

Louvain School of Management

How do smart city principles contribute to the development of circular cities?

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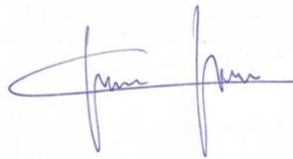
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Céline Van Vynckt



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Introduction

“Growth is inevitable and desirable, but destruction of community character is not. The question is not whether your part of the world is going to change. The question is how.” - Edward T. McMahon.

The world's cities are rapidly transforming into dense, busy centers, with half of the world's population living in them and expected to be nearly 70% by 2050 (United Nations, 2018). While this urban expansion offers opportunities, it also puts immense pressure on city infrastructures, resources, and ecosystems, prompting a shift toward smart city (SC) solutions to address these challenges (United Nations Development Programme, n.d.). Consequently, the urgent need to meet environmental and social sustainability goals is key and continues to grow daily (United Nations, 2018). Cities are a driving force of social, economic, and environmental transformation, they are already taking significant steps by aligning with initiatives such as the SDGs, Urban October, and the Cities and Climate Change Initiative (Geneva Environment Network, n.d.).

The combination of these pressures on cities around the world calls for innovative solutions that go beyond technology. The evolving idea of the circular economy (CE) calls for a more integrated and holistic approach to urban management, which requires a change in how urban spaces are designed, used, and managed (D'Amato & Korhonen, 2021). However, the literature on how SC and CE interact remains scarce, with most studies focusing on one or the other, without exploring the synergies that can result from their integration.

This thesis aims to fill this gap by investigating how the principles of the CE and SC can be successfully integrated to create a new concept, a circular city. The city chosen as a case study in this research is the city of Barcelona. By exploring how the city's government, businesses, and citizens work together to adopt sustainable practices, this study seeks to answer a key question:

“How do smart city principles contribute to the development of circular cities?”

This thesis aims to provide significant insights into the circular city concept and how to implement it. In doing so, it provides not only a deeper understanding of the complexities of urban sustainability but also a forward-looking vision of cities in the future. In other words: a city that values its resources, people, and technology.

To answer this question, this research is structured in two parts. The first section consists of a literature review, establishing the state of academic knowledge of the key subjects underlying this research: SC and CE. The first chapter of this section explores the concept of SC, how and why it has emerged, the different types of SC, and the framework on which we will focus for our further analysis. The second chapter concentrates on the CE concept, its urgent need to be integrated into our lives, and, again, the analysis of one of its well-known frameworks. The third part is pivotal, as it bridges the two concepts by introducing a new framework designed to identify and evaluate the actions undertaken by a city that integrates both principles. This framework serves as a tool to analyze the intersection of SC initiatives and CE strategies, offering insights into how their synergy drives urban innovation and sustainability.

The second part of this thesis consists of empirical research aimed at answering our research question. To achieve this, a qualitative study was conducted using semi-structured interviews. The first chapter of this section explains the methodology used, followed by the results of the interviews. Finally, a discussion of these results is presented, including the links between our results and the existing literature, the recommendations that we were able to identify thanks to our study, the limitations encountered, and future research.

Section 1: Literature Review

1. Smart City

The world is moving towards the fourth industrial revolution, with, by 2030, 60% of the world's population living in cities ("Smart Cities In Catalonia", 2022). The rapid and constant growth in population poses new challenges for city services and infrastructure, which are inadequate for rapidly growing populations (Zhang, 2015). Traditional manufacturing and agricultural jobs are becoming automated, outsourced, or obsolete in addition to cities that offer infrastructures and services that are not easily found or completely unavailable in rural areas, from public transportation to healthcare and education (Washburn & Sindhu, 2010).

The goal of SC is to mitigate the negative effects of urbanization while leveraging social and economic potential (Giffinger et al., 2007). These negative effects can be the scarcity of resources, energy shortages, price instability, or even inadequate and deteriorating infrastructure (Washburn & Sindhu, 2010). In this context, cities must advocate for a long-term vision that ensures ongoing and future resources, equitable distribution, effective welfare policies, thoughtful urban planning, and solutions to environmental challenges (Giffinger et al., 2007). The challenge here is to maintain a balance between growth and sustainability over the long term (Giffinger et al., 2007). After identifying these challenges, cities must design a clear action plan, with priorities and locally customized solutions (Acemoglu & Restrepo, 2018b).

In this chapter, we will observe that the SC model is well-known and keeps evolving alongside technology, becoming more efficient each day. Nevertheless, this concept is complex and has various forms and interpretations. We analyzed them, and we have dissected each aspect of the concept based on the six "smart characteristics" created by Giffinger et al. (2007).

1.1. Definition

According to Forrester Research (2010), what makes a "SC" is the combined use of software systems, server infrastructure, network infrastructure, and client devices — which Forrester calls Smart Computing Technologies — to connect seven critical city infrastructure

components and services: city administration, education, healthcare, public safety, real estate, transportation, and utilities (Washburn & Sindhu, 2010). A SC is a re-thinking of the relationships between government, city managers, business, academia, and the research community to improve the life quality of its residents (Hall et al., 2000).

As Acemoglu & Restrepo (2018) demonstrate, SC utilize big data analytics and real-time monitoring through Internet of Things (IoT) sensors to inform city management and policymaking. Acemoglu & Restrepo (2018) also observed in their paper that mobility is enhanced by smart transportation systems, promoting electric and autonomous vehicles. In addition, governance is simplified through e-government services and active citizen engagement. Advanced infrastructure, including smart grids and optimized water and waste management systems, is integral to SC. Furthermore, enhanced public safety and robust cybersecurity measures ensure security and resilience.

Nowadays, we can contemplate ambitious goals for digital cities thanks to 21st-century technology and its possible uses (Ferrer, 2017). Indeed, with technology, there is an opportunity to build more livable and socially fair cities, where lives can be improved and where economy is developed through innovation and new business models (Ferrer, 2017). The purpose here, among other things, is to guide our economies toward a more sustainable path (Ferrer, 2017). Many municipalities worldwide have already started, offering everything from smart parking places to smart benches for solar-powered charging of portable electronics (Esmaeilian et al., 2018).

1.2. Types of Smart Cities

The majority of SC are found in developed economies, such as the United States and South Korea but also more and more in emerging market powers (Washburn & Sindhu, 2010). The development of SC in emerging countries is being propelled by factors such as rising revenue, strong economic growth, and an increasing population possessing digital skills (« Smart Cities In Catalonia », 2022).

As SC emerges in different economies driven by various factors, several approaches to SC can be identified. Abellá-García et al. (2015) present four approaches to SC; sustainable, sensed, collaborative, and holistic.

1.2.1. Sustainable Smart City

One of the most popular models focuses on the environmental impact of the city. This approach pays much attention to energy savings, alternative energy sources, and more efficient means of transport, among others.

1.2.2. Sensored Smart City

Another popular approach is led by the IoT. In this approach, the city provides a huge amount of data coming from thousands of different sensors; traffic sensors, air pollution sensors, sound sensors, humidity sensors, and cameras, among others, dispersed around the city. However, managing the impressive amount of data generated by the sensors represents a challenge. This approach can provide a good insight into some of the most important problems of the city at the cost of keeping up complex technical infrastructure.

1.2.3. Collaborative Smart City

The third model focuses on the ability of the citizens to participate in daily city issues. Digital participation mechanisms, and participative budgets, are some of the potentialities deployed to improve city management. In this case, technical tools can be found in complex implementation projects. Nevertheless, regulations about privacy, participation, and public procurement create some remarkable barriers.

1.2.4. Holistic Approach

Finally, the holistic approach combines the three previous models and some other dimensions which might be a way to find the best solution among all these approaches. Resources are limited, so, in every case this holistic approach will have to determine which aspect of the SC should be developed first and which one should receive the biggest part of the resources.

1.3. Origin

To quote Wellington E. Webb, former mayor of Denver: *“The 19th century was a century of empires. The 20th century was a century of nation states. The 21st century will be a century of cities.”*

The term SC first appeared in the early 1990s reflecting advancements in technology, innovation, and globalization (Yin et al., 2015). The concept takes its roots from the development of “Industry 4.0” which is characterized by integrating physical processes with digital systems (University of Tennessee Research and Manufacturing Center, n.d.). Before the

rise of smart cities, terms like "digital city" and "intelligent city" were used to describe Information and Communication Technologies (ICT)-driven urban development (Yin et al., 2015). Cities such as Singapore, Barcelona, New York and Oslo are listed as the pioneers of the integration of SC initiatives in 2017 according to the news website "Digital Trends" (Halegoua, 2020).

A significant milestone for SC was during the International Business Machines (IBM) of 2008 with the "Smarter Planet" initiative, which highlighted the potential of interconnected systems to create efficient and sustainable urban environments (Yin et al., 2015). Since then, the SC concept has evolved and enables real-time monitoring and control (sensors) by all the digital ecosystems, creating interconnected networks of digital services and platforms that facilitate collaboration and data exchange, but also the cloud-based designs that store and process data (Lakshmikantha et al., 2021).

1.4. The Operationalization of Smart Cities

This literature review demonstrates how hard it is to define a SC, emphasizing that it is no longer only associated with technology but is also about people, politics, strategy, and transformation. To analyze the key aspects of a SC we chose to use the six "smart characteristics" identified by Giffinger et al. (2007), well-known as one of the reference frameworks for SC. It contains the following variables: *smart living*, *smart governance*, *smart economy*, *smart people*, *smart mobility*, and *smart environment*.

Smart Living

The smart living characteristic aims to enhance urban life's convenience, satisfaction, social and digital inclusion, housing conditions, safety, and health, among others (Shi & Shi, 2023; Neirotti et al., 2014). On the one hand, this aspect mainly focuses on, according to Crutzen & Desdemoustier (2015), the resources deployed to ensure a safe and healthy life in a dynamic city. On the other hand, other scholars see smart living through physical infrastructures and concentrate their thoughts on intelligent buildings, including roads, bridges, tunnels, pipelines, and communication lines. (Gil-Garcia et al., 2015).

Smart Government

Smart governance involves the collaboration of various actors in the collective decision-making process regarding the implementation of public policies and the management of public programs or resources (Gil-Garcia et al., 2015). It is built on a series of mechanisms, tools, and processes designed to transform traditional governance practices (Gil-Garcia et al., 2015). These include the integration of ICT in government operations (e-government) through tools such as sensors, monitoring systems, geographic visualization technologies, big data, and social media applications (Shi & Shi, 2023).

Smart governance also emphasizes the exchange of information and knowledge between social actors and governmental entities, fostering collaboration and transparency (Nam & Pardo, 2011). Decision-making processes and internal administration are enhanced through intelligent management practices that rely on reformed regulations and adaptable policies (Ruhlandt, 2018).

Finally, smart governance thrives on collaborations, intergovernmental networks, and partnerships with public agencies and other stakeholders, which enhance the governance capacity and ensure that public policies and programs are implemented effectively (Bolívar & Meijer, 2015).

Smart Economy

Smart economy emphasizes technological innovation, resource efficiency, sustainability, and high social welfare (Shi & Shi, 2023). Competition, high-tech industry, and flexibility are perfect for businesses (Chourabi et al., 2012; Gil- Garcia et al., 2015).

This economy is the link between the local, international and globalized markets with goods exchange, services and knowledge (Chourabi et al., 2012; Crutzen & Desdemoustier, 2015). The local dimension is essential, the concentration and proximity of the actors in a cluster create knowledge competition and bring all the economic benefits for the actors within the processus (Boschma, 2005; Boschma & Frenken, 2006).

Smart People

As we mentioned previously, the SC context is characterized by a strong interdependence between the city government, the citizens, and the city's ecosystems of researchers, innovators and entrepreneurs (Richter et al., 2015). All the following actors have a different role and importance depending on the SC. For example, some SC includes only technical universities, while others also include social sciences research centers (Pierce & Andersson, 2017).

The engagement of citizens in a SC is primordial, they play a key role in the development of the city. Koutra et al. (2020) affirm that there is no smart city without smart citizens. To engage the citizens, everything must be done in an open, inclusive and participatory way. Having a smart government is about the participation of the citizen and even more about citizen engagement (Ferrer, 2017b).

To achieve this, it is essential to put in place investments and public policies that encourage the development of human and social capital (Gil-Garcia et al., 2015). This investment must be in education, and more precisely in higher education with the result of economic growth and, therefore, employment growth (Shapiro, 2006). This growth, in addition to the smart living characteristic (security, health...), will attract creative people who will learn to become smart people (Appio et al., 2019).

Smart Environment

Smart environment integrates intelligent technologies and the internet into urban environmental management and pollution control (Shi & Shi, 2023).

Nowadays, we know that our natural resources are limited, it is, therefore normal that a SC has ecological goals in the management of its development (Gil-Garcia et al., 2015). The purpose is to have better management of pollution and air quality, but also thanks to ICT, to optimize the use of renewable energies allowing owners of private renewable energies to become actors (Appio et al., 2019).

This aspect has a positive impact on new solutions such as smart electricity grids, public streetlamps, renewable energy, waste management, and wastewater (Neirotti et al., 2014).

Smart Mobility

Smart mobility involves the implementation of digital, efficient, cost-effective, safe, and environmentally friendly transportation solutions aided by ICT (Shi & Shi, 2023). However, smart mobility is not only about ICT for transport but also includes logistics and the exchange of information with people using these transports (smart people) (Neirotti et al., 2014).

Smart mobility is the capacity to have access to real-time traffic information (Crutzen & Desdemoustier, 2015). It is also possible to have other solutions for moving than vehicles, such as the installation of pedestrian and cycle zones (Appio et al., 2019). The development of autonomous vehicles based on environmentally friendly fuels or applications for city bikes is possible thanks to the ICT (Neirotti et al., 2014).

The smart mobility objectives are various and include reducing costs and CO2 emissions, improving traffic flow, reducing the number of accidents, and improving public transport systems, among others (Appio et al., 2019; Caragliu et al., 2011; Crutzen & Desdemoustier, 2015).

1.5. Limitations of a Smart City

According to Acemoglu and Restrepo (2018), the transition to smart city roles can be complex and slow, similar to historical transitions during the Industrial Revolution and early 20th-century America. In fact, a SC is not that simple to implement, and even with the number of papers published, a clear definition of SC is still lacking (Dameri, 2017). Therefore, we conduct a literature review to analyze the limits that must be addressed.

1.5.1. Top-down and Bottom-up Dynamics

There is debate about whether SC projects should follow a top-down approach, led by governments and global suppliers, or a bottom-up approach, led by local entrepreneurs and community involvement (Angelidou, 2015). On the one hand, global suppliers can overlook local needs, bottom-up initiatives focus on tailor-made solutions, and entrepreneurship is a driver of innovation (Anthopoulos, 2016). On the other hand, the top-down approach does not adequately consider citizens' needs and preferences, the bottom-up approach is frequently ineffective or inefficient and lacks coordination (Dameri, 2017).

Governments play a key role in providing a sustainable vision and resources in facilitating collaboration between stakeholders, including entrepreneurs, universities, scientists, and citizens (Chelleri et al., 2016b). However, the primary driver of SC is technology, with universities, research centers, and high-tech companies serving as key players in this model for SC development (Cosgrave & Tryfonas, 2012). Nevertheless, these actors often pursue their individual goals, focusing on specific technologies, which may not always align with a strategic vision for the city (Dameri, 2013).

Capdevila and Zarlenga (2015) argue that these two perspectives are complementary, and their combination can reinforce the collaboration between different city stakeholders. However, some authors (e.g., Capdevila and Zarlenga, 2015; Dameri, 2017) argue that the importance of bottom-up initiatives is more significant. Indeed, citizens do not often have the resources to act without governmental intervention, for instance, in the case of services in a city that requires high-cost infrastructures or regulatory changes. This highlights the importance of setting shared objectives among stakeholders. We adapted the diagram created by Dameri (2013, p. 2545) in Figure 1, showing the emergence, growth, and consolidation of both top-down and bottom-up smart city approaches.



Figure 1. *"Smart city development path"*. Own Creation

1.5.2. The Trust Paradox

According to Hartley (2023), the public often expects SC technologies to bring improvements in areas like buildings, mobility, transportation, education, and health (Hartley, 2023).

The trust paradox we face here is that the public believes in technology but not in the governmental institutions managing it because of concerns about security, privacy,

transparency, and effective governance (Hartley, 2023). Public perception of SC is a complex mix of optimism regarding technological benefits and skepticism about governance (Cole & Tran, 2022). To enhance the effectiveness and acceptance of SC initiatives, governments must improve communication, boost public participation, and build trust. Addressing these concerns is essential for the long-term success and sustainability of SC (Hartley, 2023).

1.5.3. Digital Divide

The expression “digital divide” refers to inequalities in access to digital communication technologies for various activities (OECD, 2001), increasing the connection between digital disparity (Mesa, 2023).

The first inequality observed is the ‘grey divide’, which expresses the important gap between age groups, especially the oldest members of society in comparison with their younger successors (Friemel, 2014). Indeed, Lagacé et al. (2016) observed that the elderly tend to be digitally excluded from the current information. Essential services such as banking, pensions, television services, and transportation booking are transitioning to digital platforms (Mubarak & Suomi, 2022). One major consequence of the grey digital divide is its impact on healthcare access (Mubarak & Suomi, 2022). According to Fox and Connolly (2018), despite ICT availability, many elderly struggle to use mobile health services. This is alarming given that nearly 60% of Internet users rely on online resources for health information, underscoring a significant disparity in access to essential healthcare tools (Mubarak & Suomi, 2022).

The second disparity is that education gives people a better chance to develop cognitive skills to handle the complexity created by ICT and the impact of the difficulties it may provide (Hsieh et al., 2008). Education enables one to select, evaluate, and manage information effectively (Vicente & Lopez, 2011). In the context of e-government, the OECD (2016) emphasizes the need for governments to adopt strategies that address societal development in areas such as healthcare, education, and protection services, reshaping the relationship between states and citizens in the digital realm (Mesa, 2023).

2. Circular Economy

Over the past 150 years, our industrial economy has followed a one-way model of production and consumption in which goods are manufactured from raw materials, then sold, used, and then incinerated or thrown as waste (Wautelet, 2018). With a rising global population and increasing resource consumption, along with the negative environmental impacts, it becomes clear that the traditional approach is unsustainable (Wautelet, 2018).

The limitations of our planet bring important initiatives worldwide, such as the Paris Agreement for the countries (UNFCCC, 2015), the Circular Economy Action Plan of 2020 (CEAP) as a key part of the European Green Deal (European Commission, 2020), or the Sustainable Development Goals (SDGs) for enterprises (United Nations, s. d.). The fundamental need for an alternative to the traditional linear growth model sparked the emerging debate on CE. Nevertheless, even with the initiatives listed in prior, our current economy is only 8.6% circular, and this amount has fallen from 9.1% in the two years since 2018 (Anttiroiko, 2023; Circular Economy, 2024).

In this chapter, we will discover that the CE model, driven by principles like resource conservation, eco-design, and waste reduction, aligns with global goals like the SDGs and initiatives like the European Green Deal. Through CE, businesses, governments, and consumers mobilize towards more sustainable practices, illustrating the powerful shift underway across sectors. However, the transition to a CE has its limitations. The concept lacks a standardized definition, leading to varied interpretations and applications that hinder cohesive efforts. An in-depth analysis of its 10R framework was carried out to analyze it and compare it with other concepts.

2.1. Definition

The term “CE” has gained significant traction in recent years and is now popular among both scholars and practitioners (Merli et al., 2017). This rise in popularity can be seen in the increasing number of papers written on the subject. Indeed, a Scopus search on the term CE shows an increase of 50% in academic publications between 2012 and 2017 (Reike et al., 2018). This is without considering all the consultancy reports from Accenture, Deloitte, Ernst & Young, and McKinsey & Company on this subject in 2016 (Kirchherr et al., 2017). In Europe,

the first countries introducing CE initiatives, policies, and pilot programs were Denmark, Germany, the Netherlands, and the UK (EUKN, 2015).

Kirchherr et al. (2023), list over two hundred serious definitions of CE that can be analyzed, which causes inconsistencies and fragmentation in understanding and application (Gladek, 2017). This diversity of perspectives leads to controversial opinions. For instance, Lieder and Rashid (2016) note that there are various possibilities for defining CE, while Yuan et al. (2008), state that there is no commonly accepted definition of CE. Others might think that CE is, and foremost a rebranding of other ideas such as ecological economics, industrial ecology, cradle-to-cradle design, biomimicry, or dematerialization (Corvellec et al., 2021).

Nowadays, clearer definitions of CE can be found, thanks to institutions such as the European Commission and foundations such as the Ellen MacArthur Foundation). The EMF defines the CE as: *“a system where materials never become waste and nature is regenerated. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting. The circular economy tackles climate change and other global challenges, like biodiversity loss, waste, and pollution, by decoupling economic activity from the consumption of finite resources.”* (EMF, n.d.). By utilizing this definition, we ensure a clear and consistent framework throughout our research, facilitating a comprehensive understanding of how CE practices can contribute to sustainable urban management.

In other words, CE involves keeping products, components, and materials at their highest value for as long as possible, reducing pollution, and regenerating natural ecosystems. The butterfly diagram in Figure 2 gives a better understanding of the CE model and, according to Velenturf et al. (2019), suggests the belief in a perfect natural environment where waste does not exist, where people are separate from nature, and where they live in a wasteful technosphere.

Popularized by the EMF, the butterfly diagram takes three driving principles into consideration, namely the effective use of finite resources, enhancing the utility of raw materials, and minimizing waste generation (EMF, 2015.). The butterfly diagram represents, on the left side of the diagram, the biological cycle, which focuses on biodegradable materials. On the right side, is the technical cycle of the CE which focuses on non-biodegradable materials. Sorting

these two kinds of materials is the first step toward a CE since their respective reuse methods need distinct procedures (Inchainge, 2022).

The technical cycle involves managing products that are not biodegradable, ensuring they do not lose value after use (EMF, 2015). Achieving this requires a strong focus on product design, maintenance, and repair to prevent early wear and tear (Inchainge, 2022). Most products in the biological cycle are biodegradable, including natural raw materials like wood and edible waste such as food. These materials enter the biosphere as compost or other organic nutrients. Their regenerative nature returns them to the biocycle as ‘food’ or other forms of life, generating minimal waste.

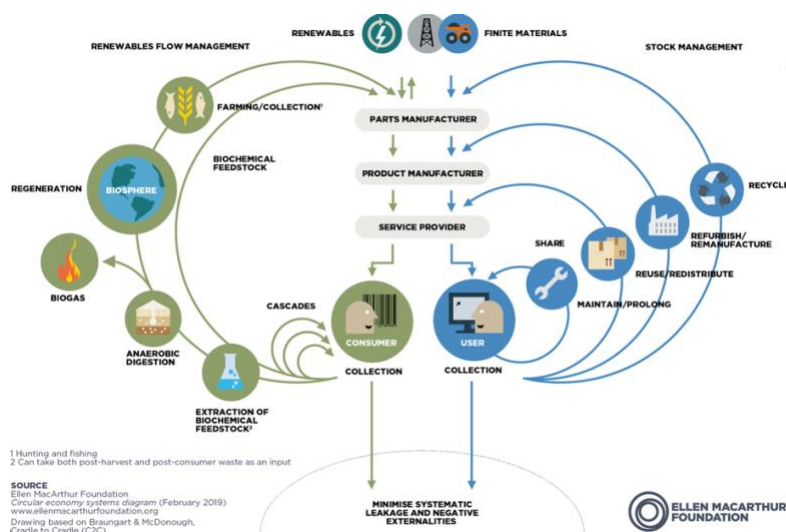


Figure 2. “Butterfly diagram” (EMF, p6. 2015)

2.2. Origin

The concept of CE has been discussed since the 1970s (Wautelet, 2018). In 2013, the EMF and McKinsey Company shared through a report the potential benefits it could create to transition to a CE (EMF, 2013). In addition to these benefits, the EMF pointed out the significant environmental and social benefits obtained from a CE.

