth, 2020)*[160].
  5. A smart city avoids dependence on big tech companies, especially those that treat personal data as a commodity or have monopolistic policies,

works on a digital public infrastructure, in cooperation with other democratic governments and citizens.

6. A responsible smart city protects privacy and personal information. It ensures that its staff are fully trained and gives citizens the maximum possible control over their personal data. It protects the individual's right not to be tracked in the public sphere and prohibits tracking through live facial recognition *(McFarlane & Söderström, 2017)*[132].

7. In a smart city, data that cannot be traced back to a person is a public common. Open data requirements extend to all companies operating on behalf of or with the support of the city.

8. A smart city places limits on decision-making by algorithms, according to the principles of good governance. Check algorithms used by and in the city for discriminatory discrimination and make them public Resist the temptation to feed algorithms with a wide range of personal data in order to predict the risk of "undesirable" behavior – this would lead to a surveillance state, especially for people who they live in poverty. Algorithms and data processing in general should be subject to regular review *(Henley & Booth, 2020)*[160].

9. A smart city uses all policy tools, from taxes to markets, to accelerate the development of green technology while preserving other public values. For example, privacy by design is paramount for smart energy grids and mobility-as-a-service platforms.

10. A smart city recognizes people's right to meaningful human contact, healthcare, education, and dealings with government *(Van Est, Gerritsen & Kool, 2017)*[159].

11. A smart city combats existing inequalities and inequalities that may be exacerbated by technological innovations. It ensures that it is equally viable and accessible for those who are less digitally savvy. It also ensures that citizens can communicate both online and offline with municipal services and service providers. It protects citizens' choice to make smaller

cash payments. It offers training and assistance to those with few digital skills, as well as shared facilities and subsidies to those with limited resources. It incorporates both the acquisition of digital skills and critical reflection on technology in education. It defends the rights of workers in the platform economy and fights for a fair distribution of income, wealth and housing *(Henley & Booth, 2020)*[160].

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