The pioneer of the CE concept is Boulding with the production of his seminal paper, “The Economics of the Coming Spaceship Earth” (1966), where he introduces a closed system where resources and waste are managed in a circular relationship, essential for long-term sustainability.

According to EMF (2023), the CE concept has evolved based on five main schools of thought: Industrial Ecology, Cradle-to-Cradle, Performance Economy, Blue Economy, and Biomimicry. It is important to analyze these schools of thought to understand the extent of their influence on CE (Wautelet, 2018).

2.2.1. Industrial Ecology

Industrial ecology (IE) emerged in the 1970s. The idea of IE is to redesign our industrial society as a specific ecosystem within the biosphere, optimizing material flows to align with natural principles (Preston, 2012).

2.2.2. Cradle to Cradle

McDonough and Braungart (2002) introduced the idea behind cradle-to-cradle (C2C). This model calls for redesigning industrial systems to create closed-loop cycles. Biological nutrients should return to the environment safely, while technical nutrients circulate in a closed loop (Braungart et al., 2006).

2.2.3. The Performance Economy

This concept developed by Stahel and Reday-Mulvey (1981), emphasizes reuse, repair, and remanufacturing over producing new goods. Smaller, localized loops are prioritized for their efficiency and environmental benefits (Stahel, 2010). This model preserves resource value and fosters local economic growth.

2.2.4. The Blue Economy

The Blue Economy proposed by Gunter Pauli, promotes local resource utilization through cascading systems, where waste from one process becomes input for another. Inspired by natural systems like waterfalls, it seeks low-cost, innovative solutions that boost local economies (Pauli, 2013).

2.2.5. Biomimicry

Biomimicry is popularized by Janine Benyus (1997) and focuses on using nature as a model, measure, and mentor to create sustainable innovations (The Biomimicry Institute, 2017).

All these models share a common vision: transitioning from the linear economy to systems that harmonize with nature. While some emphasize business models (Performance and Blue

Economies), others focus on environmental impact (IE, C2C, and Biomimicry). Together, they form a robust foundation for a sustainable future (Wautelet, 2018).

2.3. The Operationalization of the Circular Economy

The transition from a linear to a CE model is complex and requires a set of practices that develop resource value retention options (ROs) (Muller et al., 2022). In various academic disciplines and studies, the letter ‘R’ has emerged as a central concept (Reike et al., 2018). Derived from the Latin prefix ‘re-’ meaning ‘again’ ‘back’ but also ‘afresh’, ‘anew’, expressing the essence of CE (Sihvonen and Ritola, 2015). Reike et al. (2018), gathered many articles where the so-called “R- imperatives” appear and identified the use of 38 different ‘re-’ words in varying combinations. These include actions such as re-assembly, re-capture, reconditioning, recollect, recover, recreate, rectify, recycle, and redesign, among others.

However, their analysis revealed an important gap: around 40% of the reviewed studies did not show a clear hierarchical structure for these ‘R imperatives’ and often remained ambiguous as to the precise definitions and applications of these terms (Reike et al., 2018).

To reduce the confusion and vagueness coming from the wide diversity of R-imperatives, in this master thesis, we will use the 10R Framework to portray the ROs. This framework, represented in Figure 3, has been used by several authors, such as Reike et al. (2018), Morsetto (2019), Potting et al. (2017), and Muller et al. (2022). According to the framework by Potting et al. (2017) in Figure 3, Morsetto (2019) observes three RO groups: a) useful application of materials; b) extended lifespan of products and their parts; and c) smarter product manufacturing and use.

Smarter product use and manufacture	R0	Refuse	Make product redundant by abandoning its function or by offering the same function with a radically different product
	R1	Rethink	Make product use more intensive (e.g. through sharing products or by putting multi-functional products on market).
	R2	Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources
Extend lifespan of product and its parts	R3	Reuse	Re-use by another consumer of discarded product which is still in good condition and fulfils its original function
	R4	Repair	Repair and maintenance of defective product so it can be used with its original function
	R5	Refurbish	Restore an old product and bring it up to date
	R6	Remanufacture	Use parts of discarded product in a new product with the same function
	R7	Repurpose	Use discarded products or its part in a new product with a different function
Useful application of materials	R8	Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality
	R9	Recovery	Incineration of material with energy recovery

Figure 3. “CE strategies (Morsetto, 2019), inspired (Potting et al., 2017)

In the context of this thesis, it's important to analyze this Framework to get a clear understanding of each of these ROs.

Refuse (R0)

Regarding consumers, they are inclined to buy and use less but also to reject packaging waste (Clapp and Swanston, 2009; Kasidoni et al., 2015; Potting et al., 2017). As for producers, they choose to use sustainable energy sources and biodegradable materials that are easy to put again in the chain, refusing the use of non-renewable resources and any virgin materials that are harmful to the CE (Muller et al., 2022; Reike et al., 2018). The purpose of this concept is to design the production processes to avoid waste (Bilitewski, 2012) to allow the use of renewable energy (Prieto-Sandoval et al., 2018).

Rethink (R1)

According to Potting et al. (2017), rethink means the reconceptualization of ideas, processes, and concepts. This also introduces the concept of dematerialization which refers to replacing physical products with digital or virtual alternatives that provide the same utility for users and therefore align with CE principles (Morseletto, 2019). For instance, a digital e-book provides the same reading experience as a physical book but uses no paper, ink, or transport. Multiple targets for rethinking materials can be developed at the corporate/sector/regional/ national scales. This strategy is the most relevant one among all the other strategies for promoting CE (Morseletto, 2019).

Reduce (R2)

Reduce means utilizing fewer natural resources, which means fewer inputs of energy (Morseletto, 2019), but is also linked, as Reike et al. (2018) observe, to "dematerialization". The reduce concept focuses mainly on the producer's behavior and its role in the pre-market stages, using less material per unit of production (Reike et al., 2018). Muller et al. (2022) suggest the idea of eventual certifications to promote efficient use of resources in production, and the development of products according to customer's specific needs would help to reduce product consumption. Akenji et al. (2016) point out the need to reduce the global material footprints by as much as 80% before the middle of our century (Morseletto, 2019).

Reuse (R3)

Reuse can be defined as further use of a product still in good condition and fulfilling its original function (Morseletto, 2019), expressing two sides of the market transaction, the offering side and the taking side (Reike et al., 2018). Reuse is a concept well known across the world with targets such as the EU Directive on end-of-life vehicles or waste-management/reuse as defined by the EU Waste Framework Directive (European Commission. (n.d.). Reuse is mainly known as second-hand products with the existence of second-hand markets (Allwood, 2014) and marketplaces such as charities and second-hand shops. Companies can also adopt this concept within their structure, for example, by reusing the same pallets for the transportation of different goods (Muller et al., 2022).

Repair (R4)

Potting et al. (2017) and Reike et al. (2018) define repair as the maintenance of defective products so they can be used with their original function again after minor defects. The principal function of this concept is to extend the lifetime of the product (King et al., 2006), and as Srivastava (2008) affirms “making it as good as new”. An important aspect of repair is that it can be done by different actors; by the customer itself, or through a repair company (Reike et al., 2018), or even by peer-to-peer non-commercial repair workshops (Hultman and Corvellec, 2012).

Refurbish (R5)

In contrast to the previous RO, refurbishing aims to upgrade and bring back the specified quality standards and conditions of products (den Hollander et al., 2017). Scholars in the context of CE give examples in the machinery sector with airplanes, trains, or engines (Morseletto, 2019). In addition, when a product needs to be refurbished, we rarely reference the whole product, instead, smaller components of the product will have an upgrade (Reike et al., 2018). It does not involve disassembly but the replacement of parts, this is why it could also be called “light” remanufacturing (Ferguson and Souza, 2010).

Remanufacture (R6)

Also called second-life production, reconditioning reprocessing, or restoration (Reike et al., 2018). Compared to refurbishing, remanufacturing is seen as less consistent in retaining quality, often described as “up to original state” or “like new” (Morseletto, 2019). This is partly

because the product's remaining lifespan is typically shorter than that of a new product, and it incorporates recycled components.

Repurpose (R7)

Repurpose, also known as recontextualizing, is the use of old products or some of their parts in new products with a different purpose. In his paper, Morseletto (2019) explains the difficulty of putting some targets to this strategy because many parts can be reused in a wide variety of different products, or few can be reused. The buildings are a separate case (Leising et al., 2018). For example, the transformation of a building from a home to an office is considered a different function for the building (Morseletto, 2019).

Recycle (R8)

Recycling refers to processing mixed waste from consumers or producers using advanced and costly technology, such as shredding (Yan and Feng, 2014), melting, and other processes to capture almost pure materials (Graedel et al., 2011). The purpose is to obtain about the same quality of non-recycled materials (Morseletto, 2019). The recycled extracted materials are called secondary materials. Afterward, these materials can be subjected to either upcycling or downcycling. Downcycling means materials are degraded and repurposed for lower-value applications because they weren't designed to be recycled, while upcycling enables materials to maintain their status as resources and accumulate intelligence over time (Braungart, McDonough, & Bollinger, 2006). Production waste in businesses can also be recycled, which is more advantageous because materials are not yet mixed, compared to post-consumption waste (Reike et al., 2018).

Recovery (R9)

Potting et al. (2017) defines recovery as incineration of material with energy recovery. In a broader sense, recovery refers to waste that is utilized to produce useful biological components or energy but is not recycled (Reike et al., 2018). The most known form of recovery is incineration (Potting et al., 2017). Nevertheless, incineration has important downsides, it destroys materials/products forever and encourages material wastefulness (Clark et al., 2016).

2.4. Limitations

The transition towards the CE is complex due to several limitations explained in the following paragraphs.

2.4.1. The CE as a Contested Concept

Firstly, one of the main challenges of the CE is its definitional issue. This lack of clarity makes it difficult to measure and compare CE initiatives, with currently over two hundred definitions of it (Kirchherr et al., 2023). This issue makes implementing its principles into practice particularly challenging, as the concept builds upon various frameworks (Korhonen et al., 2018). Korhonen et al (2018) support these limitations and attest that CE is a contested concept because it has several definitions and interpretations.

2.4.2. The Linear Mindset

Moving from a traditional linear economy to a circular model and involving changes in production, consumption, and waste management is a challenge at many levels, especially due to the short-term business mentality (Campbell-Johnston et al., 2019).

Transitioning to a CE requires significant investment in new technologies, infrastructure, and innovative business models (Circular Economy Action Plan, n.d.). Many organizations and municipalities face funding constraints limiting their ability to implement large-scale CE initiatives, particularly in developing regions with scarcer economic resources (OECD, 2019).

In addition, effective governance is essential for the successful implementation of CE practices, yet many regions lack coherent policies and regulations. The absence of global standards for CE definitions, metrics, and practices creates fragmentation, blocking collaboration and scaling efforts (Geissdoerfer et al., 2017). Additionally, weak enforcement of environmental policies can further undermine CE adoption.

Consumer behavior presents another significant challenge. Convincing consumers to adopt refurbished, recycled, or remanufactured products instead of new ones requires substantial effort in education and awareness-building (Möslinger et al., 2023). Many consumers remain skeptical about recycled products' quality, durability, or safety, slowing the adoption of circular consumption patterns.

2.4.3. The Laws of Thermodynamics

Another limitation is the “Thermodynamic Limitation”. This scientific principle argues that matter cannot be created, destroyed, or transformed, which is ignored in the main principle of CE since you can’t perfectly recycle everything. Indeed, some amount of waste will always be produced, challenging the ideal of a completely closed-loop system (Corvellec et al., 2021). To go further, the dissipation of matter in the environment (Cullen, 2017), the contamination, and wear on materials are some limits to the concept of CE and its proper functioning. The complexity of waste cannot be ignored and must be considered.

2.4.4. The Rebound Effect

The concept of the rebound effect (RE) is well-known in the literature. Sorrel (2014, p. 2850) defines it as: “an umbrella term for a variety of economic mechanisms that reduce the energy savings from improved energy efficiency.” In the context of CE, RE emerges when the eco-efficiency of a productive system is offset by an increase in production or consumption (Zink and Geyer, 2017). Especially, ER occurs when secondary production activities, such as reuse, remanufacturing, and recycling, fail to replace primary production in the same proportion. Instead of reducing environmental impacts, these secondary activities may inadvertently increase them (Zink and Geyer, 2017). Here are several examples of when it can occur in the CE context: products with high greenhouse gas emissions, such as old refrigerators, may cancel environmental benefits if they are reused instead of being replaced with energy-efficient alternatives (Van Loon et al., 2021). Similarly, sharing economy models can lead to “re-spending effects,” with the savings redirected to other consumption, therefore increasing overall resource use (Zink & Geyer, 2017; Freeman, 2018). As a last example, premature replacement of products like LED lamps for more efficient models can generate additional waste (Dzombak et al., 2019).

3. Towards a Combined Framework to Analyze Circular Economy and Smart Cities

SC and CE are two buzzwords that have been attracting interest over the years. Since the concept of SC was introduced, there has been a growing number of surveys aiming to identify the dimensions that characterize it (Guedes et al., 2018). A SC englobes many subjects, such as digitalization, citizen involvement, sustainability, and even governance, which is one of the reasons it attracts the interest of both, academics and policymakers (Ibănescu et al., 2020). In 2000, only 15 papers on this topic were indexed in the Web of Science Core Collection. The growing popularity and significant interest of urban decision-makers (Ibănescu et al., 2020) led to the publication of 73 academic papers by 2010. Today, a search in the SCOPUS database yields an impressive 4,103 papers, highlighting the growing research interest in this area.

The CE concept takes its roots from different models as we observed previously in the origin part of the CE literature. Interest in this field has been steadily increasing since the first contributions in 2004 (Abad-Segura et al., 2020). Indeed, due to the urgent need to improve the current and future situation of the environment and change the way we produce, the evolution of the articles that were published has evolved from 21 between 2004 to 2007, to 1202 between 2016 to 2019 (Abad-Segura et al., 2020). However, the complexity of this subject has prompted significant scholarly interest, resulting in nearly 8,000 articles on the subject available in the SCOPUS database today.

The question now is: are these two trendy subjects independent from each other? Or is it possible to find a positive collaboration between them?

More and more scholars have introduced a new concept: the circular city. This new term is defined by Prendeville et al. (2017) as *“a city that practices CE principles to close resource loops, in partnership with the city’s stakeholders (citizens, community, business and knowledge stakeholders), to realize its vision of a future-proof city.”* The introduction of CE into urban cities has occurred at a time when SC have become a popular concept around the world, reflecting the important technological changes underway (Bibri & Krogstie, 2016).

However, as Anttiroiko (2023) points out in his research, there is a lack of conceptual clarity on how sustainability relates to SC development, and Ahvenniemi et al. (2016), add that there is a lack of environmental indicators in SC frameworks (Ahvenniemi et al., 2016). This knowledge gap implies that we need a better understanding of how SC initiatives and urban technologies relate to sustainability (Vainio & Sankala, 2022).

Only a few articles explore the intersection of smart and green initiatives in specific areas such as transport, energy, and water, among others. Indeed, urban smartness and circularity share common ground, but their dynamics and connections remain insufficiently analyzed (Janis Zvirgzdins & Geipele, 2020).

If we confront the two concepts and search the keywords “circular economy” AND “smart cities” in the SCOPUS database, we find a total of 68 articles. The book of Kandpal et al. (2024) seems to be one of the references and emphasizes the environmentally sustainable merits, potential for economic growth, and improvements in societal well-being that can arise from this transition. All the papers found date from 2024, which is recent and doesn't necessarily allow us to gain perspective.

In addition to this research, we introduced “circular city” as a keyword and found a number of 113 articles. Ancapi et al. (2024) conducted a case study on the city of Greater London and examined the alignment and synergies of circular built environment policies in it. The findings highlight advancements in construction practices through CE strategies, including modularity, reuse, and design for disassembly. However, these efforts fall short of creating a fully circular city, as they primarily focus on resource looping and lack emphasis on ecological regeneration and social adaptation. In addition, Herrador (2024), decided to create a Universal Circular Cities Declaration (UCCD) which suggests 10 principles for joining circularity into urban sustainable development. These 10 principles mention, among others, the promotion of CE awareness, the development of monitoring tools or even the promotion of CE economic incentives.

3.1. Relations Between 10R Principles and Smart Features

Confronted with the theoretical gap between our two subjects, we decided to compare them based on their frameworks and see the potential links that could be made. Prior in this master

thesis, we have seen two Frameworks for both topics analyzed. First, we explored the six characteristics observed by Giffinger et al. (2007), for SC, followed by the 10R Framework (Morseletto, 2019; Potting et al., 2017) concerning the CE. In this section, we decided to combine these topics to observe their positive relationship (Appendix 1). The Framework “Relations between 10R principles and Smart Features” (Appendix 1) transforms these operational concepts into actionable realities.

The rows of Appendix 1 represent the 10R of CE and the columns represent the six smart characteristics explained in our SC literature. Through empirical studies and based on our literature review, we gathered actions that match both axes of this double-entry table. These actions are referenced in the last column of our table.

Based on this first theoretical part, several questions arise, such as: "What are the synergies between CE principles and SC frameworks in addressing urban sustainability challenges, and how can these be operationalized effectively?", "What are the key barriers and opportunities in transitioning from smart cities to smart circular cities, and how can urban stakeholders collaborate to overcome these challenges?" In this thesis, we will focus on answering the following research question: *“How do smart city principles contribute to the development of circular cities?”*

Section 2: Empirical Framework

1. Methodology

Our literature review shows an increasing interest in both, CE and SC concepts. However, the intersection between these two concepts is still in its infancy. This study aims to extend the current literature by exploring “How do smart city principles contribute to the development of circular cities?”.

In this section, we will define our methodology and the targets we must reach through this analysis. The methodological approach used in our research is the qualitative methodology based on a case study (Yin 1984) focusing on the city of Barcelona and using two data-gathering techniques: semi-structured in-depth interviews and document analysis.

1.1. The Barcelona Case Study

We chose to focus our work on a case study, selecting Barcelona as our study subject to address our research question. The decision to center this research question on Barcelona is grounded in two key considerations.

The first aspect is that Barcelona is considered one of the smartest cities worldwide. Indeed, in 2014, Barcelona was awarded the European Capital of Innovation ("iCapital") with Máire Geoghegan-Quinn saying: "*Barcelona is a deserving winner of the first iCapital award, for its dedication to using new technology for the benefit of its inhabitants...*" (European Commission, 2014).

In addition, a few years before, in 2010, Barcelona's city council initiated the “Barcelona as a People City” project, introducing innovative technologies to foster economic growth and improve the well-being of its residents (European Commission, 2014). This initiative was built around five strategic pillars: (1) open data initiatives to improve transparency and accessibility; (2) sustainable urban growth through smart lighting, electric vehicle mobility, and the utilization of residual energy; (3) promoting social innovation; (4) fostering collaboration among research centers, universities, and public-private partnerships; and (5) delivering “smart services” powered by advanced ICT solutions (European Commission 2014).

Barcelona has also effectively improved its experience as a pioneer in developing innovative urban districts, exemplified by the 22@Barcelona project (Capdevila & Zarlenga, 2015). This initiative transformed the city's industrial area into a vibrant hub for knowledge-based industries, fostering collaboration between businesses, research centers, and academic institutions while driving urban regeneration and economic growth. (22@network Barcelona, 2023).

Capdevila and Zarlenga (2015) describe the case of Barcelona city as a 'successful ecosystem' where improvement in urban development, business opportunities, and quality of life have been progressing for decades. Barcelona is also organizing, each year in November, the Smart City Expo World Congress to tackle subjects such as urban issues and the technological revolution (Smart City Expo World Congress, 2024).

In addition to the SC aspect, Barcelona is also a city that focuses on CE. Indeed, the city of Barcelona has been promoting green and CE (*ProACCIÓ Green*, n. d.). As we just explained in the previous paragraphs, Barcelona is an innovation-oriented city and has proven to be a pioneer in designing solutions to the city's environmental challenges with initiatives such as Ecoparks to manage solid urban waste ((Ecoparc Barcelona, 2023), setting up a waste-water treatment plant and solar panels, consolidating the separate collection of waste, enforcing limits on metropolitan CO2 emissions by private vehicles, boosting public transport,... (Ajuntament de Barcelona, Barcelona Activa, 2023).

To add an example, Barcelona just adopted the 2021 Zero Waste Plan that will last until 2027. This plan follows three pillars, reducing and reusing, fostering the circularity of products and materials, and improving and increasing selective collection, with public participation and communication as cross-cutting values (Barcelona Zero Waste Plan 2021-2027, n. d.).

The second reason is personal. Indeed, I had the opportunity to complete an internship in the city of Barcelona for six months from February 2024 until July 2024. I knew already that my thesis would be on SC and CE and, therefore, it was obvious to me, while discovering this new city to choose it as a case study.

1.2. Data Gathering

As we already explained, we used two different techniques to gather our data: semi-structured in-depth interviews and document analysis. We have followed a data triangulation strategy to add data validation and perspective in addition to the analysis of our qualitative research based on the interviews (Denzin, 2015).

For the collection of interview data, we used the qualitative methodology of the single case study. A single case study can be conducted on individuals or communities and the data compiled into a community case (Harris et al., 2008). The setting of a geographical site is chosen and the collection of data from common and differing personal characteristics is analyzed.

The first step is then, to determine the geographical site to be studied (Jacquemin, 2018). Our study is about the eventual collaboration of SC and CE in the city of Barcelona. The first criterion for our interviewees was to be Barcelona citizens to be able to give concrete examples for our analysis. The second aspect was to either have an active role in the circular economy system or smart city.

To ensure the relevance of our qualitative study, we followed the homogenous sampling method (Harris et al., 2008) and we selected participants based on these two key criteria. We prioritized participants who demonstrated a broader understanding of the interplay between the two concepts, even if their primary work focused on only one of them. Among our five interviews, two are junior profiles, and the three others, seniors, are listed in more detail in Appendix 2. Unfortunately, due to the niche criteria, the partiality of the samples could not have been reached, with four men and only one woman. Nevertheless, as shown in Appendix 2, all the interviewees are experts in their sector.

There are many techniques for collecting qualitative data, the three main ones being individual interviews, group interviews, and observation (Jacquemin, 2018). In the context of this master thesis, we decided to conduct individual interviews to have intrinsically subjective and individual perceptions. Individual interviews are an effective method for capturing the depth and complexity of participants' responses. They provide valuable insights into personal perceptions, which often differ significantly between individuals (Jacquemin, 2018).

We decided to conduct semi-structured individual interviews due to their ability to balance structure and respondent freedom. This flexible method is particularly well-suited for studying perceptions and opinions (Kallio et al., 2016). It allows the conversation to focus on the key themes of our research while enabling interviewees to elaborate based on their perspectives. By asking open-ended questions and providing opportunities for follow-up, we can delve deeper into responses and extract valuable insights (Jacquemin, 2018). This adaptability enabled us to tailor questions based on participant answers, ensuring a nuanced understanding of opinions and meeting our research objectives.

A semi-structured interview is elaborated with the template of an interview guide that we have created (Appendix 3). We used the funnel-shaped approach by starting with general questions about their knowledge of the concepts, followed by more precise questions combining the two concepts (Giannelloni & Vernet, 2019). All the interviews were recorded and transcribed (Appendix 5) following the qualitative method to be able to analyze them afterward. The timing of the interviews varies from 30 minutes to 1 hour as shown in Appendix 2. Even though you see in Appendix 3 that we have precise questions in our guide, we had a certain flexibility to add, delete, or even change some questions depending on the interviewee's preferences and answers. Even with the interview guide as a template, all interviews were conducted in a manner as open and informal as possible. Interlocutors brought up topics themselves, without or with only a few general directions, such as a discussion (Masset & Decrop, 2019).

In addition, we used secondary data such as reports, documentation, press articles, and the online content of the institutional webpage in Barcelona. To aid in the research process, the primary keywords utilized in the literature are determined (Harris, et al., 2009), "Barcelona", "smart cities", "circular economy", and "collaboration".

1.3. Data Analysis

To analyze our data, we decided to use the qualitative content analysis method, applying the deductive coding approach for a case study.

Content analysis is particularly suited for semi-structured data, such as interviews (Blanc et al., 2014). In our case, interviews were conducted to address a lack of information on the

subject. As previously explained, we recorded and transcribed these interviews to facilitate the analysis of their content. A positive aspect of this method is that data are spontaneous and provide an accurate reflection of the interviewees' thoughts (Blanc et al., 2014).

After collecting these data, we chose to apply the coding method. This method involves identifying repeated words, expressions, themes, or concerns that reveal areas of interest for the speakers (Krippendorff, 1980). These interests are then organized into categories.

For this research, the themes and interests were identified through deductive coding, as shown in Appendix 4, with some extracts from the interviews. These themes were previously analyzed in our literature section using the “Relations between 10R principles and Smart Features” framework (Appendix 1). Therefore, data was transformed into a case study around the 10R principles (Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, and Recover) as well as the key SC characteristics (mobility, government, people, living, economy, environment) in the case of Barcelona. Using the 10Rs framework and key features of SC as a basis for analysis and approaching these features with insights from previous literature improved the internal validity of our method. Finally, secondary data is added to this section to be able to give a complete result.

2. Findings

To answer our research question, we found it relevant to use the “Relations between 10R principles and Smart Features” framework.

The collection of data from the five interviews were collected in Table 1, as we just mentioned in the previous paragraph. We complemented it with examples of Barcelona's actions from some reports, and papers that weren't mentioned during the interviews and that we found relevant to complete this analysis.

Table 1. “Relations between 10R principles and Smart Features” Barcelona Case

Smart city/CE	Smart Living	Smart Government	Smart Economy	Smart People	Smart Environment	Smart Mobility	References
Refuse (R0)	-Teleastro.net (D)	-Public administrations help companies to cluster on find organizations (I2) -Barcelona's Wi-Fi Mesh network (D) -Barcelona Energia (D)	-Start-ups collaborate with entities for financing help to develop their ideas (I1)	No refuse identified in the case.	-Teleastro.net (D)	No refuse identified in the case.	(Bakıcı et al., 2012) (ACCIO, 2022)
Rethink (R1)	- Super blocs/ 15-minute neighborhood in districts (Eixample, Poble Nou, San Antonio) with the 22@Barcelona district (I1) - The traditional infrastructure is redesigned to ease the ICT integration at all its levels and new services for citizens (D) -DEFCON8, (SEBR– Smart Energy Building Renovation) (D)	-Public company force the change of new infrastructure to transform the city (to create bike lines) (I3) -Some public schools choose food suppliers that englobe CE in their process (I2) -Multi-Council Open Data (D) -Citizen virtual office: >40% virtual procedures in one year, 34% users >50 years(D)	-Companies (eg: Torres wine company) ask their supplier to use new green options (I2) -Using virtual reality and Google Glass in citizen workshops to defend projects (I1)	-Open collaborative space; Fab Lab BCN (D) -Smart City App Hack (D) -Digital city lab (D) -Barcelona in your pocket (PL)	-The 22@Barcelona district integrate green infrastructure (I1)	-Pedestrianization around schools, with between 300 and 500 new crossings in the last eight years (I1) -Smart traffic light system that prioritizes public transportation (D)	(Bakıcı et al., 2012) (<i>Fab Lab</i> 2024) (Gascó-Hernandez, 2018) (Ferrer, 2015) (Velooso et al., 2024b) (ACCIO, 2022)
Reduce (R2)	-LED street lighting with sensors for security (PL) -DEFCON8, (SEBR– Smart Energy Building Renovation) (D)	-City-council doesn't have papers (I2) -Implementation of challenges. (e.g.: keep your consumption under a level X, you will be given a discount on your next bill) (I4)	-Provision of services to citizens directly or indirectly as public administration providers in areas such as energy, water, waste management, education and health (D)	No reduce identified in the case.	-Use of fire leaves instead of natural gas (I4) -Master lighting plan: 1,155 urban lights with LED bulbs (D) -Cooling and heating network: 29km connecting >60 buildings (D) -Smart irrigation systems) (PL)	-Public bike-sharing system: Bicing with 12,000 bicycles, almost 95% of which are used every day (I1, I3) -Mobility plan: >500 hybrid taxis, >130 electric bikes to rent (D) -Bus fleet utilizes hybrid vehicles to minimize emissions (D) -Free parking system based on sensors and applications (D) -eCooltra (scooter sharing service) (D)	((Bakıcı et al., 2012) (Gascó-Hernandez, 2018) (Velooso et al., 2024b) (ACCIO, 2022)

Reuse (R3)	No reuse identified in the case.	-Catalan Water partnership (I5)	No reuse identified in the case.	No reuse identified in the case.	-Heating and cooling urban networks such as Districlima (D)	No reuse identified in the case.	(ACCIO, 2022)
Repair (R4)	No repair identified in the case.	No repair identified in the case.	No repair identified in the case.	No repair identified in the case.	No repair identified in the case.	-Electric vehicle charging points (D)	(Bakıcı et al., 2012)
Refurbish (R5)	-Refurbishment of older districts like Sagrera (D)	No refurbish identified in the case.	No refurbish identified in the case.	No refurbish identified in the case.	No refurbish identified in the case.	No refurbish identified in the case.	(Bakıcı et al., 2012)
Remanufacture (R6)	No remanufacture identified in the case.	No remanufacture identified in the case.	-Collaboration between companies and 22@Urban Lab (D)	No remanufacture identified in the case.	No remanufacture identified in the case.	No remanufacture identified in the case.	(Bakıcı et al., 2012)
Repurpose (R7)	-Creation of community hubs such as Fab Lab (Living labs) in old industrial spaces with 5,400 citizens and 200 institutions (D)	No repurpose identified in the case.	No repurpose identified in the case.	No repurpose identified in the case.	-Textile Cluster: textile waste is repurposed into insulation materials for urban construction (D)	No repurpose identified in the case.	(Bakıcı et al., 2012) (Gascó-Hernandez, 2018) (van Buren et al., 2016).
Recycle (R8)	-Card-related garbage cans in the suburbs of Barcelona (I3) -Innovative products in the urban furniture are created with state-of the-art recycled materials (D)	-Government-supported recycling of construction materials (D)	No recycle identified in the case.	No recycle identified in the case.	-Use of sensors in waste management bins (I2, I3) - Urban recycling initiatives, such as recycling construction debris during redevelopment projects (D) -EV battery (D)	No recycle identified in the case.	(Bakıcı et al., 2012) (Gehin et al., 2008)
Recovery (R9)	No recovery identified in the case.	-Requirement for biogases for biomethane plants in the waste energy sector (I4)	No recovery identified in the case.	No recovery identified in the case.	-Energy recovery initiatives in the 22@Barcelona district (generating renewable energy) (D) -Districlima (D)	No recovery identified in the case.	(Bakıcı et al., 2012) (ACCIO, 2022)

Note: I1: Interviewee 1, I2: Interviewee 2, I3: Interviewee 3, I4: Interviewee 4, I5: Interviewee 5, D: Documents; PL: Previous Literature

2.1. Relations Between the Two Metrics

When we analyze Table 1, we directly observe stronger relations between some characteristics than others.

Firstly, as shown in Appendix 2, the five interviewees we selected are experts in their respective fields and topics. This means that during the interviews, they chose to share what they considered to be most relevant and important. Consequently, as observed in Table 1, certain Rs are prioritized over others, which are considered more “basic”. In fact, in Table 1, all the data collected during the interviews mainly cover the first three Rs of the framework, i.e., refuse, rethink, and reduce. On the contrary, actions in lower Rs, such as repair, refurbish, or remanufacture seem to be less significant for our candidates. As far as the main columns of the SC are concerned, the examples of action come mainly from smart people, smart government, and smart mobility (which necessarily involves smart living).

Concerning the secondary data collection, examples were found in city council reports, scholars, and public companies’ analysis of Barcelona. Even if we found actions in quite a few intersections, the same pattern is observed with the majority of examples found in the intersections of the refuse and reduce principles.

2.2. Definition of Circular City

A broad definition of a circular city was gathered from each interviewee, revealing that most shared a similar vision of what constitutes a city in the future. Indeed, for I3, the circular city’s purpose is *“to facilitate the place where we live”* with actions from governance and the mobility sector. For I2, *“smart cities initiatives do not make sense if they do not include the concept of circular economy or decarbonization in each of their topics”*. For I5, this would imply mobility and energy efficiency, and I4 thinks that biomethane will be in the focus center of cities. On the other hand, I1 has a completely different perspective by saying, *“I would even go so far as to say that artificial intelligence and sustainability are at odds”*. For him, technology is polluting and can’t match with sustainability, such as I4, who sees a circular city as a city where all public services are in less than ten minutes, calling it *“a 15-minute city”*. In addition, here is a selection of words that have been repeated: “security”, “life quality”, “natural resources”, “and collaboration” during interviews.

2.3. Evolution of the Smart City Concept

During the interviews, a recurring subject that occurred was the evolution of SC objectives over the years. Nowadays, technology in SC is no longer the only purpose and is not even the best solution. Interviewees 2 and 3 demonstrated this saying with examples of failed technology-centric projects in Barcelona. The project that I3 highlighted is a project that used sensors in waste bins to optimize collection plans by tracking fill levels. The goal was to use data to establish efficient schedules, but the high frequency of waste collection needed (every two days) made the approach inefficient and overly complex. Despite significant investments in digitalization, the project demonstrated that technology alone cannot address all urban challenges. This highlights the sentence of I2: *“cities or people were very focused on technology, even as a target and forgot that technology was supposed to be a tool that could make things easier or more efficient or better managed”*.

2.4. Top-down and Bottom-up Complexity

According to I4, the private sector is more inclined to try innovative solutions, but they will always depend on the support and funding of public institutions. For I2, the city councils themselves cannot implement these kinds of initiatives alone and must raise awareness among citizens and businesses. I4 and I2 conclude this topic by suggesting a complementary role for the public and private sectors. However, there is a distinction in emphasis. I4 and I2 implicitly stress the importance of government involvement and the need to raise awareness among businesses and citizens.

2.5. Citizen's Implication

All five interviewees agree that nowadays, citizen implication must be the main focus of cities. Indeed, it is one of the main challenge circular cities has to face. The collaboration must be taken into account in every step of an innovation (interviewees 1 and 3). I2 attest that when we introduce technology, smart technology, in CE initiatives, it is certain that we will have more effective results if the citizens are included in innovation. In the data collected, Fab Labs and Google Glasses are relevant examples. I4 agrees but focuses on the importance of transparency and awareness.

3. Discussion

The results, as described in the previous section, show a degree of consistency with existing theories and some interesting observations can be made.

Our first analysis reveals some contrasts with the literature. Indeed, according to D'Amato and Korhonen (2021), the actions prioritized within the CE concept tend to focus on the middle loop Rs such as reuse, remanufacturing, refurbishment, and repair and recycling. These activities are primarily implemented by businesses rather than cities, aligning with the CE's emphasis on product lifecycle design and management. This focus is further supported by research from van den Berg and Bakker (2015), among others, with the support of the well-known butterfly diagram designed by the EMF (2013). This diagram highlights the reuse, redistribution, refurbishment, remanufacturing, and recycling aspects of the Rs framework (see Figure 2). This comparison reveals a clear distinction between the approaches of businesses and cities within the CE and adds a new perspective to our literature. Businesses tend to focus on the middle and low loop Rs, optimizing resource recovery and product lifecycle extension, while cities concentrate on the higher Rs, such as refuse, rethink, and reduce to change the living aspect and mentalities. This divergence highlights the complementary roles of cities and businesses in the CE concept and demonstrates that cities might be better equipped to implement high Rs.

The definitions of circular city provided by the participants do not conflict with the prior definition of Prendeville et al. (2017) in our literature: *“a city that practices CE principles to close resource loops, in partnership with the city's stakeholders (citizens, community, business and knowledge stakeholders), to realize its vision of a future-proof city.”* Nevertheless, based on our study, we can complete it and improve it with the creation of a new definition: *“A circular city can be defined as an urban environment designed to optimize resource efficiency, enhance sustainability, and improve the quality of life for its inhabitants. It achieves this through the integration of circular economy principles into governance, mobility, energy systems, and public services. Collaboration, life quality, security, and the preservation of natural resources are central to its vision. While technology, such as artificial intelligence, is often debated for its role in circular cities, its application must align with sustainability goals to ensure minimal environmental impact.”*

Our results on the evolution of the SC concept confirm what we observed in prior in the literature. Indeed, Ferrer (2017) explains that SC are no longer only driven by technology but also by people, politics, strategy, and transformation. The observation that there are various types of SC (sustainable SC, sensed SC, collaborative SC, and holistic SC) also reinforces this idea. Building on the existing literature and additional sources (Minnovation, n.d.; Anthopoulos, 2017), we developed a timeline (Figure 4) tracing the evolution of the SC concept. This timeline confirms, as experts have argued, that modern SC no longer focuses on the technological aspect. As shown in Figure 4, the evolution of SC initially focused on the integration of technology into urban planning, followed by the development of digital tools and digital cities. It was only in 2010 that their focus shifted to include citizen engagement and sustainability. Since 2020, SC have been moving towards a holistic approach, combining the three types of SC previously identified in our literature review. The next step of this timeline might be the idea of a circular city. The next phase in this timeline could be the emergence of the circular city concept.

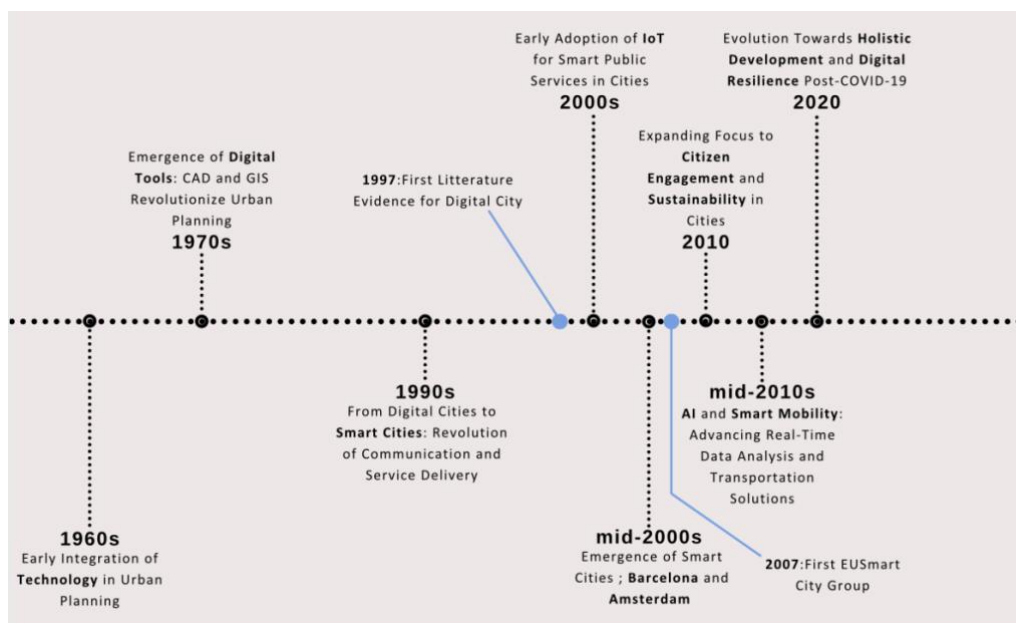


Figure 4: "Smart City Evolution Timeline". Own creation

Regarding the results found about the implication of the citizens, these assertions align with previous theories, as highlighted by Koutra et al. (2020), who state that there is no smart city without smart citizens. However, this perspective can be expanded to include the CE framework. Not only must the citizens of a smart city be engaged and informed, but the citizens of a circular city must also play an active and integral role in its implementation.

The top-down and bottom-up complexity reflects the key argument in our prior literature, which highlights the need for collaboration between stakeholders. For instance, Angelidou (2015) and Anthopoulos (2016) debate whether SC projects should be primarily top-down, led by governments and global suppliers, or bottom-up, driven by local entrepreneurs and community initiatives. In our literature, both perspectives converge on the importance of setting shared objectives and fostering collaboration among stakeholders. The ideas from I4 and I2 complement the findings in the literature, supporting the notion that smart city development is most effective when top-down and bottom-up approaches are synergized, rather than treated as opposing forces. In Table 1, smart governance and mobility take an important place but so as smart people.

4. Conclusion

In this research, a case study on the city of Barcelona has been made to analyze and answer our questions about the collaboration between the CE and SC concept. The purpose of this thesis is to explore the integration of CE principles into SC frameworks, focusing on the case of Barcelona, to answer the following question: “How do smart city principles contribute to the development of circular cities?”

Our findings reveal several key elements that address this question in the context of Barcelona.

Firstly, over time, as you can see in Figure 4, SC objectives have evolved from being purely technology-driven to adopting a holistic, people-centered approach. This shift allows the integration of CE principles, making the combination of SC and CE principles a suitable framework for achieving circularity. This finding certifies that we need both, technology and sustainable practices to address urban challenges.

One significant finding emerges from our initial analysis. Drawing on the data from our framework (Table 1) and comparing it with the literature, we observed that the actions taken by the city government differ significantly from those typically implemented by companies. However, as we observed, the most impactful actions in the context of Barcelona are led by the government and focus on the higher Rs of CE (e.g., refuse, rethink, and reduce). In contrast, firms tend to concentrate on the middle loop Rs (e.g., reuse, remanufacturing, and

repair). This comparison highlights a crucial distinction: compared to firms, and by leveraging the SC concept, government-led actions are better positioned to drive the transition towards a circular city. Nevertheless, this distinction underscores the complementary roles of cities and businesses within the CE framework. Cities set the vision and drive systemic changes, while businesses innovate within their operational domains. This relation leads the city through the foundation of a circular city transformation in ways that align with both SC and CE principles.

Interviews and literature emphasize that while governments play a critical role in providing resources, regulation, and strategic vision, grassroots initiatives address localized needs and drive innovation. The synergy between these approaches is crucial for fostering stakeholder collaboration, raising awareness, and ensuring inclusive participation in the transition to circular cities.

Lastly, interviewees unanimously emphasize that citizen involvement is crucial for cities today, particularly in circular city initiatives, where collaboration must be integrated into every stage of innovation. Transparency and awareness are also key factors in fostering this engagement.

The contributions of this research are both significant and multifaceted.

Firstly, a new framework that explores the combination of CE and SC is introduced (Table 1). This framework is versatile and can be adapted to various contexts and cities beyond Barcelona.

Secondly, the research proposes a definition of what constitutes a circular city. As this concept remains underdeveloped in the existing literature, offering a clear definition addresses an important gap.

Finally, this research offers an example of how these two concepts can be applied successfully, in the case of Barcelona. Indeed, Barcelona demonstrates its implication through the development of circular cities via cluster initiatives, an e-government, the multi-Council Open Data, its Bicing solution, hybrid vehicles, pedestrian zones, its sensors to collect waste, manage light but also the implementation of its Fab Labs, new city infrastructures and more as you can see on Table 1.

4.1. Personal Reflection

While analyzing data from the interviews and literature, several reflections related to the implementation of circularity in Barcelona and the integration of CE and SC concepts have emerged.

First, Barcelona faces a significant challenge with its popularity as a tourist destination. I3 tackles this subject explaining that the massive influx of tourists throughout the year puts pressure on the city's infrastructure and resources. Tourists may not be as informed or committed to circular practices as residents, which can undermine the collective efforts of the local population and strain urban systems. According to us, this issue is an obstacle for Barcelona to transition more smoothly through a circular city.

Another observation made is the concept of the twin transition that was tackled during the interview with I3. The twin transition is the advancement of the green transition (environmental sustainability) and the digital transition (technology-driven innovation), it envisions a future where digital tools optimize sustainable practices, creating a mutually reinforcing cycle of innovation and environmental preservation (European Commission Joint Research Centre, 2022). The key limitation here, as noted by I1 during the interviews, is the high energy consumption associated with digital technologies. While these tools can optimize CE practices, their energy use can conflict with CE goals of resource efficiency and sustainability. This tension presents a significant barrier to harmonizing these concepts. There is therefore a sort of a paradox in the pursuit of this transition.

5. Limitations and Further Research

This thesis presents certain limitations that should be acknowledged to contextualize its findings and scope.

The limitations of this thesis start with the scarcity of information found concerning the combination of our two subjects (as demonstrated previously). Furthermore, the creation of the concept of a circular city is also recent and data is difficult to find. This is one of the reasons why this subject is so interesting but also can lead to bold or hasty conclusions. In the same thought, one of the interviewees observed that both CE and SC are current trends that may lose interest over time. For example, I3 mentioned that the city is already shifting its priorities

toward the emerging trend of decarbonization. This shift could reduce long-term commitment and investments in circular and CE initiatives, limiting their full potential. Therefore, "today" also imposes a limitation with the lack of information and the uncertainty of the interest in the future. SC is a more integrated concept and comparing it with CE is relevant today but may not be in the following years. Future research should consider adopting a longitudinal case study approach to address the limitation of "time". Following research for Barcelona would involve examining the evolution of strategies and plans related to both SC and CE concepts over an extended period. Such an analysis would provide valuable insights into how priorities and interests have shifted over time (Caruana et al., 2015) but also let the time to other papers empower observations. For example, a confrontation with the UCCD of Herrador (2024), could maybe bring valuable insights.

Another methodological limitation concerns the interviewees. The use of interviews, for the qualitative dimension of this study, may be limited by the diversity and number of experts involved. Indeed, even if a geographical dimension had to be followed, as we already mentioned, the partiality of gender was unequal with only one woman among five interviewees. Moreover, due to the specificities required, only five persons were interviewed, reducing the precision of this analysis. To deepen and enrich this research, it would be necessary to take a larger sample. Visiting the city analyzed could facilitate direct engagement with more influential stakeholders. For further research, at least one expert in each of the six smart characteristics would permit us to have a complete vision of our framework and therefore, the actions taken to go towards a circular city.

As a last comment, I would say that further comparative research with other case study cities would bring consequent added value to the combination of these two subjects. In this thesis, only one city has been studied, and even if Barcelona is a perfect case study, comparing it with another city would have brought a much more critical outlook. Cities such as Amsterdam, known for its CE initiatives (Ferrer, 2015), or Singapore, renowned for its SC technologies, could serve as complementary case studies. This comparative approach would offer valuable insights into the applicability of CE and SC integration models across other urban contexts. One of its key objectives, supported by the framework in Table 1, would be to determine whether other cities prioritize the same ROs.

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Appendices

Appendix 1: Relations between 10R principles and Smart Features. Own creation

Smart city/CE	Smart Living	Smart Government	Smart Economy	Smart People	Smart Environment	Smart Mobility	References
Refuse (R0)	-No inefficient heating/cooling systems - Co-living apartments	-No single-use plastic bags and secondary packaging at the national or city level	-Supply chains dependent on sustainable materials	-Educational programs encouraging minimal consumption	Rainwater harvesting systems -Replace incandescent lamps such as LEDs	-Banning gasoline- in certain urban areas -car-free zones	(Hultman & Corvellec, 2012) (Hedlund-de Witt, 2012) (Allwood et al., 2011) (Muller et al., 2022) (Gil-Garcia et al., 2015). (Appio et al., 2019).
Rethink (R1)	-Multifunctional buildings Dematerialization of services (teleconsultations or Teleworking)	-E-government services (online tax filing) -Public consultation via digital platforms	- Reusable, modular or repairable products to market -Integrating the circular economy -Support renting economy	-Integrate the circular economy into educational programs -Collaborative platforms to share knowledge	-Trash management -Intelligent infrastructures to capture renewable energy and/or wastewater	-Shared mobility (bike-sharing, carpooling) - pedestrian and cycle zones -Digital platforms for transports -Dematerializing travel (home working)	(Neirotti et al., 2014) (Crutzen & Desdemoustier, 2015) (Reike et al., 2018). (Morseletto, 2019) (Shi & Shi, 2023)
Reduce (R2)	-Lightweight design in houses (Solar panels -ICT systems reduce waste in healthcare -Energy use in public spaces (e.g., smart streetlights)	-Governmental carbon footprints policies -Waste reduction targets in public works projects	-Promoting lightweight manufacturing -Supporting Green Startups	-Awareness on waste reduction -Programs to track and reduce waste -Energy footprints via apps -Educational programs on dematerialization, lightweight materials, ...	-ICT-based systems to monitor and reduce waste -Lightweight materials for renewable energy installations (e.g., solar panels)	-Lightweight designs for vehicles (electric and autonomous models) -Encouraging car-sharing and public transport	(Ndaguba et al., 2023) (Neirotti et al., 2014) (Appio et al., 2019) (Ramos, 2020) (Morseletto, 2019)
Reuse (R3)	-Second-hand marketplaces -Repair stations within residential areas -Reuse of building materials (wood and bricks...)	-Municipalities support platforms for residents to exchange goods -Reusable public infrastructure, modular urban furniture (street benches and bus shelters)	-Take-back programs where customers can return used goods, which are then cleaned, repaired, and resold (Ikea, Patagonia)	-Citizens participating in sharing platforms for tools, vehicles, or household goods	-Reuse of treated wastewater reduces the need for fresh water - Materials from demolished buildings are reused in new construction projects	- Reuse of electric vehicle batteries into power storage units for public transportation systems	(Allwood, 2014) (Neirotti et al., 2014). (Morseletto, 2019) Yan & Feng, 2014) (De Brito & Dekker, 2003) (Stahel, 2010)
Repair (R4)	- Intelligent home systems include modular designs, enabling easy repairs	-Efficient public asset management through repair tracking systems	-Repair-focused business models (smartphones and laptops)	-Promoting repair workshops or "fix-it" cafes within communities	- Waste-to-value projects (repair hubs)	- Recycling bike parts for repair	(Veloso et al., 2024) (Shi & Shi, 2023) Potting et al. (2017) (Willskytt et al., 2016)

	of components such as lighting or appliances						
Refurbish (R5)	-Refurbishing social housing units by upgrading insulation, plumbing, and electrical systems to improve energy efficiency	-Refurbishing existing government IT infrastructure (servers and databases) to extend their operational life while upgrading them with energy-efficient components	- Encouraging businesses to refurbish office furniture and electronics	- Refurbish and modernize public libraries or schools (furniture and digital equipment)	-Replacing outdated bulbs with energy-efficient LEDs while reusing existing infrastructure	-Refurbishment of public transport systems such as buses with electric motors	Hultman & Corvellec, 2012) Neirotti et al., 2014) (Veloso et al., 2024) (Tecchio et al., 2017) (Loomba & Nakashima, 2012) Shi & Shi, 2023)
Remanufacture (R6)	- Incorporating remanufactured materials (e.g., flooring, windows) into affordable housing projects	- Municipal programs for remanufacturing public transport components (train engines or bus parts)	-Remanufacturing industries within urban clusters (e.g., recycling components for electronics or vehicles)	- Programs that promotes the use of rebuilt furniture or electronics	-Urban reconditioning plants dismantle household appliances or industrial equipment to reuse the parts	-Remanufacturing electric vehicle (EV) batteries with the extraction valuable materials (e.g., lithium, cobalt) for reuse in new batteries	(Morseletto, 2019) (Gehin et al., 2008) (Lim et al., 2021) (Veloso et al., 2024)
Repurpose (R7)	-Adaptive reuse of old buildings, like converting warehouses into apartments	- Repurposing underutilized public buildings to house government services or community centers	- Repurposing materials and components from obsolete industries to create new products or services (textile, jewelry)	- Local workshops	- Reuse of used materials	- Repurposing old transport infrastructure or vehicle components for new mobility uses. -Using old shipping containers as community centers	Veloso et al., 2024) (Stahel, 2010) (Van Buren et al., 2016) (Sihvonen & Ritola, 2015) (Leising et al., 2018)
Recycle (R8)	-Recycling infrastructure, urban waste processing hubs - Smart bins equipped with sensors	- Municipal waste management policies where materials like glass and metals are recycled into new streetlights and public furniture	- Recycled plastic from urban waste is transformed into raw materials for 3D printing	- Educational campaigns promote household recycling and proper waste separation practices, enhancing	- Urban waste recycling systems (plastics) - Convert organic waste into bio-based materials or biogas for heating and electricity	-Recycling programs for end-of-life vehicles -Recycling materials from old vehicles into new transport infrastructure components supports sustainable mobility	(Neirotti et al., 2014) (Graedel et al., 2011) (Veloso et al., 2024) (Lim et al., 2021b)
Recovery (R9)	-Integrate of waste-to-energy technologies that recover energy from organic waste, such as food or green waste, to power building systems like heating, cooling, and lighting	-Policies that govern the reduction of incineration through the implementation of energy recovery systems	-Businesses collaborate to use energy recovered from waste streams (n industrial park can use energy recovered from nearby waste-to-energy facilities to power manufacturing processes)	-Community engagement programs that educate residents on how waste is converted into energy	-Utilizing waste-to-energy plants to recover energy from organic waste supports sustainability goals	-Waste-to-energy plants convert organic waste into biogas for urban heating and electricity	(Gil-Garcia et al., 2015) (Worrell and Reuter, 2014) (Stahel, 2010) (Neirotti et al., 2014)

Appendix 2: Characteristics of Interview Participants

Codes	Profile	Position	Duration of the interview
Interviewee1 (I1)	Knowledge and interest in international migration and development studies, urban mobility and city planning, policy analysis and recommendation. Location: Barcelona, Spain	Education Partner Development Officer at EIT Urban Mobility	52.45 minutes
Interviewee2 (I2)	Working for sustainable, economic and social development, while engaging smart city companies in the projects that will change our cities and our lives. Location: Barcelona, Spain.	Talent & Smart Cities Lead at ACCÍO	44.02 minutes
Interviewee3 (I3)	Has participated in more than 70 projects related to cluster development in different fields such as smart cities and circular economy. Location: Barcelona, Spain.	Partner&Consultant at Cluster Development	49.45 minutes
Interviewee4 (I4)	Fresh graduated from a double master's in Energy for Smart Cities. Player in the energy transition. Location: Barcelona, Spain.	Renewable Energy Engineer at FICHTNER RESA	28.55 minutes
Interviewee5 (I5)	Manager of a team of highly specialized professionals in	Senior Manager of Clusters at ACCÍO	29.56 minutes

	charge for cluster policy and development in Catalonia with a special focus on shared value and sustainable competitiveness. Location: Barcelona, Spain.		
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Appendix 3: Interview Guide

Thank you for taking the time to take part in this interview. This discussion is part of my thesis on “Circular Economy Integration in Smart Cities focused on the case of Barcelona”. This interview is confidential, and the information gathered will remain confidential and will be used for academic purposes only. Do you agree to be recorded during this interview? Would you like to be quoted or prefer to remain anonymous?

Presentation of myself:

Student in my last year of master’s in international business in the school of Louvain school of management in Belgium. Currently busy writing my thesis which is about:

“How can smart city initiatives optimize resource management to support circular economy practices such as waste reduction and recycling?”

Structure of the interview

- Talk about you, your role within your enterprise,...
- Your understanding of circular cities
- Innovations that promote circular economy
- The role of the technology
- Challenges you may face
- Your vision of the future

1. Personal and Professional Background

- Can you briefly describe yourself, your background and current role and responsibilities in your enterprise?
- What are the main objectives of your department/organization in terms of smart cities?

2. Understanding of Circular Cities

- How do you define a smart city in the context of your work?

- What role do you believe smart city initiatives play in achieving the goals of a circular economy?

Knowing that a circular economy is:

a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. The circular economy has emerged as one of the most widely used theories to address environmental problems.

Core Questions

1. Innovations in Resource Management

- What innovative approaches have you implemented or observed in resource management within smart cities that promote the circular economy, particularly in waste reduction and recycling?

Ex: using sensor networks and data analytics to improve energy efficiency, waste management, and mobility.

Ex: Smart technologies can support the implementation of circular design principles, such as digital fabrication and 3D printing.

For example, smart cities can use sensors and analytics to monitor and manage energy consumption in buildings, optimize traffic flow to reduce fuel consumption and emissions, and use data to identify areas where waste can be reduced and recycled.

- Can you provide specific examples of technologies or systems that have been successful in optimizing resource use in urban environments?
- What challenges do you face in ensuring that these plans are both sustainable and economically viable?

2. Role of IoT and Big Data

- How do IoT and big data analytics contribute to the development of smart cities in your experience?
- Can you share any case studies where data-driven decisions have led to significant improvements in resource management?

3. Collaborative Models

- How important is collaboration between government, businesses, and citizens in your smart city projects? ok
- Can you describe a project where such collaboration led to successful outcomes in line with circular economy principles?

4. Challenges and Opportunities

- What are the main challenges you encounter when trying to align smart city projects with circular economy goals? (or sustainability)
- What opportunities do you see for the future in integrating more circular economy practices within smart city frameworks?

Conclusion

1. Future Vision

- How do you envision the future of smart cities contributing to the circular economy?
- What steps do you believe are necessary to accelerate the adoption of circular practices in urban environments?
- *Do you believe a circular city is possible in the future?*

2. Final Thoughts

- Is there anything else you would like to share regarding the role of smart cities in achieving sustainable and circular urban development?

Closing Remarks:

Thank you, Mr(s). X, for sharing your insights and experiences. Your contributions are invaluable in understanding how smart city initiatives can support the circular econom

Appendix 4: Codes Table

Interview Excerpt/Quote	CE	SC
I1: “Par exemple, cette piétonnisation autour des écoles. Il y en a eu 300 ou 500 ces huit dernières années.”	Rethink	Smart Mobility
I1: “ ... la base de chaque projet doit être la consultation citoyenne. Et ça, c'est quelque chose qu'on fait pour chacun de nos projets.”	Rethink	Smart People
I1: “...un quartier du quart d'heure ou une ville du quart d'heure, où les gens peuvent à pied accéder à tous les services publics en moins de dix minutes, par exemple.”	Rethink /Reduce	Smart Living / Smart Mobility
I1: “...qu'à Barcelone il y a les Bicing, qui sont, en tout cas de ce que j'ai pu voir, une réussite.”	Reduce	Smart Mobility
I2: “So, E-government is important, but simplification is important.”	Rethink	Smart Governance
I2	Recycle	Smart Environment

"I always remember the initial use of sensors in waste management bins in Barcelona."		
I3: "Because in the whole industry, in food, in retail, in packaging, we visit companies that increasingly say that one of the criteria they have when they choose suppliers is the kind of solutions they have for the circular economy, decarbonization"	Rethink/Reduce	Smart Economy
I3: "For example, if I have 2,000 employees in the city council, I make sure that they do not have papers."	Rethink/ Reduce	Smart Governance/ Smart Environment
I5: "we're making a requirement for a lot of biogases for biomethane plants here in Spain"	Recovery	Smart Governance/ Smart Environment

Appendix 5: Interview Transcriptions

I1 online (EIT Urban Mobility)

A.B : Je vais te demander un dernier truc avant qu'on commence.

C.V : Oui, bien sûr.

I1 : Qu'est-ce que tu as envie de prouver avec cette question de recherche ? C'est quoi en fait le but du mémoire ? Parce que c'est une question théorique intéressante, mais est-ce qu'il y a un but derrière ? Est-ce qu'il y a des choses que tu as envie de démontrer en analysant cette question de recherche ?

C.V : Oui, en fait j'aimerais vraiment voir si les deux peuvent... Enfin je sais que par exemple les Smart Cities, tout ce qui est avec les AI et le fait que tout arrive à être managé de façon plus efficace. Il y a aussi un côté sustainable avec les SDG et tout ça. Donc c'est vraiment... Oui, c'est aussi pour l'écologie, mais est-ce qu'on peut arriver à mettre aussi l'économie circulaire dedans ? Et j'ai pas vraiment énormément trouvé de papers qui expliquent tout ça et qui disent oui, il y a un lien concret entre l'un et l'autre, et j'essaye de voir s'il y en a un en fait. Parce que je sais que les Smart Cities aident aussi à aller vers une qualité de vie et à aller vers tout ça. Enfin c'est comme là où vous travaillez, donc l'Urban Mobility. J'ai un peu regardé le site, si j'ai bien tout compris. C'est quand même dans un but d'avoir une qualité de vie supérieure et que tout... Enfin j'ai pas envie de... Vous me direz plus en détail après, mais voilà. Je crois qu'il y a quelque chose derrière et le but ce serait de voir quoi. Mais là je suis au début de la rédaction et de tout ça. C'est pour ça que l'interview est peut-être aussi un peu tôt, ça va m'aider juste à avoir plus d'informations sur comment me diriger.

I1 : Je pense qu'on en reparlera après, mais tout dépend de la définition de Smart City. Est-ce que Smart City ça veut dire il y a de la technologie partout, tout est automatisé, il y a de l'intelligence artificielle dans tout ce qu'on fait, ou est-ce qu'on considère qu'une Smart City c'est une ville où chaque personne dans la ville a accès à un transport public gratuit par exemple, sur demande, de bonne qualité, sans retard. Pour moi ça c'est une Smart City aussi. Je pense que le point de départ c'est de considérer plusieurs définitions de la Smart City et voir avec lesquelles de ces définitions-là l'économie circulaire peut rentrer en compte. Je pense que la Smart City full technologie, si tu tombes sur des gens qui disent que ce sera

possible tout en étant durable et que ça émettrait moins de CO₂, je pense que c'est un peu n'importe quoi. On le voit actuellement avec l'intelligence artificielle et à quel point ça produit des émissions de CO₂, c'est une folie. Je pense qu'à court terme, c'est pas correct de dire qu'une Smart City où il y aura de la technologie partout est possible à mettre en oeuvre d'une manière sustainable. Peut-être qu'à terme oui, mais moi je pense que c'est une vision un peu biaisée. On en reparlera.

C.V : C'est sûr, mais c'est pour ça par exemple que j'essaie de focus sur est-ce qu'une Smart City peut optimiser les ressources qu'on a ou pas. Dans le sens de l'économie circulaire, le but c'est de ne pas rester linéaire et de réintégrer les ressources. On a tous le symbole de la boucle et c'est voir si on peut optimiser ces ressources premières et que ce ne soit pas juste de la production linéaire comme on la connaît, de la consommation comme ça. Et si on peut aussi changer la vision, parce que les Smart Cities impliquent énormément les citoyens. Tu ne peux pas être Smart City sans avoir des Smart Citoyens. Pour voir si... Je ne sais pas où. C'est un peu là où j'en suis pour l'instant. On va commencer. Juste avant, vous êtes à Barcelone actuellement.

Pour commencer cette interview, est-ce que vous pouvez vous présenter en quelques mots s'il vous plaît ?

I1 : Antoine Berwart, je suis project officer à EIT Urban Mobility. EIT, c'est l'Institut européen pour l'innovation et la technologie. Il y a en fait neuf organisations organisées de la même manière et qui dépendent tous de l'EIT qui est la maison mère de nos neuf organisations qui est basée à Budapest. Et l'EIT, ainsi que nous, dépendons de la Commission européenne qui nous fournit la plupart de notre budget. Donc on travaille avec de l'argent public. La mission principale de l'EIT et des neuf EIT ou des EIT Kick, comme on appelle ça, c'est d'accélérer l'innovation et l'entrepreneuriat dans un secteur propre. Donc l'EIT Urban Mobility doit avancer l'entrepreneuriat et l'innovation dans la mobilité urbaine. Et les huit autres EIT doivent le faire dans leur propre secteur. Donc il y a EIT Health, sur la santé, EIT Food, etc. Donc la mission première, c'est de vraiment utiliser l'argent public qu'on reçoit pour accélérer l'innovation et l'entrepreneuriat dans un secteur. Comment est-ce qu'on fait ça ? On le fait de trois manières différentes. Moi, je travaille dans la partie académie de l'EIT Urban Mobility. Et donc, en gros, ce qu'on fait, c'est de former les leaders de demain dans le secteur de la mobilité urbaine.

Donc on a un programme de master, on a un programme de doctorat et on a un centre de formation continu pour les gens qui travaillent dans les villes et qui, justement, sont les décideurs qui mettent en place des politiques publiques sur la mobilité urbaine. Donc le gros de ce qu'on fait, c'est de la formation master, doctorat, formation continue. Et on a aussi une partie formation en ligne où tout ce qu'on produit comme cours, en collaboration avec des universités, est disponible en ligne, gratuitement, pour tous, avec diplôme. La deuxième partie de ce qu'on fait, c'est de l'investissement dans des SMEs, c'est dans des start-up. Ce que ces start-up ont en commun, c'est qu'ils veulent améliorer la mobilité urbaine dans les villes. L'idée, c'est que chacune de ces solutions, d'une manière ou l'autre, permet à réduire les émissions dans le transport des personnes ou des choses ou des matériels. Donc on investit dans les start-up, on prend parfois de l'equity dans ces start-up, on aide aussi des jeunes entrepreneurs à développer leurs idées. Donc on travaille vraiment de l'idée jusqu'à la SME. Et la troisième partie de ce qu'on fait, c'est qu'on teste des innovations directement dans les villes. Donc si une start-up a un nouveau produit, une nouvelle technologie, un nouvel objet qu'elle a envie de tester dans une ville, on peut les mettre en lien avec des villes à qui on est en partenaire. Et donc on teste ces innovations dans les villes. Et si on voit que ça fonctionne, on peut investir pour vraiment développer cette innovation-là, que ce soit dans cette ville-là ou aussi l'amener dans d'autres villes. Donc ça, c'est les trois choses qu'on fait. La formation, l'investissement dans les start-up et tester directement des nouvelles technologies dans les villes avec qui on travaille. Ça, c'est très vite résumer ce qu'on fait. Comme j'ai dit, on utilise majoritairement de l'argent public pour faire ça. Mais l'idée, c'est que sur un cycle de 14 ans, l'argent public, on va en recevoir de moins en moins. Et par nos investissements dans des start-up, par nos formations qui sont censées à terme faire des revenus, on est censé pallier au manque d'argent public et continuer comme une entreprise privée après 14 ans. Donc ça, c'est le modèle EIT que nos huit entreprises sont censées suivre aussi. Donc ça, c'est la manière dont on fonctionne. Évidemment, on ne peut pas avoir comme objectif de changer la mobilité urbaine en Europe et travailler tout seul. Donc on travaille avec 600 ou 700 partenaires, que ce soit des universités, des grosses entreprises. On travaille par exemple avec des grosses boîtes automobiles. On travaille avec des research centers et on travaille avec des villes. Et donc, avec ces quatre types d'acteurs-là, on veut vraiment mobiliser de l'argent public pour accélérer la transformation vers une mobilité plus douce et une mobilité à terme qui doit être neutre en carbone.

C.V : Donc par exemple, est-ce que vous, particulièrement, vous opérez que sur Barcelone ou pas ? Parce que j'ai fait justement mon stage à Barcelone et je trouvais justement tout ce qui était mobilité, c'était vraiment pour une ville aussi grande, vraiment très bien managée. Est-ce que vous, vous avez un impact là-dessus, du coup ?

I1 : Alors, on est basé à Barcelone justement entre autres parce que c'est une ville référence. Mais on a aussi cinq bureaux au nord, ouest, est, centre et sud de l'Europe. Mais comme entreprise, on est censé agir dans les villes partout en Europe. Donc on est censé avoir vraiment un focus européen. Mais c'est vrai qu'étant basé à Barcelone et ayant notre QG à Barcelone, beaucoup de nos activités se passent ici, mais aussi dans d'autres villes espagnoles. Mais on est censé avoir un impact au niveau européen. Toujours avec ce focus sur les villes, pas sur les pays. Mais à notre niveau, on a contribué à quelques projets à Barcelone. Par exemple, cette piétonnisation autour des écoles. Il y en a eu 300 ou 500 ces huit dernières années. C'est un projet auquel on a contribué. On a contribué pendant le Covid à mettre en place un système de lampe UV qui était censé éliminer 99,9% des bactéries dans le métro en moins de cinq minutes. Donc, ça a permis de reprendre le transport public et de redonner confiance aux gens assez vite après le Covid. Alors que dans d'autres villes, on voyait vraiment une fréquentation dans les transports publics. Donc, ce sont des petits projets auxquels on a pu contribuer. Mais évidemment, on n'a pas un budget pour avoir un impact énorme dans chaque ville européenne. On travaille avec plus ou moins 100 millions d'euros par an. C'est la moitié du budget mobilité de Barcelone. Donc, pour avoir un impact européen dans toutes les villes, ce serait compliqué. Oui, c'est sûr.

C.V : Parfait. Et par rapport à voir si c'est rélevant, mais vous au day-to-day, c'est quoi vos tâches ?

I1: Moi, je suis en charge de projets d'éducation. Donc, je travaille en partie avec le centre de formation en continu. Donc, on travaille avec des universités pour produire des cours en ligne. Et je suis aussi en charge d'un projet un peu plus compliqué à expliquer qu'on met en place avec les autres IIT et dont l'objectif est d'améliorer la capacité d'innovation et d'entrepreneuriat des universités en Europe. Et donc, ça, vu que c'est quelque chose qu'on a en commun, une mission qu'on a en commun avec les autres IIT, c'est quelque chose qu'on met en place à neuf entreprises. Et donc, on finance 40 ou 50 projets par an en majorité des universités où, dans

ces projets, les universités nous disent ou nous proposent des activités pour mettre en place des programmes qui sont censés les aider à être plus entrepreneurial. Donc, ça s'éloigne un peu de la mobilité urbaine.

C.V : Oui, ok. Ok, parfait. Et voilà, peut-être maintenant ici, la question est comme ça en tant que telle. Quelles initiatives de Smart Cities liées à la mobilité urbaine sont actuellement mises en oeuvre dans votre ville ? Donc, initiative, ça pourrait être justement la participation de citoyens. Je vois que vous avez évidemment, comme vous avez dit, vous avez un budget qui est de la Commission européenne. Est-ce que vous voyez d'autres, allez, d'autres grandes initiatives d'une Smart City qui sont dans ce projet-là, d'Urban Mobility ?

I1 : Je pense qu'on, pour commencer, il faudrait revenir à cette discussion de ce qu'est une Smart City, parce que pour moi, la plupart, si pas tout ce qu'on fait, pourrait contribuer à l'éclosion d'une Smart City. Voilà. Donc, évidemment, la base de chaque projet doit être la consultation citoyenne. Et ça, c'est quelque chose qu'on fait pour chacun de nos projets. On doit être sûr que les citoyens sont d'accord avec ce qu'on veut faire. Et donc, on a un département à part entière dans l'Urban Mobility qui travaille avec ça, avec comment est-ce qu'on peut inclure les citoyens dans des projets européens dont ils se sentent parfois un peu déconnectés. Et donc, comment est-ce qu'on peut prendre en compte leur avis avant même qu'on publie des appels à projets et qu'on décide de ce qu'on veut faire. Ça, c'est toujours une base dans chacun de nos projets. Mais après, pour moi, tout ce qu'on fait contribue à l'éclosion de Smart City ou au développement de villes. Je ne sais pas comment on les appelle avant qu'elles soient Smart City. Pas Dumb Cities, mais Old Cities. Pour moi, la Smart City, c'est l'utilisation des technologies d'une manière telle que la qualité de vie augmente, tout en n'augmentant pas ou même idéalement en diminuant les émissions de CO2 de cette ville-là. Et donc, pour moi, en investissant dans des startups qui proposent des solutions de mobilité, d'électrification, d'utilisation de l'hydrogène dans le transport public, tout ça contribue à des solutions qui, à terme, pourraient contribuer à ce qu'une ville devienne une Smart City. Et donc, c'est vraiment là où je dirais qu'il faut faire attention à bien définir ce que tu considères être une Smart City, parce que ça va vraiment influencer tout le reste du travail, je pense. Et donc, la même chose avec tout le reste de ce qu'on fait, je pense que tout ça doit s'inscrire dans ce que doit être une ville intelligente. Et une ville intelligente doit être une ville où les gens se sentent en sécurité, où tout le monde a accès à des services publics de qualité, où on

se sent en sécurité, qui doit ou être très peu cher ou parfois être gratuit, même si je pense que la question du transport public gratuit est une question où il n'y a pas vraiment de réponse. Je pense que des villes ou des pays très riches peuvent se le permettre. Dans d'autres villes, c'est compliqué. Et puis, donner un service public aussi important gratuitement à certaines personnes, c'est parfois pas la meilleure des idées. Mais en tout cas, ça doit être payable pour tous. Ça doit être un service public où les gens se sentent en sécurité à n'importe quelle heure du jour et de la nuit, qu'on soit un homme, une femme, un enfant, qu'on fasse partie d'une minorité. Et donc, tout ça pour moi contribue à ce qu'une ville soit une smart city.

C.V : Parfait, merci. Ah oui, et du coup, là, ça rejoint peut-être ce que vous avez déjà dit, mais ici, la question suivante, c'était comment ces initiatives influencent-elles la gestion des ressources dans la mobilité urbaine, donc par exemple, l'utilisation de l'énergie, la gestion des véhicules et tout ça. Donc ça, c'est un peu ce que vous avez répondu, je crois, déjà, en disant que c'est avec les start-up que vous arrivez à la lumière dans les transports. Vous avez parlé d'hydrogène ?

I1 : Oui, c'est ça. L'hydrogène, c'est une grosse question en ce moment. C'est une des pistes pour avoir des transports à zéro émission. Et c'est très intéressant parce qu'un bus, il roule à l'hydrogène, tu peux le recharger de 0 à 100 en 30 minutes, alors qu'un bus électrique, ça prend toute une nuit. Donc, tu dois le ramener au hangar en dehors d'une ville, le charger toute la nuit, etc. Alors qu'un bus à hydrogène, ça peut être rechargé très vite. Et donc, c'est une des solutions dans lesquelles beaucoup d'argent est investi pour l'instant pour voir si ça peut être développé à scale et si ça peut être rentable surtout, parce que ça coûte très cher pour l'instant. Et donc, c'est une des solutions dans lesquelles on investit beaucoup. Et après, si je dois revenir à la question de l'utilisation des ressources, c'est vrai que ça doit être en tout. Si on électrifie tout, mais que l'électricité vient du pétrole, du gaz russe ou encore pire, du charbon, on a vu des villes pendant le Covid ou pendant la crise énergétique il y a deux ans qui ont relancé des centres au charbon. Et donc, là, c'est un exemple même de comment une smart city où tout est électrifié peut être le contraire d'une ville sustainable ou une ville où on utilise l'économie circulaire. Parce que si on brûle du charbon pour recharger des bus électriques, on n'y arrivera pas. Donc, ça doit être en tout. Et là, c'est vraiment au niveau des politiques publiques et peut-être même au niveau national qui doit avoir une vision globale du développement des villes et du pays. Quand l'électricité n'est pas zéro carbone, ça ne sert

à rien de tout électrifier. Et donc, ça doit venir du politique et d'une vision globale du transport, mais aussi de l'énergie, etc. Et je pense à ça maintenant, parce qu'à la question précédente, on disait qu'il faut demander l'avis du citoyen.

C.V : Et quelles démarches sont mises en place par rapport à ça ? Comment est-ce qu'on demande ? C'est sous forme de pétitions ? Ou justement, c'est plus je ne sais pas qui gère la ville, par exemple à Barcelone, et qui doit faire ça ? Combien de temps ça met aussi pour qu'un projet puisse démarrer ?

I1 : Ça dépend des projets et qui le fait. Le responsable du projet principal doit être en charge de la communication aux citoyens. Donc, généralement, ce qu'une ville fait, c'est de communiquer, que ce soit par Internet, dans les journaux ou même via prospectus dans la boîte aux lettres d'un quartier concerné, qu'il pense transformer, prenons un exemple, un quartier en un super bloc. Je ne sais pas si tu connais le concept des super blocs.

C.V : Non, j'allais demander.

I1 : À Barcelone, c'est ce concept où on piétonnise plusieurs rues dans un quartier, que les voitures peuvent toujours tourner autour, mais que le centre de ce quartier ou de ces quelques rues est totalement piéton, et on va reverduriser, et on va en faire plutôt un lieu de rencontre plutôt qu'un carrefour.

C.V : Un peu comme à Eixample.

I1 : Il y a ça beaucoup à Eixample, oui. Il y a à Eixample, à Poblenou, à San Antonio. C'est une manière de vraiment redynamiser un quartier et d'en faire un peu un quartier, je ne sais pas si tu as entendu parler de ça, un quartier du quart d'heure ou une ville du quart d'heure, où les gens peuvent à pied accéder à tous les services publics en moins de dix minutes, par exemple. Donc c'est vraiment un projet de piétonnisation, mais global, un peu comme le piétonner à Bruxelles, mais peut-être fait d'une manière un peu plus raisonnée, même si c'est très bien ce qu'ils ont fait à Bruxelles. Et donc quand tu veux mettre en place un changement aussi énorme, qui va impacter la vie des citoyens, tu dois leur communiquer bien avant que même les premiers travaux commencent.

Donc ça, ça peut être fait dans les journaux, comme j'ai dit, les journaux locaux, ça peut être fait par prospectus. Et puis la deuxième étape, c'est d'organiser des réunions publiques qui sont ouvertes à tous, et où normalement les citoyens pourront s'exprimer. Ces réunions normalement commencent par la présentation du projet. On va leur dire qu'est-ce qui va changer, comment ça va changer, qu'est-ce que ça va coûter. Et puis après, on va écouter des gens qui ont des opinions différentes. Et normalement, on va laisser les gens se faire une opinion. Le but, si tu es responsable du projet, est quand même de les convaincre. Et ces réunions, on va en faire plusieurs sur plusieurs mois, étalées sur plusieurs mois. Donc toute cette consultation peut parfois prendre un ou deux ans. Et l'idée, après la fin de cette consultation, c'est qu'une majorité soit convaincue que ce changement sera plutôt positif que négatif, et donc que les travaux peuvent commencer sans grandes oppositions. Après, ça arrive que la consultation ne se passe pas bien, qu'il y ait des collectifs de citoyens qui se forment, qu'il y ait des pétitions, comme tu disais, qu'il y ait des manifestations. Et là, ça peut bloquer les débuts des travaux. Mais évidemment, c'est un peu le schéma théorique classique. Je pense que beaucoup de choses peuvent être faites pour essayer de convaincre les citoyens d'une manière un peu plus didactique. Ce qu'on a fait, ce qu'on peut faire, par exemple, quand on veut transformer le quartier autour d'une gare, c'est d'utiliser la réalité virtuelle. On va faire des ateliers avec les citoyens, où en leur mettant les fameuses Google Glass ou quoi que ce soit, on va leur montrer ce que ça va être. Et donc, directement, ils vont être immergés dans cette réalité future et se rendre compte de comment leur quartier va changer. Et ça, d'habitude, ça a beaucoup plus d'impact que juste de leur montrer un plan ou de leur expliquer quels travaux on va faire. Et ça, ça peut vraiment aider à convaincre qu'une piétonisation ou qu'un changement de tout un quartier peut vraiment être bénéfique. Il y a vraiment mille trucs à faire au niveau de la réalité. Pour convaincre. Désolé, ça fait des années que je travaille en anglais, j'ai parfois du mal à m'exprimer en français.

C.V : Non, non, mais je me suis dit, justement, même si on écrivait en français, si vous préférez que je parlais anglais.

I1 : Ton master, il sera écrit en français.

C.V : En anglais.

I1 : Ah, en anglais. Oui. C'est même encore plus de travail pour toi de le faire en français, parce que tu devrais traduire après.

C.V : Oui, je savais. Oui, oui, c'est vrai. Complètement. Je sais que toutes mes interviews sont en anglais, sauf celle-là. Mais bon, on a commencé en français, donc continuons.

I1 : OK, parce que justement, moi, mon anglais, il n'est pas rouillé, mais ça fait.

C.V : J'ai parlé en anglais à Barcelone, mais comme j'ai préparé tout en français. Bon, on continue en français. Mais pour l'avenir, en effet, c'est mieux que je le fasse en anglais. Ce n'est pas faire deux fois l'exercice.

I1 : Même si les logiciels peuvent traduire plus ou moins bien les interviews, mais c'est quand même un peu plus de boulot.

C.V : En effet, en effet. Et oui, je demandais du coup, par rapport, voilà, pour convaincre, comme vous disiez, avec les casques virtuels et tout, ce budget, il vient d'où alors ? C'est vous qui donnez ce budget pour convaincre ou c'est l'entreprise elle-même qui doit débloquer ce projet ?

I1 : Normalement, quand tu construis le projet, tu prends en compte cette phase-là et tu fais en sorte qu'une partie du budget soit dédiée.

C.V : OK, parfait, merci. Peut-être alors à voir maintenant si on peut voir s'il y a des parties d'économie circulaire là-dedans. Et ici, ma question, c'était dans quelle mesure êtes-vous familier avec le concept d'économie circulaire?

I1 : Assez peu. Je comprends ce que ça veut dire en théorie. Quand on l'applique à la mobilité urbaine, c'est un peu plus compliqué pour moi de voir concrètement quelles seraient les applications. Je comprends bien qu'une des questions clés pour l'instant, par exemple, ce serait la réutilisation des matériaux dans mes projets. C'est la seule qui m'est venue à l'esprit quand j'ai lu ton email. Dans le reste de la mobilité ou des transports dans les villes, je vois moins où ça pourrait s'appliquer. Peut-être que tu as des idées?

C.V : Justement, non, parce que je réfléchissais aussi. Mais vous utilisez beaucoup l'intelligence artificielle en elle-même. Mais sinon, tout ce qui est justement matière première, c'est moins

le cas. Comme vous disiez, vous devez utiliser les transports en tant que tels. Mais dans la mobilité urbaine, je cherchais aussi. Je n'avais pas spécialement d'idées pour l'instant. C'était plus une discussion pour voir si vous aviez des idées.

I1 : Pour moi, la question clé, ce sont les batteries. Je pense qu'on commence tout doucement à y arriver. Il y a des entreprises, dont une entreprise américaine, qui a commencé à développer des solutions pour réutiliser des batteries en fin de vie et réutiliser une grosse partie des matériaux rares dans ces batteries pour en faire des nouvelles batteries. Je pense que ça, c'est vraiment la clé. Il y a des entreprises qui arrivent à développer ça dans les 3, 4, 5 années à venir. Ça sera vraiment la clé pour la transition vers une mobilité bas ou zéro carbone. Si on n'arrive pas à réutiliser ces matériaux rares, je pense qu'il faudra vraiment changer de perspective et changer les habitudes des gens, parce qu'on ne pourra pas avoir une voiture électrique par ménage ou par personne. Ce sera impossible. Ça revient un peu à ce qu'on disait au début, dans le sens où ce n'est pas parce que c'est AI que c'est spécialement sustainable. Je mettrais même un signe pour l'instant d'opposition entre l'intelligence artificielle et la sustainability. Évidemment, les entreprises d'intelligence artificielle voudront nous faire croire le contraire. Mais je pense que pour l'instant, c'est vraiment une technologie qui a un potentiel révolutionnaire, mais qui, pour l'instant, a plus d'effets négatifs que positifs, en tout cas sur l'environnement.

C.V : Et aussi, d'autres principes de l'économie circulaire, c'est aussi tout ce qui est biomimicry, c'est utiliser ce qui est actuellement de la nature et essayer de le retranscrire dans notre quotidien de tous les jours. Je ne sais pas si c'est quelque chose que vous essayez de faire dans la mobilité ou pas. Je n'ai pas vraiment d'exemple qui me vienne à l'esprit. Je peux essayer de donner un exemple, moi, comme ça c'est peut-être plus simple. J'ai plus l'exemple qui était vraiment frappant là sous les yeux, mais c'était par exemple quand on analyse, donc c'est biomimicry, et c'est quand on analyse la nature, on s'aperçoit qu'on peut parfois la transmettre dans notre quotidien. Donc c'était par exemple, je vais regarder comme ça, on a un exemple concret. Donc c'est du mimétisme, et si un exemple... Désolé.

I1 : Non, il n'y a pas de souci.

C.V : Donc c'était par exemple se baser sur les... Je veux vraiment trouver un exemple qui explique bien. C'est par exemple... C'est plein de choses comme ça, mais je ne sais pas si dans

les transports, c'est quelque chose qu'on fait. Donc je n'en ai pas encore entendu, mais je ne sais pas si c'était... Si ce n'est pas obvious, c'est que vous ne le faites pas spécialement.

I1 : Il y en a sûrement, mais en tout cas pas qui me viennent à l'esprit. Donc c'est utiliser des choses qu'on voit dans la nature, que la nature a produit, et les retranscrire dans un secteur, dans la mobilité.

C.V : Il doit souvent y en avoir. Ici je vois aussi où des architectes s'inspirent des termites pour designer des structures de cooling, de passive cooling, ou des choses comme ça. Oui, il doit y avoir beaucoup d'exemples dans l'architecture, dans la manière dont on construit les nouvelles habitations, dans les transports.

I1 : Il y a ces nouveaux arrêts de bus avec les toits végétalisés, ou avec les toits pour essayer d'amener un peu de nature dans la ville, et un peu de biodiversité dans la ville, mais je pense que ce n'est pas vraiment un exemple qui corresponde à ce que tu viens de me décrire. Non, s'il y en a qui me reviennent à l'idée, ou si je lis quelque chose, je t'envoierai des articles, ou des références, mais pas tant que maintenant, non.

C.V : Ok, parfait. Et voilà, ça on avait déjà dit, mais s'il y avait des exemples de recyclage des matériaux, de réutilisation des ressources, ou des réductions des déchets, mais à part les batteries pour l'instant dans l'urban mobility.

I1 : Je pense que les batteries c'est la clé, et peut-être si on le prend d'une autre perspective, un point important c'est la taille des véhicules aussi, parce qu'on peut parler de batterie tant qu'on veut, mais si on fait des voitures toujours de plus en plus grosses, on a besoin de batteries de plus en plus grosses. Alors que dans des villes comme Barcelone, ou que ce soit Bruxelles aussi, avoir une voiture qui fait 2 tonnes et demie pour transporter une personne qui en fait 80, ça n'a pas beaucoup de sens. Une autre manière de voir les choses aussi, c'est de réduire la taille des véhicules et pour ça des véhicules encore plus petits, des motos électriques, des scooters électriques, des vélos électriques, pour ça tu as besoin de 10 à 30 fois moins de matériaux rares pour produire des batteries qui vont aller dans ces véhicules-là, qui sont tout aussi pratiques, si pas plus pratiques qu'une voiture, pour se déplacer en tout cas en ville. Donc je pense qu'il y a aussi besoin d'un changement de perspective, on n'est pas obligé de produire des batteries de 200 kilos, mais on est peut-être aussi obligé de penser à

des véhicules plus petits, plus compacts, et qui aussi permettent de moins envahir l'espace public avec des bagnoles. Je n'ai pas le chiffre pour Bruxelles, mais à Barcelone, 70% de l'espace public est dédié aux voitures, et 95% du temps sont à l'arrêt. Donc ce n'est pas non plus une très bonne utilisation de l'espace public, mais là je m'éloigne un peu de ton thème.

C.V : Ça m'intéresse. Et aussi je me demandais, parce qu'à Barcelone il y a les Bicing, qui sont, en tout cas de ce que j'ai pu voir, une réussite. Ils sont vraiment partout, comparé par exemple à Vilo ici, qui je trouve est vraiment moins efficace, se trouve moins partout. Ça c'est par exemple quelque chose que vous vous gérez, ou c'est vraiment plus la ville ?

I1 : Non pas du tout. Ça c'est la ville, c'est 100% public, et ça a été lancé par la ville il y a quand même déjà longtemps, il y a une vingtaine d'années. Mais ça ce n'est pas le genre de truc qui est financé par des projets européens, c'est vraiment la responsabilité de la ville. Et c'est un service qui coûte très cher d'ailleurs à la ville, mais dont les bénéfices, on rapporte encore plus d'argent entre guillemets, parce que je pense qu'il y a 12 000 vélos qui sont utilisés presque à 95% tous les jours. Une grande partie est maintenant électrique, donc ça veut dire que même les parties en hauteur de la ville peuvent bénéficier de ce service-là, parce qu'ils peuvent remonter en vélo électrique. Et donc je suis d'accord avec toi, c'est un service qui fonctionne très bien, qui désengorge à des heures de pointe les transports publics, ça permet aussi aux gens de ne pas faire de trajet en voiture de 2-3 kilomètres, qui vraiment contribue à boucher les artères principales de la ville. Donc c'est vraiment une des manières dont les villes peuvent le plus efficacement possible diminuer la dépendance aux voitures, c'est d'avoir un service public de vélo en partie électrique à un prix abordable, c'est 50 euros par an, c'est vraiment abordable pour tous.

C.V : A Bruxelles, il pleut beaucoup plus souvent, c'est peut-être moins aussi avoir à s'adapter à la ville.

I1 : C'est toujours un peu l'excuse des Belges, mais après si on regarde nos voisins néerlandais, danois, suédois, le temps est encore pire, il neige une grande partie de l'année et ils sont quand même tout le temps en vélo. Donc c'est une question de disponibilité des vélos, de volonté, mais aussi d'infrastructure. A Bruxelles, prendre la rue de la Loi en vélo sur des espèces de pistes cyclables avec des gros blocs en béton quand il pleut, moi je ne serais pas à

l'aise non plus. Donc c'est une question d'infrastructure et donc encore une fois de politique publique et d'investissement.

C.V : Ok, et du coup vous, parce que j'essaie de bien comprendre la différence, je ne vois pas à quel moment vous intervenez, et c'est la ville qui intervient dans le sens où vous occupez de l'urban mobility, mais je crois que je ne vois pas jusque où ça va. Désolée si ça a déjà été dit ou pas.

I1 : Non, c'est assez difficile à comprendre, les grands projets européens comme ça, les projets européens ou les instituts européens sont souvent créés pour venir en complément de ce que fait la ville ou un pays et de vraiment essayer d'aider sur une thématique. Donc évidemment la majorité de ce qui est fait dans la ville de Barcelone ou dans les autres villes européennes est décidé par la ville ou par le pays. Et c'est eux qui mettent la plupart de l'argent et ceux qui ont la plupart des ressources humaines ou financières pour financer les bus, les trams, les métros, etc. Nous on vient et on se préoccupe de l'innovation dans la mobilité urbaine. Et donc on finance des projets à petite échelle pour essayer de prouver à la ville qu'une certaine innovation est viable et que s'ils sont convaincus par ce projet où on a mis un demi-million d'euros, un million d'euros, eux vont arriver et mettre le budget nécessaire pour l'implémenter dans toute la ville. Et donc on vient vraiment en complément de ce qui est fait par la ville et par le pays et on essaie de démontrer que des nouvelles innovations et des nouvelles technologies seront bénéfiques. Et puis après c'est à la ville ou au pays de la prendre en main. Donc c'est vraiment en complément. On n'a vraiment pas les budgets ni les responsabilités pour avoir un impact majeur dans quelques grandes villes européennes que ce soit. J'espère que c'est plus clair maintenant.

C.V : Oui, ça l'est beaucoup plus clair. Je ne voyais pas jusqu'où ça allait. Mais ok, parfait, c'est beaucoup plus clair. Alors, je regarde. Je crois que là ça a déjà été dit, mais d'après votre expérience, comment les technologies des smart cities ont-elles contribué à une gestion plus efficace des ressources dans la mobilité urbaine?

I1 : D'après votre expérience, comment les technologies des smart cities ont-elles contribué à une gestion plus efficace des ressources dans la mobilité urbaine? C'est une vaste question. La technologie est partout dans la mobilité. Une des grandes questions actuelles, c'est le MAS. En gros, c'est l'application dans une ville qui permet de gérer tous les services de mobilité

intégrés dans une seule application. Et donc ça, c'est vraiment ce que toutes les villes essayent de faire pour l'instant. C'est d'avoir tous les réseaux, toutes les applications des services de train, tram, bicycling, vélo partagé, de services privés, etc. en une application pour que chaque citoyen soit capable de voir les horaires, les disponibilités, etc. Et donc ça, ça nécessite une intégration des données de différents services, une plateforme mobile qui soit user friendly, etc. Et donc ça, ça nécessite une capacité technologique énorme qui est vraiment la clé de la réussite de ce genre de système. Pareil pour la gestion des trains, des trams, etc. La technologie est partout. L'automatisation de certaines lignes de train, par exemple, qui permet de les avoir, qui roulent 24 heures sur 24. La technologie est vraiment partout. Pour cette question-là, c'est peut-être un peu trop vaste. Ça peut aller vraiment dans tous les sens.

C.V : Et si possible, à part les batteries, comment envisagez-vous que ces technologies améliorent la gestion des ressources et la durabilité à l'avenir ? Si c'est possible, parce que voilà, je crois qu'on l'a déjà un peu répété. Comment les technologies vont améliorer la gestion des ressources et la durabilité à l'avenir ?

I1 : Si c'est assez vaste, c'est parce que ça peut vraiment aller dans tous les sens. Par exemple, il y a des technologies qui peuvent te dire comment conduire avec ta voiture ou avec ton bus pour optimiser l'utilisation d'une batterie et la faire durer le plus longtemps possible. C'est un exemple très niche, mais c'est un exemple qui permet de voir une application de technologie pour mieux gérer les ressources. Ça peut être pareil avec un million de choses. Je ne sais pas si tu avais des exemples en tête déjà dans d'autres secteurs que la mobilité par exemple. Ça pourrait peut-être m'inspirer.

C.V : Par exemple, le fait qu'on puisse savoir quand une personne utilise de l'énergie dans une maison ou dans une entreprise. Il y a en fait justement cette gestion de l'énergie et aussi le coût de l'énergie qui augmente et qui diminue en fonction de quand il y a une grande demande ou pas. Je sais que grâce à cette technologie, on arrive à réduire les coûts de l'énergie. C'était un exemple qu'il y avait. On peut passer à l'autre question. C'est un peu trop vaste, mais j'ai marqué que ces deux questions-là étaient un peu trop vastes.

I1 : Je pense qu'il y a moyen de les rendre un peu moins précises. Je pense que si tu sais à l'avance avoir quelques exemples pour que la personne interviewée ne sache pas que ça l'inspire un peu. Parce que là, ça pourrait vraiment partir dans tous les sens. Même pour toi,

pour après revenir vers les notes et les utiliser pour ton mémoire, c'est un peu compliqué parce que ça peut vraiment partir dans tous les sens.

C.V : Parfait. C'est parce que vous êtes ma première interview. Je tâte un peu le terrain.

I1 : Non, il n'y a pas de souci.

C.V : OK. Maintenant, c'est plus dans le futur. Comment est-ce qu'il y avait un pied dans la mobilité urbaine ? Comment est-ce qu'on voit les perspectives d'avenir ? Ici, la question telle qu'elle, c'est comment voyez-vous le rôle de la mobilité urbaine évoluer dans le cadre plus large des smart cities au cours des cinq à dix prochaines années ?

I1 : Ça dépendra des villes et des pays. Ça dépendra des contextes. Mais de mon propre point de vue, de ma propre opinion, j'aimerais voir des villes qui sont moins dépendantes des voitures, des villes où les émissions des transports ont été réduites ou on arrive presque à zéro. Les émissions européennes sont des secteurs où il faut vraiment agir le plus vite possible. Je pense que c'est possible. Et des villes où la majorité des gens se déplacent à pied ou se déplacent en transports publics. Je pense que c'est la clé. Pour que les gens puissent se déplacer à pied, il faut que les villes soient agréables. Il faut que ce soit agréable de se promener dans ces villes-là ou agréable d'aller d'un point A à un point B ou même possible. Dans certaines villes, ce n'est pas possible ou en tout cas pas possible de le faire en sécurité. Donc ça, c'est une chose. Les transports publics, on en a déjà parlé, il faut qu'ils soient partout, il faut qu'ils soient agréables, il faut qu'ils soient à l'heure, il faut qu'ils soient abordables. Et ça aussi, ça nécessite des investissements énormes dans certaines villes qui sont un peu nulle part. Je pense à la ville d'où je suis, la Liège, qui est en pleine transformation pour l'instant et qui, j'espère, arrivera dans quelques années à être une ville où c'est plus facile d'aller d'un point A à un point B sans voiture. Quoi d'autre ? Je ne suis pas du tout anti-technologie, anti-nouvelle technologie. Pour l'instant, un de mes boss est à San Francisco. Ils sont en train de tester les taxis automatisés de Waymo. Waymo, c'est une entreprise, une start-up californienne qui est vraiment maintenant leader dans les robots taxis, les taxis qui t'amènent d'un point A à un point B sans conducteur et qui sont en circulation dans la ville. C'est une des premières villes au monde qui a mis ça en place. Et donc, ça en tant que telle, c'est impressionnant parce que la technologie est impressionnante, mais c'est aussi la capacité de révolutionner la manière dont les gens qui habitent en périphérie ou même autour d'une ville

et qui n'ont pas accès aux transports publics pourraient se déplacer de chez eux dans le centre de la ville. Ça coûte parfois trop cher de mettre en place une nouvelle ligne de bus pour amener dix personnes d'un village à 50 km de Bruxelles jusqu'à Bruxelles, qui n'est pas desservie par un train ou par le bus. Si on arrive à mettre en place une navette automatisée qui peut faire le chemin huit fois par jour, ça peut vraiment aider des gens qui sont pour l'instant pas pris en compte par les transports publics. Et ce serait une solution qui coûterait moins cher que de mettre une personne qui ferait l'aller-retour huit fois par jour avec son bus. Ça peut être l'une des applications de la technologie ou de ce que certains appellent la smart city qui peut vraiment avoir une contribution positive que ce soit pour les gens mais aussi pour la planète et au niveau de la sustainability parce que ces taxis-là qui sont en train de tester en Californie sont tous électriques et ils vont se recharger à la borne le soir tout seul aussi donc c'est assez impressionnant. Donc ça c'est une des applications que j'aimerais voir dans les villes qui ferait partie de ce que certains appellent la smart city. Après il y a plein d'autres choses. Il faut que dans les villes du sud de l'Europe, il faut végétaliser partout parce qu'il fait trop chaud. C'est impossible de sortir en rue de midi à 16h dans le sud de l'Espagne par exemple. Donc il faut massivement remettre des arbres, protéger les gens, qu'il y ait de l'ombre partout. Mais là on s'éloigne encore une fois du thème ou de la thématique. Est-ce que j'oublie des choses importantes en cinq à dix ans ?

C.V : Ce serait en 34 mais c'est déjà pas mal.

I1 : Si on parle des ressources et de l'économie circulaire, je pense que peu de villes sont à la pointe au niveau de l'utilisation des ressources naturelles pour générer de l'électricité. Donc dans les villes du sud de l'Europe où il y a 300 jours de soleil par an, tu vois quand même très peu de panneaux solaires. À échelle, il y a certains particuliers qui ont des panneaux solaires. Il y a des énormes bâtiments qui appartiennent à la ville qui pourraient être couverts de panneaux solaires et générer de l'électricité pour que la ville ait de l'électricité propre. Ça arrive quand même très peu souvent. Une autre question est la gestion de l'eau. Ça rentre aussi dans la question de l'économie circulaire. Comment est-ce qu'on fait en sorte que chaque litre d'eau soit utilisé de la manière la plus optimisée possible, qu'on recycle le plus d'eau possible ? C'est une question clé. À Barcelone, il y a quatre mois, ils pensaient apporter de l'eau de Marseille par bateau parce qu'on avait presque plus d'eau douce. C'était vachement flippant quand on dit qu'il va falloir mettre des restrictions sur la consommation

des ménages parce qu'il n'y a plus assez d'eau. Ça c'est quand même une question clé pour l'avenir.

C.V : Ça fait un peu peur. Parfait. C'était toutes mes questions. Je ne sais pas s'il y a d'autres points que vous voudriez aborder ou que je n'ai pas abordé ou que vous dites là, c'est peut-être bien de le faire. Moi aussi, je réfléchis entre temps. Mais voilà, c'est encore un peu brouillon. On voit très bien les deux concepts, mais comment est-ce qu'on peut les mettre ensemble ? Je crois que je dois encore travailler sur la façon dont je pose mes questions. Et oui, l'urban mobility aussi, par rapport à l'économie circulaire, comme on a dit, c'est peut-être plus limité par rapport à ce sujet-là. Mais c'est sûr que moi, tout ce qui a été dit, c'était quand même super intéressant et que je vais évidemment l'utiliser.

I1 : Il n'y a pas de souci. J'espère que ça t'aura aidé, mais c'est vrai qu'on n'était peut-être pas vraiment dans la thématique. Mais vu que t'es au début, c'est peut-être pas mal d'avoir eu cette interview-là comme première parce que ça peut aider peut-être à rediriger ou à reformuler certaines questions. De toute façon, les quelques premières interviews, d'habitude, c'est souvent pour faire ça. C'est pour découvrir au fil des interviews ce sur quoi tu veux te concentrer. Parce que je pense que pour l'instant, c'est un peu trop vaste. Je ne sais pas combien de pages tu dois écrire, mais je ne pense pas qu'en 40 pages, tu vas pouvoir.

C.V : Non, oui. Déjà, ma théorie, c'est déjà trop. C'est sûr qu'il faut que je centre un peu le sujet parce que ça va être trop vaste. Et même dans l'interview, vous l'avez dit, mais il y a certaines questions qui sont trop vastes parce qu'il y a en même temps trop à dire. Et ça handicape même dans la réponse.

I1 : Je pense que la clé, c'est de trouver une définition de la Smart City qui te convient, sur laquelle tu veux te concentrer. Et puis après, de décider quel concept ou quelle partie de l'économie circulaire sur laquelle tu veux te concentrer, et de voir si ce concept d'économie circulaire se retrouve dans ta définition de la Smart City. Et de voir quelles sont les applications, quelles sont les limitations, et qu'est-ce qui pourrait être fait dans le futur pour que cette partie de l'économie circulaire qui t'intéresse puisse vraiment être intégrée ou faire part intégrale de la Smart City. Ça reste très vaste, mais je pense qu'il faut ou faire ça ou se concentrer sur un secteur. Je pense que la Smart City comme concept, c'est trop vaste. Et donc pourquoi pas un secteur de la Smart City. Ça peut être plein de choses, ça peut être la mobilité

de demain, ça peut être 25 autres trucs. Mais je pense que les deux concepts, tant qu'on est là, sont un peu trop vastes, surtout si tu les mixes tous les deux.

C.V : Oui, en effet. Et j'avais une question, mais quand je regardais un peu ici, ça m'était venu lorsqu'on parlait. Par exemple, vous êtes, si je comprends bien, une filiale de la Commission européenne.

I1 : Oui, on est un des instituts qui finance une filiale, ça peut se dire comme ça.

C.V : Et à part travailler avec les autres EIT, est-ce que vous avez des relations avec les autres filiales de la Commission européenne ou pas ? Parce que, par exemple, la Commission européenne joue un grand rôle aussi dans l'économie circulaire en Europe. Et du coup, je me demandais si parfois, apparemment non, mais il n'y avait pas un échange, mais une possibilité.

Oui, voilà, une collaboration.

I1 : Il y a plein d'initiatives, plein d'instituts, plein de centres, je ne sais même pas comment on les appelle, mais il y en a plein qui sont financés par l'UE avec lesquels on travaille. Et on est même obligé de le faire, sinon ils financeraient plein de projets qui sont censés collaborer, mais qui ne collaborent pas. Donc ce serait pas du tout efficace. Donc oui, on collabore avec Civitas, avec Smart Cities Network, avec d'autres EIT, avec d'autres divisions de la Commission. L'EIT, c'est une partie de la Commission qui ne fait qu'investir dans les startups avec lesquelles on collabore, avec lesquelles on a des incubateurs de startups, avec lesquelles on co-finance des startups. Et donc c'est vraiment tout un écosystème qui se concentre sur différentes parties, mais qui ont la même mission, de rendre les villes plus vivables et neutres en CO2. Donc on doit collaborer avec eux. Et évidemment, on a un canal de discussion avec la Commission eux-mêmes, qui fixent les priorités sur la base desquelles on design nos projets et nos initiatives.

C.V : C'est un peu plus clair, merci. Ok, parfait. Moi, j'avais plus de questions-là, mais en tout cas, merci pour l'interview, pour le temps.

I1 : Avec plaisir.

CV : Oui, merci aussi de m'avoir aidé un peu à voir où est-ce que moi j'en étais. Et voilà. Quand c'est fini, ce ne sera peut-être plus le même sujet au final, mais si vous voulez, j'enverrai mon mémoire pour voir ce que c'est.

I1 : Oui, avec plaisir.

C.V : Une bonne journée.

I1 : Merci, bonne chance avec la mémoire. Merci. Ciao.

I2 online (Acció, Catalonia)

I2: and develop them, or help them develop them, to put it correctly. The other is internationalization, helping companies go international and establish themselves in the markets where they need to be. We have 40 international offices all over the world. And the third one, which is the one I am working in now, is innovation. In innovation, we help companies do, or to initiate, or finance their research and development programs and their innovation programs. So in that sense, I think it was a little over 10 years, 15 years probably, we saw this movement Smart Cities. We saw that it affected a lot of SMEs that were mainly focused on services for cities. So, we thought it was a very good opportunity for us to tackle these companies that were at that time, let's say, less innovative companies. They were giving services, that was all. But the Smart Cities opportunity has created this niche market, of growing services through digitalization, and lately, through, let's say, to circular economy. So our approach is on the supply side, let's say that way. We focus on businesses. How can we help businesses? So that was our approach. And then I started working with that. I don't work with Smart Cities businesses anymore. We have another unit in our organization that deals with them. It's called the International Public Procurement Unit. The International Public Procurement Unit. Because the development of internationalization, of innovation towards Smart Cities companies, supply side the big challenge is to help them develop internationally. This means, in general, going into public procurement processes.

C.V : Okay, okay. I have more an overview on what you do and where you working.

I2: But we don't manage ourselves, let's say, Smart Cities programs. In the case of the city of Barcelona, for example, you will find the units that deal with Smart Cities initiatives, because they have their own initiatives. As for the Government of Catalonia, from the original government, we help companies. We don't have our own Smart Cities initiatives.

C.V : Okay, okay, I understand. Okay, perfect. So, yeah, but I think if you give me as much insides as you have, that's perfect. And it's more of a discussion that I'm looking for here, because this is the beginning of my thesis. And I really want to know more about, if you find the topic interesting. Or maybe, I'll ask you some questions and you can tell me, okay, this question is not exactly relevant. Or maybe you can spin it in another way. And yes, this is just a discussion to help me go further in my work, and in the best way. I didn't ask you, but is it

ok if I recording our interview? Yes, it's fine. Okay, perfect. And also, I have to ask, because it's an interview, but do you want to be quoted, or do you prefer to remain anonymous in my work?

I2: As you prefer, I mean, I have no problem. The only thing you have to mention is that I work for Accio, for the agency of Catalonia, because I'm here in that role. Let's put it this way.

But yeah, if you just mentioned that I work for Accio, there's no problem that you mentioned me.

C.V : Okay. Perfect. But let's start. I know you're already talked a little bit about yourself, but do you want to add anything? The question was, can you briefly describe yourself, your background and your current role and responsibilities in Accio?

I2: Yes, I already mentioned something. I am an economist. My training is to be an economist. I worked a few years in international marketing. I also worked in foreign investment, direct foreign investment company. Attraction of foreign investment. Direct in foreign investment. I also worked in the regulatory company, a few years ago. Regulation of the audiovisual system, here in Catalonia. And today I am in the innovation unit of Accio, helping companies to grow more competitively. I was daily in the back of the Smart City. But now I am focusing on something that is very related to that, which is what the European Union calls the twin transition. That is, digitalization and the focus on sustainability for companies in general. Even though, as a public agency, we mainly focus on small and medium-sized enterprises. We also help any company, but small and medium-sized enterprises. That's my job now.

C.V : Ok, perfect.

I2: And the last ten years we have especially collaborated a lot with this process of internationalization of smart cities companies. Our work has been in two lines. The first is the analysis of the supply side of the Smart City, here in Catalonia. You often hear about the demand side, the projects. What are we going to do as a city to improve our public transport, our smart water network, electricity, power, our smart buildings, etc. But you don't hear much about who provides all of this, or who provides. And that's our job. Years ago, we did some research, which is available on our website. This is information on the supply side of the Smart

City here in Catalonia. We found out that, three or four years ago, in the last edition of this study, we discovered big numbers. 500 companies, only in Catalonia, are dedicated to the Smart City, mainly to the Smart City Business, selling about 10,000 million euros, with around 50,000 employees. These are figures for Catalonia. For us, it was the discovery of a large sector, a large cluster, because this sector did not exist before. With the hype of the Smart City, we received a lot of information about projects, ideas, the future, but on the demand side, not on the supply side. And the supply side was mainly in the hands of a number of large contractors, a number of companies, but also a number of small mid-size companies. The small mid-size companies had to adapt, from let's say making traditional lamps to smart parts, where you could add sensors, you could add your own energy, you could connect through telecommunications, through the different technologies in telecommunications, and you could install a network that could provide better service to the two customers that the Smart City has. The first one, or the middle, if you want, which is the city government. But the second one is the citizen. And all of this has made a paradigm shift, a model shift, if you want, in these companies that were just used as the final subcontractor of the main subcontractor. It has helped to develop this whole very dynamic sector, and the growth of new companies, like Smart Mobility, or Sustainable Mobility, if you want. One of the biggest initiatives, and one of the oldest in Barcelona, was the bike network.

Are you familiar with Barcelona Céline?

C.V : Yes, actually I have done my internship. I just went back. For me, Bicing is really a success. It works so well. I was wondering if it was one of the initiatives you had.

I2: Yes. It was one of the first initiatives. It helped to change the network, because it was how to use a new model of company, because in fact it is a public company, to force the construction of, because it was the infrastructure, of new bikes lines, and to transform the city. For good or for bad, there are criticisms about this, and you have probably heard a lot of things, because there are bike lines that are not used much. To get information about this, it is very difficult. But in any case, nowadays, you see a lot of bikes in Barcelona. I'm from Barcelona, so there was nothing 15 years ago. Not a single bike. You couldn't ride a bike in Barcelona. This is one example. But there are others, of course.

C.V : Ok! You said that mid-sized companies have two customers, and one of them is the citizens. But are citizens aware they are clients of these companies? I don't understand their relationship.

I2: No, that's an issue. Because in general, what citizens feel as city service providers is the municipality. At least in the southern countries. I don't know if it's different in Northern Europe or in other countries of the world. But I think in general what we feel is that the citizen doesn't relate that much with the final builder of. But that doesn't mean that the company doesn't have to bear that in mind. The citizen's point of view, and if we jump towards innovation, we must have a type of collaborative innovation where the citizen is present. If not, we risk of just following the norms and procedures in public purchase procedures. Which is usually very bureaucratic and very specific, etc. But you can't relate with what the end citizen thinks. And at the end of the day, it shows. If we go back to the Bicing, for example, to the Bicing app in Barcelona, some of the things that the Bicing app criticized could have been foreseen by a good relationship or a good innovation process with the presence of the users. That's what's happening, yes. That's a good question.

C.V : Okay, perfect. And yes, maybe more personal, but for you, how do you define a smart city in the context of your work? For you, personally, what is a smart city?

I2: Personally, it is a city that works, that offers you the right services. One of the problems with the city or with municipalities in general, and I have been living in other municipalities as well, is the bureaucracy, the complication of processes, etc. So, make your life easier. Make your life easier in terms of picking up your trash, or moving around the city, or paying your city taxes. So, E-government is important, but simplification is important. When you try to digitalize the formal bureaucratic processes that you already have in your house or in the municipality, then you probably create more of a mess and things should be, at the same time, the processes should be eased for the citizens in general. So, yes, for me, it is a very good opportunity, and an opportunity that should be taken from a strategic point of view on the part of the municipalities. Again, it is not only a question, and it also happens in companies as well. Usually, the question is not only to go digital, but to use the digitalization process to

rethink the company in a simplified way, in a way that is easy for the customer. Of course, I think about the customer. And yes, that is my position.

C.V : Perfect. And what role do you believe Smart Cities initiatives play in achieving the goals of a circular economy? So, you already said that you are familiar with the circular economy model.

I2: Yes. OK.

C.V : To connect the two. There are two aspects here.

I2: One is the city itself. The city itself, with its purchase process, with the consumables that they use. So, I think that's probably the easiest part or should be the easiest part. It's probably not, but in any case, like in any business, what do you buy? And if what you buy is reusable and can be recovered later on, etc., and can go towards circularity, you establish your own levels of circularity, the levels that you want. And the second, probably the most difficult, is that the same thing applies to everyone who lives in cities. So how can we make our waste connection process really helps citizens to increase their circularity, let's say in this way. At the end of the day, as a citizen, you're probably more of a consumer. You don't produce, so you can't recirculate. But yes, you can in a way. You can sort of. You can do it with water. Then to install systems, for example, in Mediterranean countries, it's critical, so you can collect rainwater in deposits, that would be something. So far, there have not been, in my opinion, any major initiatives like that in the big cities. We have seen that in the energy side. How can we transform residential buildings or the backstage of residential buildings into a kind of small energy farm through solar panels and apply it to the consumption of buildings to the elevator, the energy consumer through the elevator, etc. But not in the water side. There is a lot a city can do to transform the lives of its residents towards circularity. That is very good. That's very good.

C.V : For you, because now I've seen on the papers that the expression of the circular city is used more often. It's something that... Is it something that doesn't bother you? You can say that you live in a circular city.

I2: Yes, on the contrary. The problem is that we have to think about how we do things. I give Barcelona as an example. We are a touristic city.

C.V : I know.

I2: If we start to touch on these issues, how can we do fit in tourism? Tourism has a lot of pressure because more people, at least during a certain time of the year, use the services of the city. Services that have been invested for a certain amount of people. And then, the services get stressed. The... The same concept of tourism at stake when we talk about circularity. I mean, if we take the principle that you should take home all the residue that you produce, there should be some kind of thinking about how you do that. And whether it can be done, of course. Some things can't be done. But some things can be done. In small towns, now that I'm in a small town, the issue of waste collection is always in question. And how to do that very effectively, it seems to me, at least in some models, is through the card related garbage can. They give every other resident in the city a cart. And you can only open the garbage collection site if you have this card. This means that the city has some control over who does what. That's probably not the goal. But at least, what's happening with visitors? What's happening with tourists?

C.V : Because they're not educated.

I2: your question. I see a role. It needs to be discussed. It needs to be invested in. We need to invest a lot in this.

C.V : Perfect. That's kind of what we've already said. The question is what approaches of initiatives have you implemented or observed in resource management in smart cities that promote circular economy, especially in waste reduction and recycling? You have already answered it. I have examples that I found in the papers. For example, we use sense networks and data analytics to improve energy efficiency, waste management and mobility. Have you ever seen this kind of initiative? More on resource management.

I2: I have seen some. I always remember the initial use of sensors in waste management bins in Barcelona. It was a curious process where the sensors had to measure the volume of occupation of the bins. This required a lot of technology and investment. They made pilots for

the result that it was not effective in the city of Barcelona. Because the theory was, they just going to draw the pick-up collection based on the data of the bins. If the bin is full, we're going to select this, this, this and this, and then we're going to draw, to establish the collection line every X or Y days based on these data. It wasn't efficient, because the need for recollection of the Barcelona bins was generally high. So, it was much more complicated and not so efficient to base it on some data because at the end of the day, you had to go every two days to collect that kind of garbage. And it made more sense. What I mean is that it's interesting to try to verify, but not to become, let's say, overconfident that technology is going to solve everything. They invested a lot of money in digitalization and sensorization of certain bins in a platform that was supposed to retrieve all the information, in the design of the new lines. All this was not useful at all, which is what the test is for. I am not criticizing what they did, but the overconfidence and overselling it too much because sometimes you go to the level of politicians and the politicians in charge say that they are going to solve everything with technology. But they didn't. The hype that they created compared the expectations - the expectations - have been very negative for the city, and sometimes. And most importantly, because at the end of the day, it's used politically. They said they would solve this whole problem of waste collection. They could not do it, and it is even worse. Citizens take, let's say, a skeptical look at this type of initiative. And that's what we have to avoid, I would say.

C.V : So, you said that there is a political aspect to every initiative. Yes. I was wondering what the process is. You are also part of this, but when an initiative is there and a person wants to develop, what is the process for which person you have to... Sorry, I can't say my question correctly, but what is the process for whom you have to address to make the initiative well done?

I2: Okay, it's difficult. It's governance. I am not very expert in city government. Some experiences that I know are the establishment of Smart City offices in municipalities. In a way, the Smart City offices were, at the beginning, at least in the cases that I know, placed above every other unit of the municipality so that they could coordinate everything. It was the holistic approach. We all solved the holistic approach. The holistic approach was nice, but theoretically. The complication of putting together the rolls and the needs of the different units of the municipality under one umbrella, a digital umbrella, was very complicated and I think it was not so useful in many cases. The idea was, for example, to go towards the initiative

of digitalization or smartization, if you want to use that word, to go towards the different units of the municipality so that the different units have different initiatives on how to use the smartness or digitalization and the circular economy in their own different needs. For me, it is a very good approach. That's from the government's point of view. But from the citizens' and consumers' point of view, if you want, I feel like we still need that relationship with users. And that's difficult to organize. But you have always said that these pilots, that these initiatives can be explained to the citizens. They are aware of the needs. Why are we doing this? A lot of criticism has been directed towards the door-to-door garbage collection, which seems very good, but in some places it does not work. In some places it works perfectly. But here you need the implication of citizens. That will always be important to me. I've already told you that from the point of view of the supply side, of the companies that provide these services, they have to make that link. But of course, the municipality has to make that connection. When they think of new ways of doing things, I go towards circular economy.

C.V : Ok, perfect. Thanks. We've already answered a lot of questions. I don't know if this is a very important question, but I prefer to ask you. We have already talked about this. How do IoT and big data analytics contribute to the development of smart cities in your experience? Are all initiatives based on big data analysis and technology? Maybe it's not very important.

I2: No, for sure it's key, it's one of the basics. IoT is one of the big things. The city structures have not taken this into account historically, because the technology was not there. But today, it is key. I always think at the beginning about the traffic control management. Many taxi drivers, if not all, were relying on Waze, to this private application. Today, I think it is bought by Google Maps. But if you want to know what is happening on in any major street in the city, you get more information in real time than in the electronic panels installed by the municipality, which give you information, but when you are already in traffic. We've all been used to work with mobile phones. They're big sources of bigdata that need to be analyzed, analyzed, and analyzed. So yes, that's true. But I never settle for qualitative analysis. It means going back to citizens, to markets, to old people, who don't have much digital abilities or don't use them as much. But we always have to do a personal analysis of how people behave. Cities in southern Europe, especially in Italy and Spain, are full of people who leave their garbage

bag outside of the garbage can. Nobody knows why. They just have to open it and put it inside. But they don't. There's something here. It's human. This is not big data. This is not IoT. This is reality. There is a role here for sociologists, psychologists, for interviewers.

C.V : Excuse me. Can you hear me?

I2: Yes, I can hear you.

C.V : Yes, I can hear you. That's better. Perfect, we're back. I don't know if you finished your sentence or not.

I2: Yes, I can hear you perfectly. Do I have a bad line from my site?

C.V : I think... I'm looking, but I think I have enough Wifi. Okay. I think not, we're not... We're good. Perfect, I see you.

I2: Pefect. Okay, perfect. I think now, we're on the same page.

C.V : Ok. Perfect. I don't know if it's too much to ask. You told me before that there were initiative that wasn't really... that wasn't good with the garbage example, and the data and garbage initiative, and also with the card.

I2: That was just an example. I'm not really that familiar with... It just came... Okay....as useful for what we were discussing. I don't know too much about that. You probably have to talked to the Barcelona municipality. Okay. The thing about waste collection, at least in big cities, or at least in the big cities that I know, is that they are based on confessions, on public packaging contracts, which have lasted for several years, five or even seven years. They require investment, which results in a difficult task. It's a difficult thing. It's one of the management things that can condition how the process and how the process works. If you have difficulties, if you find problems in this process, or there are new realities, like for example the explosion of a package at the user because of the waste at home, etc. If you have to change the conditions of the public packaging contract, or if you have an additional one, which is already a large company, it makes things very difficult to manage. But it's probably more a question of governance and flexibility of contracts than anything else. It's not a lot of IoT with

digitalization or with Big Data or with anything else, but with the flexibility needed in public contracts.

C.V : Okay, perfect. More on challenges and opportunities. What are the opportunities for the future in integrating more circular economic practices into Smart City frameworks?

I2: Difficult. It's more about... It's more about the future. Again, for me, anything that can be done to facilitate the place where we live. So the consumption that we do in terms of energy, water, even food, moving towards circularity, it has to be done, because it's the challenge of the planet. It's the climate crisis and we have to move towards that. Mobility is another thing. I think we have to improve and increase public transportation everywhere. Continue to work on... I wouldn't say the gates, I would say the air quality, the conditions in certain areas, and expand it as much as possible. Again, I think tourism is a great challenge. So, yes, there is a lot to do on all the aspects related to the big questions, energy, water and food, but there is also a big issue related to unnecessary mobility, which creates a lot of problems for traditional mobility and unnecessary mobility. It also affects housing. As we see in all our cities, the rising cost of housing and the gentrification... of our cities. It's a very big question.

C.V : And for you, what steps do you think are necessary to accelerate the adoption of circular practices in urban environments? What steps do we need to take? I2: What steps? We probably need to... For me, governance part is very important. And avoiding the concentration of services in some of few large suppliers, that's one of the key aspects. That would probably make things more complicated and costly. Maybe, I don't know. But it would help to modernize our companies and create a sector of city suppliers that will be competitive. If you talk about it, we try to avoid positions that are oligopolistic. In the city sector, we have oligopolistic positions. While the last provider is not the big companies. It is the small business. But we need to put this big company in the middle so that it can sign the contract with the municipality. It would be great to find a way to make things more flexible and give more opportunities to small and medium-sized companies. This is very clear for small towns and big villages. You create your own sector of city suppliers. That makes perfect sense. For big cities, it's a little more complicated. But why not go from district to district? This is already done a little. Because Barcelona is divided into three or four zones. You have to go this way. It's not

the same to collect garbage in the city center than in certain neighborhoods. But yes, governance would probably be the point.

C.V : That was my last question. Is there anything you want to add? Or give me more information? If you have any other questions, let me know.

I2: If you want to see our analysis on supply side, let me know. I can send that to you.

C.V : If you can already.

I2: I will try to send that. Thanks. It's in Catalan, but there's an English edition. Perfect. I'll send it. It's in Catalan, but you'll find a link in English. Perfect. It's another point of view. It's another point of view because it's a supply side. We think it's important because it's a type of business related to the situation that addresses digitalization, IoT, big data, but with daily problems. I think it helps everyone.

C.V : Perfect. I'll check that out. If I have any questions in the future, I don't know if...

I2: If your research is published, let me know.

C.V : I will share it with you. Perfect. Thank you very much for this discussion. It helped me a lot. It was really... How should I say it? It was really helpful and interesting.

I2: If you come to Barcelona, let me know. I will be happy to help you.

C.V : Thank you very much. Am I pronouncing it correctly? Xavier.

I2: Xavier. Xavier. Perfect. Thank you. Goodbye. Goodbye.

I3 online (Cluster Development, Catalonia)

C.V : Maybe we can start with an introduction of yourself. Can you briefly describe yourself, your character and your current role and responsibilities in cluster development?

I3 : Ok, thank you. My name is Maria Pedras, I am a partner and consultant in Cluster Development. This company specializes in strategic consultancy, mainly based on strategic projects, usually for public administration, neutral organizations, which aim to improve the competitiveness of companies in a specific region. To do this, the majority of projects are based on the concept of clusters. I don't know if you are familiar with the concept of clusters.

C.V : No, I tried to do a little bit of research.

I3: Sometimes you look for information, and it's hard to understand. I tried to summarize it. As Michael Porter said, 40 or 50 years ago, economists tend to concentrating. Companies from the same business tend to be located in the same area or same region because they shared the same resources or the same suppliers. That's why economics tends to specialize and focus on a specific business in a specific region. Are you from Belgium or another country?

C.V : From Belgium.

I3: I don't remember. For example, in Belgium, there is a city called Antwerp. There is this micro-cluster of diamonds. Or Antwerp, for example, for printing. The idea is that large groups of companies that compete in the same business in the same region because they share the same resources. For example, for large companies that have access to water. Or because there are specialized suppliers, and they tend to position themselves next to them. This is what affects the economy. This already happens naturally. The idea behind clusters is that for the public administration it is a good idea to be able to work, to be able to develop projects, initiatives to help companies in a single cluster to be more competitive. Since they are located in the same region and in the same business, it is easier to identify common challenges. Instead of going one by one, one company, one company, we work with a group of companies that are in the same business, the same customers, the same challenges, the same needs. Since they are located in the same region, the needs are perhaps similar. That's the idea behind clusters. Regions and national governments especially in Europe, have policies based on working with these clusters policies. For companies in Antwerp, to help them be

more competitive. Most are designers who work internationally. Even though they are different companies, the challenges they have when they open new markets or a pop-up store, are the same. For the public administration, it is easier to identify common challenges and actions and projects to help these companies. Our company is a private company, and we do this kind of project for the public administration. The public administration says that they want to help fashion companies in this region, or pharmaceutical companies in the other region. So, let's see match the companies that we have in this region, in this business. Let's see their challenges. Let's see what's happening in their business. And then let's define the actions and involve the actions so that these businesses are more competitive. That's our goal. Based on this, we are specialized in developing a specific methodology, but we are not experts in any kind sector. Even if we have, after having done, I don't know, 15, 20 or 25 projects in food or in the fashion industry, you know a little bit about the sector. But we are not technical experts. So, some of the projects that I have done in the past, I have done them in fashion, in food, in the pharmaceutical and chemical business, in the enterprise, in security, IT in general, but also, for example, Smart Cities and circular economy. That's why I know something about circular economy and Smart Cities. In fact, the projects that we have done in circular economy, I have done them with Oriol. He was my colleague in this project. And the objective of these projects was the same, it was to try to hear in Smart Cities or a few years later in the circular economy. First, to identify the types of companies that we had in this field, in this subject, let's say, because it is not a business, but a subject. And see what can be done from the public side to help these companies be more competitive. That would be more or less my role in the company and what the company does, which is more important to understand.

C.V: Okay. And you had these cases in which area? In Barcelona? I don't know if it's in Barcelona.

I3: Yes. Yes. The projects, in general, we do them in different areas. We are very focused, we have done many projects in Catalonia, because in the end, it is our natural area of work. But we do projects all over Spain, also from an international point of view. For example, we also have an office in Colombia, as a company. But in the case of Smart Cities and circular economy, these are projects that we have done specifically only in Catalonia. In Smart Cities, we have done someone in another region of Spain, but the majority of the projects were in Catalonia or specifically for Barcelona, the City Council Barcelona, which was our client. But these

projects were, I think, about 20... 2015, something like that. A few years passed. And then the economic circulation, I think it was about 2017 and 2020, something like that. Okay. But it's interesting because I think both concepts, both topics are these kinds of topics that have become something trendy. Everybody talks about Smart Cities and one day, somebody talks about Smart Cities and we don't talk about Smart Cities. And then, on the other side, on the green side, there is the topic of economic circulation and everyone talks about economic circulation and now, it is not circulation but decarbonization. Sometimes, there are topics that are trendy and the projects respond or follow this trend. But the concept behind it, it is also something that I wanted to ask you. What do you understand for Smart Cities initiatives? This is something I'm trying to understand. What is your definition of Smart Cities initiatives? In the past, it was more focused on technology. But maybe it has evolved and now it is not only technology but other topics. I wanted to ask you this question.

C.V: For me, it's still what I've done and my research in my thesis. It's really more the technology aspect, the data and the Internet of Things. For me, it was the initiatives that I was talking about. And yes, that was the aspect. It was more to know. I know that Smart Cities wants to improve the quality of life, as I understand it, to improve the quality of life of citizens by using technology. But to be more sustainable as well. I don't know if it goes with the concept of circular economy. I know, for example, that technology pollutes a lot. I don't know if the concept goes with the circular economy. It's a bit complicated. That's why I'm trying to understand it. So that's the point. I don't know if you understand how I see it.

I3: Yes, of course. And I think that as I told you, the Smart Cities projects are projects that we have done before. And I think that at that time, no one talked about the circular economy. I don't remember anyone talking about the circular economy. We can talk about the green economy, but not the circular economy. But of course, Smart Cities is one of the topics that, apart from making life better for citizens, can also be a way to maximize resources and be more efficient. So, it can also be linked to the circular economy. And the circular economy can have a good impact on citizens and on the way, we treat the ecosystem and the environment. So, of course, there can be links. Or, theoretically, Smart Cities, at that point, should also focus on the idea of being smarter. The whole Smart Cities initiative has already taken into account these green topics on circular economy, decarbonization. So, theoretically, I understand that all Smart Cities initiatives should be integrated and take into account these topics. A Smart

City that is not sustainable from an environmental point of view does not make sense. So, of course, it should be there. I also wanted to ask you this question, because I remember that, at that time, when we were doing this Smart Cities project, I remember that there was a discussion in the sense that, sometimes, cities or people were very focused on technology, technology, even as a target.

And forgot that technology was supposed to be a tool that could make things easier or more efficient or better managed. That was never the goal. And to do so sometimes there was this discussion that technology was not the best idea. So maybe there would be another tool that was not technological and that would be better. Sometimes, being smart, is also trying to find the best option in each case. Most of the time, it is technology, because the development of technology is like artificial intelligence.

But, smart is more than technology. Smart intelligence has a very good understanding and finds the best solution for each case. This is also important.

C.V : I understand. I also wanted to ask, when you say about what you did, for example, for the Circular Economy companies, do you know the project that they did or are you just targeting one Circular Economy company and you cluster them?

I3: Yes, in this case, it was more of a mapping exercise. It was a kind of identification, because in the end, the Circular Economy is a combination of a variety of businesses. On one side, you have water management companies, waste companies' management companies, eco design, energy efficient companies. It was more of a kind of identification, which companies had solutions for the Circular Economy or not. For example, we had a company that managed waste. They did not recycle or do upcycling activities. It was like collecting waste. For us, it was not the Circular Economy. Instead, we had an engineering company who provided services to other companies by trying to redefine the design of an object or material to make them more sustainable. For us, it was absolutely the Circular Economy. In this case, it was more the idea of identifying companies and saying that in Catalonia, we have many companies that make solutions that can be linked to the Circular Economy. More than doing specific activities.

Waste companies need different things than water companies. They are already clustered; they belong to organizations that do things for them.

C.V : Okay. I had another question. What are the key trends that you see in this sector of the Circular Economy? What are the trends of the companies?

I3: In this case, when we talk about the Circular Economy, we always have two perspectives. The first one is the supply side, the offer side. These are the companies that offer solutions. These are the companies that offer solutions to implement the Circular Economy, as the ones I just told you. But there is also the demand side, these are the companies that buy solutions to implement the Circular Economy in their companies. This differentiation is important because most of the time, when we analyze the policies to develop the Circular Economy, there were a lot of things that were done to stimulate demand, to grow demand. But nobody was addressing the supply side to say that you have solutions to implement the Circular Economy. How do you make them known to your clients? How do you adapt to these solutions? There was also this kind of side that was not very known or very well addressed. It's not a trend, but I think it's important to take care of it. In terms of trends, what I've seen is that there has been a very important growth in the implementation of this strategy in many industries. For example, in fashion, there are things that have been said that it's impossible to have new materials based on recycled materials, recycled textile materials. It was impossible and now it is possible. They are developing it. I have seen that a lot of efforts in innovation and research development have been made and things have improved. Also, because big companies are often like demons. In fact, in the end, they helped develop these strategies. Because, even if most of the time it's greenwashing or whatever, at least they're doing something. A big company does something in innovation, development, market, awareness. It has an impact because there are many small companies that do things, but nobody knows. It is another thing, the impact of big companies. It is interesting to see that in some industries, these large companies also have a value chain impact on the market. So, once they start to develop actions in their own organizations, they need their suppliers to change the way they produce their products or services. For example, we have one company here in Catalonia in the wine industry. It's called Torres. It's a company that has always been very aware of green things, green aspects, green topics. It's one of the first companies to do important projects in this sense. One of the things I remember them doing was saying that their glass bottles for

wine should be lighter. So, the weight should be less. So, they asked their suppliers to make bottles that should be lighter. So, this is a very clear and practical way to see that, once these big companies also start to print these strategies, they have a direct impact on the value chain. This is something that we realized, I remember, a few years ago, with Oriol, because we tried to understand the economic impact of making the circular economy change. At least, at that time, we understood that the economic impact was negative, because most of the time, companies had to invest money in innovation, in development. So, it was not something that gave them more money or gave them more profits, but they lost money because they invested in these kinds of topics. Maybe not losing, but they didn't earn as much. And at the end, it's like that, but if your customers are asking for these kinds of solutions more and more, if you want to stay in the market, if you want to be competitive in the future, you have to invest in these things. The economic impact was to think whether I could have a client, a sophisticated client in the future or not, if I don't make this change, I won't be able to compete in the market. This is another thing that we understood a few years ago, and I think it's happening more and more. Because in the whole industry, in food, in retail, in packaging, we visit companies that increasingly say that one of the criteria they have when they choose suppliers is the kind of solutions they have for the circular economy, decarbonization, etc. It's still small, but it's becoming something on the table. It's a big trend.

C.V : Because I was wondering when I was studying the circular economy if it was something economic like a benefit or not. I was wondering if I was reusing my rare materials. Is that something beneficial or not? And you're telling me it's not in most cases.

I3: At that time, it wasn't. Maybe as it gets more and more developed, there will be technologies that will make it more expensive than before. Because at that time, there were a lot of things that had to be analyzed to see if it was supposed to reuse one material or another or what the purpose of those materials was. Things had to be analyzed. It means money. But once these things are more developed, I think they won't be like that anymore. But also, let's think about recycled materials. When you talk to a company and you ask them what the cost is of buying a certain product made of green materials or the same product made of recycled materials, in general, the recycled one is more expensive at that moment. But this, perhaps, if the quantity of purchase increases and, I do not know, some parts of them will be more expensive, others not, because there is a process behind it. It will depend. I'm

sure the economic impact will be better over time. I'm sure of that. But that's not the main reason for doing this. This is not the only reason. In other aspects, for example, for energy, there may be things that if I can do something with my waste, I can produce energy for my own benefit. It is sure that it is beneficial for the economy, but there are other things that are not so clear.

C.V : Sorry. It's okay. You said it, there will be more initiatives related to technology.

I3: Yes.

C.V : For me, as I understood it, the circular economy can grow and be more and more efficient thanks to technology.

I3: Yes. Technology, in this case, may not be just IT technology. It may also be machine technology. For example, for cities, it is a good point to focus your research on specific kinds of initiatives. In this case, it is the city's initiative. So, we can only think of the circular economy for the specific case of city management. What is true is that when we talk about the circular economy, depending on the industry, we can find different challenges and situations. The circular economy for the building industry is very well developed compared to other industries, for example. Because in this case, as far as I know, the economic impact of applying the circular economy is much higher. It's much more beneficial. It makes it more interesting for companies to implement it. But yes, in any case, the way the circular economy is developed compared to other industries is different. It's the same thing for cities. Focusing your analysis on cities will allow you to understand the implications. But there is also one thing I wanted to tell you. I'm sorry for jumping from one question to another. It's for this conversation. I'm not forgetting anything. For city councils, when they are trying to implement circular economy strategies, they can focus on citizens. We make sure that citizens or businesses do better management of their resources, etc. Or by looking at the organization of the city itself. For example, how the city council is organized. The organization itself. And then, how the place of the city is organized. There are these three areas. One is the organization. For example, if I have 2,000 employees in the city council, I make sure that they do not have papers. This is a very basic example. Another area is how I manage the city to make sure that we are implementing these kind circular economy initiatives. That would be the case of the waste recycling. But also, how I raise awareness citizens and businesses so that they can better

manage their resources. They select products made from recycled materials. These would be three areas from the city area which could be developed by city councils to implement the circular economy. So, the organization, the management of the city of the place and then, the awareness or the improvement of the changes for businesses and people. Ultimately, for me, it is something that is connected because, as you said, when we introduce technology, smart technology in circular economy initiatives, it is certain that we will have more effective results in the case of waste reduction and recycling. I'm sure you've heard of projects where they have RFID tags in the container to know when the container is full or not. There are a lot of things that can be done with the implementation of the technology. I think it's really connected. So, ultimately, it's how a Smart City initiative, how each project or initiative or action in a specific area, takes into consideration the circular economic aspect. And I would say not only the circular economy, but also decarbonization. I mean, decarbonization, so having less impact in this area. Because not all the things we do in decarbonization are circular economic things. If I have an electric car, that's not circular economy. Or yes, it's a circular economy because it uses less energy. But ultimately, it's more about decarbonization. So, it's also about having a bigger perspective in general.

C.V : Okay, perfect. We have already answered many questions, so I will see if I have any more. You have already given me many examples of Smart City and the circular economy. For you, but we might already answer this question, what are the main challenges that the circular economy faces these days? We are talking about the citizen aspect to raise awareness among citizens, but are there other challenges that the circular economy can face?

I3: I would say that if we focus on the subject of Smart City, I understand. So, based on the city initiatives, I would say that, first, one of the main challenges is that the city councils themselves cannot implement these kinds of initiatives. As I said, you can raise awareness among citizens and businesses, but first, you have to be the first to implement them yourself. It is related to waste management that takes these things into account. But also the issue of paperwork, or asking your suppliers to be responsible for resource management in their own home. So, first, it is the city councils themselves that have to be ready to implement the circular economy for the way they manage the city council, and the same for the area. And then, there is also this kind of awareness for businesses. I think that companies, right now, in Europe, are already aware of the importance of all this. But maybe by helping them, by having support lines to

help companies doing the change or find the resources for the change, for example, if in a certain industry, they need recycled materials, maybe they don't know where they can find them, with the suppliers they can have. So, by helping these companies, by doing this research. And sometimes, also, related to the city council theme, sophisticated demand. So, one way to help companies make the change is starting to ask your suppliers for different things. For example, if I ask, I don't know how it works in Belgium, but for example, here, the public schools, schools that are run by the government, they also have to select the companies that provide the food and lunch for the children. So one thing can be, how do we choose, how do we decide the suppliers of this food? Can we ask these companies, how do they make the packages? How do they choose the ingredients? How do they make these things? So that they are more circular, so that they have less impact on the environment. So that is a very direct way to attract the whole value chain of specific companies to make the change, like the demand, like the market. That would be interesting as well.

C.V : Okay, perfect, thank you. So, you talk a lot about the public, so the councils are a public institution, if I understood well. My question was, how can public and private partnerships be structured to foster innovation in the circular economy solution in smart cities? I don't know if there is a big private aspect, or only public?

I3: No, it's both things. We always say that this is our main objective of the work. Most of the projects developed are promoted by the public organization, the public institution, but these projects are addressed to private parties. And in the end, we want to build an agenda that applies to public and private partnerships. Some things have to be done by the public organization, but also some things have to be done by the private parties. Most of the projects are done by the private parties, because we can say a lot, but in the end, it is the company, with its own business, that decides with its owners, how they position the market, etc. What the public organization can do is to make the environment more favorable for them and support the companies that make this change. That's the idea. Coming back to the example, I also put this sophisticated demand. This also happened a lot in the Smart Cities business. Technology companies, when they wanted to open new markets, especially when they were small, said that it was difficult for them to sell their interesting solution to manage traffic intelligently, in London. But if Barcelona, the city where I come from, does not buy my solution, how can I tell London that my solution is the best? This is the sophisticated demand that I

mentioned. It is also a bit like helping companies to make the change, but also making this kind of demand that can make it easier for companies to access the market, to innovate, etc. For innovation, it is always easier to do it in your own market, in your local market, and based on that experience, try to open a new market. Yes, there can be many areas where there can be collaboration between the public and the private, and both sides have to do their own work. But there are also places where there can be collaboration. In terms of innovation, so that you understand better, imagine that we say that in Smart Cities, in a circular economy, we have to invest, we have to understand better innovation, how we recycle the textile materials that come from clothing, once people have used it. Because of textile materials, we recycle them based on factories that have never been used. It is not a problem here. It has always been done. It is not a problem here. The problem is that when the clothing is already made, there is a combination of fibers, and someone has worn it, and we do not know if it has been washed, if it is dirty or not, and it is not only that, but jeans, which are other materials, and shorts, it is another problem. So, if we have the innovation challenge in this area, then, from the public point of view, if they know it, if they understand it, and they understand that this is the key thing of innovation that needs to be invested in the fashion trade, to develop a circular economy, then we need to make sure that the innovation projects, which are funded by the public administration, in this area, are intended for this area, and not for others. So, it is as if the public part prioritizes and supports the projects that are really key for the circular economy in each industry. This is also one of the things that can be good.

C.V. : Okay, perfect. And maybe, because I see that we are running out of time, here, maybe from a point of view from the future, how do you see the relationship between smart cities and the circular economy evolving in the next decades?

I3: Okay, I would say the same as before, I think it is absolutely integrated. So, for me, Smart Cities initiatives do not make sense if they do not include the concept of circular economy or decarbonization in each of their topics, so it can be absolutely articulated in this area, and it is the same on the other side, when it comes to circular economy practices in the city, technology, Smart Cities must be included, because it is also a way of doing something more efficient, more intelligent, so I would say they are already combined, but they must be integrated, absolutely integrated in the future.

C.V. : Okay, maybe one thing, because it was my last question, and here, it's more of a thought that I had. I also saw that the European Commission was doing a lot of actions, also in Barcelona, and how is the relationship and the collaboration with the European Commission? Because I interviewed someone who was part of the EIT Urban Mobility, so it's something completely different, but he was doing actions in Barcelona, and is the relationship difficult? Okay, the company collaborates with your company, but also the Council, and also the European Commission, or is it clear to everyone that everyone runs their business, or is the collaboration everywhere?

I3: Collaboration is everywhere. What is true is that every company, every company, their main objective is their company. So that's it. Companies don't think about the benefit of society. Some women, they think, but generally, the men and women in the company think about the benefit of the company, and I can pay my employees, etc. But, when there are structures or organizations that energize, and that ensure opportunities for collaboration between companies, between technology centers, institutions, etc., things work better. Because it's like we help companies to address institutions, because companies don't have time to think about who is the entity that I have to address, who is the project, the program that I have to focus on for the next project. Big companies do it because they have structures for that, but small companies don't have the time or the resources for that. So the good thing is that there are neutral organizations, like clusters, for example, or associations, that help companies, but at the same time, they have the public perspective, and they know the institutions, the European programs, the institutions, so they can do this work of knowing them, etc. I don't know if that answered your question.

C.V. : Yes. Perfect. I don't know if there's anything you want to add to our discussion, or that you think I don't know. No? I think we've already talked.

I3: Ok. I hope there is some interest for you. I also know who other entities you interview. I don't know if you do a lot of interviews, or a lot of meetings.

C.V.: I already interviewed someone from Accio too, in Barcelona.

I3: X.

C.V. : No, not X, another person actually. I wanted X, but she's not answering my emails right now, so maybe I'll ask again. Maybe.

I3: Ok. Sometimes, yes. I don't know, I haven't seen her for a long time. Theoretically, she was the person responsible for the circular economy.

C.V. : Yeah, I think that I have a lot of insights I want to know, but I'll email you again. I'm trying to interview people from different sectors. Not sectors, but companies to get other points of view. But I always have to reach out to some people because I don't have enough interviews yet. It's hard to know the person, especially for these topics. So, yes, I have to look for other people.

I3: I would recommend you to have a profile like me. We can give you general topics and maybe it will be more interesting for you. For example, let's talk about specific companies. I might recommend that you do a little research. You may have already done that. Companies, for example, as you said, in the waste management industry, which often work with city organizations. They are already integrated or part of the Smart Cities initiative. So, I recommend that you identify companies like this.

And try to interview some of them because I guess having specific examples of companies that do these kinds of projects can be interesting. We can also extract conclusions.

C.V. : I will do that. Thank you very much for your time and for all your insights and information. It helped me a lot. And if you want, when my work is finished, I can send it to you, if you are interested.

I don't know if I have any questions in the future, if I can send you an email. Okay, no problem. Thank you very much.

I3: Whenever you want. Thank you very much. Have a nice day.

C.V. : Goodbye, Maria.

I3: Goodbye

I4 online (Fichtner Resa, Catalonia)

C.V. : Maybe you can start by introducing yourself. Tell us briefly, what is your background, and what is your current role and responsibilities.

I4: My name is Alejandro. A few months ago, I finished my double master in Energy for Smart Cities. The first year I did it in Stockholm, Sweden, and the second year I did it here, in Barcelona. So I have a little knowledge about both cities and how they integrate the circular economy, especially in the waste sector. As of now, I work in an engineering consulting company, and we specialize in wasted energy, which, in the end, is not much reduced on recycling, but it is a bit of a circular economy, if you like. But, yeah, at that point, I use project management and project engineering in the company that I work for. But yeah, that's basically my background.

C.V. : Okay, and what are your main goals in what you're doing now, or in the day-to-day that you have to do at work?

I4: Well, we're making a requirement for a lot of biogas for biomethane plants here in Spain, because at that time there's a lot of interest in biomethane. I'm not sure if it's in Sweden, but here in Spain they're very interested in that. And then the waste energy sector seems to be getting a little bit better, because from what I can see, the plants are getting to the 25-year mark. I don't know if you're aware, but typically when you plan an energy project, you plan it for 20 or 25 years. So, yeah, at that point, they're getting to the end of the fog, so a lot of stakeholders are asking, what do we do, how do we renovate, how do we implement better systems. In this case, it's a little bit interesting. I mean, it can be interesting for circular economy practices and waste reduction. I also recycle, because recently I've been looking at how to integrate the bottom ash of waste energy incinerators. What processes need to be put in place to reintegrate bottom ash as a building material?

C.V. : Okay, super interesting. When you say you work with parties, who are you talking to?

I4: I think it can be confidential.

C.V. : No, but like a government or a company?

I4: I mean, more or less like that. Both.

C.V. : Okay, because now, in my thesis, I'm working on how difficult it is for a smart city to analyze who a smart city works with and in what order. I don't know if this is something you feel. I don't know how to say it. Do you have a hard time knowing who to go to for permits for innovative solutions, or is it clear to you?

I4: I would say that the private sector is more inclined to try innovative solutions, but they will always depend on the support and funding of public institutions. So if you're going to offer a public service, I don't think the government or the municipalities are going to want to try innovative solutions. Because at the end of the day, they're offering a service, so they have no margin for error. We tried this technology, it didn't work, and the payer paid for it. If you want to implement more innovative solutions, I would say that the private sector is the go to. But in the end, everyone relies on public funding.

C.V. : In fact, I have already interviewed people from EIT Mobility or Accio, but Accio is public, if I am not mistaken. It's a mix of everything, and for me it's a little bit difficult to know which company is funding it.

I4: Funding also comes from the public. Funding goes to the university. A lot of innovation comes from research. But in this context, this is what I discovered in my thesis, is that there is a breach missing between research and business.

C.V. : Yes, of course.

I4: There is one breach that is missing, because everything looks good on paper, but once you want to implement it, nobody wants to pay for it.

C.V. : What was your thesis about?

I4: My thesis was about integrating a carbon capture or a waste-to-energy facility. I don't know if you are aware, but there are several technologies to capture, and I chose to create a model with carbon and a multi-carbon few set ? The difference is that the carbon helmet captures CO₂, it produces energy. Unlike all other technologies that consume energy.

C.V. : Very interesting. Maybe we can follow the questions. How do you define a smart city, personally?

I4: Personally, for me, it's more of a 15-minute city. For me, it's the smartest you can find. There are these three philosophies, I don't know if you're aware of them. The first one is that it's all data-driven. So, we automate everything, we register all the data. I'm not in the school that thinks this is a smart city. I'm more in the school that thinks a smart city is one that works for its habitants. If you live in a city where you have to walk five minutes to get to a store, that's smarter. To me, that's the city that facilitates sustainability. I'll give you an example. When I was in Sweden, they took me to this neighborhood, the smartest neighborhood in Stockholm. It's called the "Royal Seaport". They have a system of waste collection that is neomatic. You have a button; you press the tube and it opens. But what really amazed me is that inside the building, in the sink, they have a grinder. You throw your young waste into smaller pieces to the grinder. You grind the organic waste, and it goes into the water system. The water system goes into a water treatment plant where they extract the organic fractions and create biomasses. For me, the smart city is the one that facilitates sustainability.

C.V. : I know I focus on Barcelona. Because Barcelona is really a step forward compared to other cities in Europe and the world. I have already heard of many projects like the cards for the beans. But this one you mentioned is really surprising compared to what we know. What role do Smart City initiatives play in achieving circular economy goals? You already gave an answer.

I4: From my perspective, I really focus on waste. I think Barcelona does it really well. There is a container where you can put waste like plastic bottles, metals, containers, general waste, organics, glass. It's everywhere. It's really simple to separate the waste. What happens after it is up to the market. As far as I know, the recycling market is not there.

You can separate everything you want, but if there is no market for the recyclables, you probably won't get into the economy.

C.V. : I also lived in Barcelona for 6 months. I lived, of course, in the tourist part, Barceloneta. For me, I have read many articles that talk about how efficient Barcelona is with waste management. But there is a problem for me. In Barceloneta, many people did not sort their

garbage. And there is also the problem of tourists in Barcelona. I don't know if you act on what I say.

I4: Yes, I don't know for sure. It's really uncomfortable. Mass tourism, I think it's gotten a little out of hand. Gentrification, gentrification and tourism are parts of gentrification. But yes, it can happen that tourists don't take so much time to separate. You know, when you go to a place, you have to build your own system with different things. So maybe for people who are periodically in Barcelona, who don't stay longer, it's a little bit harder to separate.

C.V. : What innovative approaches have you implemented or observed in our case, in resource management in smart cities that promote the circular economy in Barcelona, if you can.

I4: I think about it, but I haven't been part of any so far.

C.V. : I don't know, for example, if you want, I can give you examples. You can use sensor networks and data analytics to improve energy efficiency or waste management or mobility. I don't know if you've seen or heard anything like that.

I4: I don't know if there are sensors here. There might be. For me, I would say maybe it's a little bit more on the information side. People may not know where to put what. Maybe an innovation regarding that, but I don't know. I don't know how to answer this question.

C.V. : When I see, I read a little on LinkedIn about what you did. You also focused on solar panels. I'm wrong. I don't know. I wonder day to day if you implement something or if it is confidential. I don't know.

I4: My work with PD was in Mexico. We were doing solar plans for distributed generation. That's what I was saying before. That's my experience. The market does not take innovation unless it is completely proven. In my opinion, I do not know. Maybe the district heating in Barcelona, in Poblenou. It may be the newest thing that people are moving towards. It's cheaper, more efficient. Energy efficiency. If you can connect your building to the district heating network. But it's only a section of Barcelona. I don't know how to answer this question.

C.V. : No problem. Speaking of IoT and Big Data, I don't know if you specialize in that.

I4: No, I tried to stay away from that.

C.V. : I know this is really bad for a lot of E-waste. I don't know if you've talked about this.

I4: No, there's two or three schools of thought. One is really data driven. The other one is more about putting the person at the center. For me, the data part, it's really nice to have Netflix. It's really nice to be able to do everything more efficiently. But I tried to focus on the people who live in the city. Not the data system. I don't like that.

C.V. : I'm asking you because I want to know your opinion. Is it possible to have a smart city without sensors, data, technologies?

I4: Absolutely not. I mean, you need sensors and metrics at the end. Data dictates improvements. It's not a smart thing you don't realize.

C.V. : You're right. I had an interview with another person in Barcelona. She said the same thing as you. You don't need to use technology to use it. She gave me an example. For example, the city decided to use sensors to know when they should pick up trash on the street. But they had to do it every day. So, it was a lot of money to use technology for nothing. But in the end, it wasn't efficient at all.

I4: It makes sense if you have to collect waste more than once a day. Here in Barcelona, if you live here, you know that it's 3am and the garbage goes through.

C.V. : I agree with the smart city. Not without technology, but without focusing on technology, on IoT and big DATA.

I4: There is something interesting about waste. It is innovative, but difficult to implement because it requires a lot of space. It is like 12 power plans. Technically, you can come with your block or your neighborhood and implement PD and the roofs. You can participate in the energy market as a power plan. I don't know if you're in the energy community. There are regulations for energy communities where you can participate and get granted the same rights as our generator.

C.V. : Okay, super interesting.

I4: That would be interesting, but ultimately, there is no space. In the end it's a bit complicated.

C.V. : Okay. I'll check the other questions. I don't know if you know much about this, but I don't know if you know how important the collaboration for a smart city is between governments, businesses and citizens in the projects. We've talked about this before, but I don't know if you want to add anything.

I4: I think the most important part is communication. If recycling is not increasing, the government needs to make a comment or a publication that clearly explains what citizens should be doing. In my opinion, I think it is important to make transparent the costs of being correctly handling waste. I don't remember. I think it costs Barcelona 21 million euros per year. They are correcting waste management. I don't know why there is no public campaign saying that if you don't sort your waste, you will be prevented from paying more. I think there has to be collaboration between everyone.

For the private sector, something came to mind. The other day I looked at my bills, my energy bills, and I saw that there was a challenge. It is a challenge. If you can keep your consumption under this level, you will be given a discount on your next bill.

C.V. : It's interesting.

I4: For me, living with roommates is a bit difficult because you have to be really aware. Is there a valued demand and a high demand? Measures like that I think we could integrate with the municipality, the private sector, with citizens.

C.V. : Of course, citizens play an important role. Is that the link?

I4: Yes, it's the energy community. That's the directive.

C.V. : Perfect. Of course, in Barcelona, when I was on my trip there, I don't know if you know it, we had to spare a lot of water because the water was not enough for the whole city. In this case, for me it is very important to share information about waste, water waste, etc. More about the future and how we see things in the future. What are the opportunities for the future to integrate ecological practices in Smart City?

I4: I think what comes to mind where I come from is biomethane, in my opinion. It's a proven technology, it's just a matter of trying to persuade people to part with their waste and it's

something that can be integrated relatively easily into the community. Because ultimately, biomethane is indistinguishable from natural gas. A lot of people here in Barcelona are using fire leaves rather than natural gas. A lot of energy steel is produced by natural gas. This is one way that is almost immediate because the technology is there and there are a lot of projects that are trying to develop it. The other is energy efficiency and cooling. It's a bit more complicated because in the end, many people don't want to renovate their places. But if we can renovate and people, instead of using fire sheets, change to fire sheets, it's already a big increase in terms of energy. For me, the future would be to use the city's waste to produce biomethane and biomethane can be used to produce electricity. If everyone has a heat pump, we can use the electricity from biomethane to produce heat in our home instead of using flannel.

C.V. : Of course. What steps are needed to accelerate the adoption of circular practices in smart cities ? It has already been said that we need to raise citizens' awareness, but I don't know if you see anything else.

I4: I think this is the most important. Many people are not aware of the amount of waste we produce. The European average is half of the waste per year per capita. For me, if people were aware of the amount of waste we produce. How much is a consumer for and producer for at the end? It's hard to step away from losing waste because everything you buy comes from a package that you don't use anymore. I don't know. For me, transparency and awareness are the strongest of all. Many people do not know that if you buy a pump, you would save money in the end. Why buy a heat pump? I have always been using that gas boiler and always used an electric pump. If you change to a heat pump, we earn three times more money. I don't know if you know, but a heat pump with 1 kW produces 3 kW of heat. And the gas boiler is like 1 kW of natural gas produces 0.7 kW of heat, because the efficiency is very poor. I think there are options to take steps in our own home that will save us money.

C.V. : I understand. I agree with you. But to be a little skeptical, for me it's hard to be aware of everything. You have to be aware of the environment, of politics, of what's happening in the whole world. As I write this thesis, I think we have to raise awareness. But there are so many things that we have to be aware of that sometimes it's hard to just say... I don't know. I'm getting a little skeptical about all this.

I4: Everybody who starts researching it up, there are so many things. You have to focus on one thing. Otherwise, it's impossible. For me it's transparency. There is this option. I don't know if it's in Spain, but I think it was in Italy or the UK. that were promoted grands. The government will give you donations to change to a heat pump. But nobody knows it. It's that kind of thing. If you change that, and the government will help you do it, you will end up cycling.

C.V. : But you think it's more of a government action.

I4: Yes. I think... To be honest, I think with everything in energy transition, it's the legislative base. The technology is already there. It's just legislation. And bureaucracy is what is making it slow. The bureaucracy and the capital that we have, it's just a matter of legislation for something that helps citizens decide to do something that makes the house more energy efficient. For me, it benefits the environment. And it also benefits the government. But yes, in my opinion, it is legislative.

C.V. : Perfect, thank you. I don't know if there's anything else you want to add about the discussion we had.

I4: I think that's all. I hope this is helpful.

C.V. : Yes, of course. It's just a chat to share information and get your point of view.

I saw on your profile that you know this topic and are currently involved in this environment. It was important for me to have your opinion and insights.

I4: Okay, I'm happy to help.

C.V. : I don't know if I have any other questions I can ask you.

I4: Yes, if there is something I can help, I will try to help.

C.V. : Thank you, and at the end, if you want, I can share my work.

Thank you very much for your time again, Alejandro.

I4: Céline, good luck with your thesis.

C.V. : Thank you. Have a good day.

I4: Goodbye.

15 online (Acció, Catalonia)

C.V. : For the structure, we're going to talk a bit about you, your role within Accio, about Smart Cities, the concept of circular economies, and, as I said, how we can combine both subjects. The first question is, can you briefly describe yourself, your background and your current role and responsibilities in Accio?

15: Well, as I told you, I hope, in my first answer, I'm not directly involved in the issue of Smart Cities, although it's a topic that touches on different topics that I can work on. My role here is that I'm the Senior Manager of the Cluster Program. The Cluster policy, it is one of the main and longest policies that we have in Catalonia without interruption. In fact, in Catalonia, I think it is one of the 2 or 3 cases worldwide of more than 30 years of Cluster policy without interruption. In fact, last year, a business case from Harvard University wrote about it, about the 3 decades of Cluster policy in Catalonia, about what is to come. In fact, the Cluster policy refers to using clusters as an aggregation of companies with a concentration of firm and the classic definition, maybe you already know. Using clusters to improve the competitiveness of companies. Currently in Catalonia, in our Cluster program in Catalonia, we have 27 Cluster organizations that are grouping more than 300 members, 90% of which are private firms, and the rest are other, such as the Technology Center, the University, the Association, all related to the specific segment that the Cluster is working with. Basically, I'm managing this program with a team of about 14 people who are responsible of the different aspects of the Cluster policy, defining the program, helping the Cluster organization in defining significant projects, and managing the financial aspects of this project. But our focus is particularly on the capacity of the Cluster teams, each of which, these 27 Cluster organizations, has an average of 6 employees, which makes the difference between a very small Cluster of 2-3 employees, and a larger structure with more than a dozen employees. So, we work with this private organization, the Cluster organization, and the from the government, from Accio, agency for competitiveness of the Catalan government. We help them to design and implement valuable projects aim to improve the competitiveness of firms. Then, we have different topics. We prefer to talk about sustainable competitiveness, in the sense that, in the last year, we really focused on projects that have shared values. For shared values, it is about generating at the same time an economic value and a value at the level of society, which can be a social aspect, but often an environmental aspect. I can give you more details if you want, as an example.

C.V. : Yes, if you have some. But I just have one question. I interviewed someone who also works for Cluster companies and to improve their competition. I don't understand the difference between your company, the government company Accio, and a private company that does this. You have private companies clustering, but you also have government companies clustering. I don't understand.

I5: No, let's clarify. Accio is part of the government. It's a 100% public government company. It's a 100% public company, so, in a way, it is part of the government. We are part of the government, but we are not like the ministry, but we are totally similar to a department of the government. So, we are on the side of the public administration and policy makers. In the concept of clustering, you have to distinguish between natural clusters, clusters that are an aggregation, a concentration of companies and other partners in a location and around a specific business. There are also many of these in Belgium. You can find it naturally because of the evolution of economic history in a specific location. And clustering organization, the Cluster organization is a private association. Normally, it is an association, it can also be a foundation, but normally it is a non-profit organization that is created by the cluster main partners, So, basically, firms. In our case, to be part of the program the cluster, we say that the cluster organization should be private driven. There should have at least 70% of private companies in the board of the director of the organization. And it is a private organization. It can be a private guild, a private business association or a confederation of industrial enterprises, whatever but in this case, it is a specific association that represents the entire value chain of a specific business. So, there can be different levels. There are clusters that are more defined at a narrow level. There may be, I don't know, **the clustering** industry in Catalonia, that's true because it's something very specific. Or, I don't know, there may be clusters, for example, there is a cluster on food service, that is, all the companies in the food industry that are in the value chain that are serving restaurants, hotels and collectivities, soo, a specific one, not a company on food). In fact we have another cluster on food(??? **Idem mm mot mais jspqs c quoi**), or a cluster on the wine industry, etc. Then there are clusters that are widely defined. There may be, I don't know, the automotive industry, or in some cases, even if it is not our case, there are clusters that are more defined on smart cities, or concepts that are wider, like the blue economy, etc. It depends on the focus of your methodology, your approach. In our case, we prefer, even if we evolve it over time, when we started in the early

90s, we have a very, very narrow focus. In fact, at that time, the policy was called micro-cluster, because we were really talking about the knitwear industry, the leather tanning the **task of food**, etc. Then the concept evolved, because now it is difficult, everything is much more cross-sectoral, much more globalized. So now we are talking about clusters that have a larger scope, but at the same time, they are still very much linked to a business. We have the sports cluster in Catalonia, for example, or the beauty cluster that is linked to all the companies in the cosmetics and wellness sector, etc. But still on that.

C.V. : I don't know if it's on your site, but if not, yes.

I5: Yeah, on our site. Okay, perfect.

C.V. : Yeah, I've already checked a little bit, but I'll... If you have the link there, yeah, or maybe later. Perfect.

I5: Yes, there is... A lot of information is in Catalan, but...

C.V. : I know, I know in Spanish, but not in Catalan.

I5: Yes, I don't know, maybe with French it's not so hard to understand, but I... I can send you information in English, no problem.

C.V. : Perfect, thank you. Okay, so the next question is... How do you define a smart city in the context of your work? I don't know if you work, as you said, if you focus on the smart city, but I'm not sure.

I5: Well, I don't focus on the smart city. I know the concept, because it is a concept that is very... Yes, popular. It is very common, popular in the field of economic development and local competitiveness. And in Barcelona. This is something that, in Barcelona, of course, because we also have this event that was actually less than a month ago, the smart city congress that started as an event very focused on the concept of smart city. And my definition of smart city is a city that is well managed in a more sustainable way, which implies a problem at the level of mobility, at the level of energy efficiency, at the level of sustainability in general, so I think the concept is a bit like this. And of course, we do not focus in our work on this specific concept, although there are some people that you have been in contact with Xavier Villalta,

he focuses more on this concept. In our case, we have different clusters, and I'll give you an example right away, that work on domains that are very related with smart city. For example, we have a cluster on the Catalan Water partnership. It is a cluster that groups together about 160 companies in the field of water management. Water management is a cluster that was created 14 years ago in another very important environmental crisis that we had in Catalonia with the **over ???** in the year 2008 to 2010. Then again, 15 years later, we are going through, although the situation has improved significantly in recent months, but the last three years, from 2022 until today, until the beginning of the summer this year, we had a very severe draught, with restrictions on water for industry, for agriculture, so a significant reduction in the volume of water provided to industry in terms of 25%. It is very, very significant. So, this cluster groups together companies that provide solutions for the best use of water in terms of infrastructure, in terms of digitalization of the use of water. And this cluster plays an important role for helping other sectors, other clusters, to make more efficient use of water. For example, in the food industry, etc. This cluster also has a significant importance in Smart City, but there are also others, like the energy efficiency cluster, which is very involved in the efficient use of energy, with a clear focus on renewable energy, and in particular solar energy. So, they play a very important role in the energy transition. There are projects related to the energy community, etc. Then there is the mobility cluster. Actually, there are three clusters. There is the automotive cluster, which is more on the industrial side, which may be less involved. But there are two other clusters, a cluster called e-Move, which was originally a cluster on the railway transportation, but has recently evolved, with a wider scope and a wider concept of sustainable mobility, and which includes not only railway transport, but also mobility for passengers and goods.

Then there is the light mobility cluster, which is the evolution of a cluster very focused on the motorcycle industry, which was a traditional sector, a manufacturing sector in Catalonia, which has recently evolved, because of the location of most of the main factories here, of traditional manufacturing of motorbikes, particularly in the off-road segment. Some are still here, some are located in other low-cost countries. But at the same time, there has been a substitution of this company by other companies, particularly in the manufacturing of electric vehicles, light mobility vehicles, etc. So, as you say, an important part of our work is to help this sector, this cluster, to evolve and transform according to the demands of the market. So,

as I said, the example of the railway industry has transformed this cluster into a sector more focused on mobility. And we have other examples, perhaps in a sector that is not strictly related to the Smart City, but an important cluster in one of the traditional main sectors in Catalonia, which is meat production, the meat processing in the north of Catalonia, in Girona and in all the surrounding counties. This cluster has evolved based on the meat procession, especially on pork meat. Now, we have added, for the last few years, including company on alternative proteins, that is, a substitute of meat. So, both traditional companies in the meat processing sector have created startups, companies to explore the business in this sector, or other completely new companies that have joined the cluster because they are working on alternative proteins of plant, vegetal origin or other. So, regarding the question, we are not focusing on Smart City, but we have a lot of clusters that are directly related to that.

C.V. : OK, perfect. Thanks for all these examples. Regarding the circular economy, do we also have examples of clusters or less?

I5: No, we have many examples of the circular economy. In fact, at Accio, there is another person called Maite Ardevold who is responsible for the circular economy. Probably Xavier has already suggested.

C.V. : Yes, but she is not answering, so I don't know.

I5: Ah, OK. But, regarding clusters, we have a lot of projects that are on the circular economy. In fact, last year, this was one of the main examples. We have clusters that are, let's say, the suppliers of solution for the circular economy. And, as I mentioned before, there are clusters like the Catalan Water Partnership and other clusters that are more on the demand side of these solutions, like the packaging cluster. Packaging, it's a very... They are always looking for solutions that are more sustainable, for their packaging, or other clusters, like for example the cluster on the fashion industry of apparatus, which is one of the largest in Catalonia, because we have the headquarters of some of the main chain brands, like those of Inditex Group, or companies like Mango, like Desigual. Practically all the brands of Inditex Group, but Zara, which is in Galicia, in north-west Spain, all the other brands, like Massimo Dutti, like Bershka, like Stradivarius, are located here, in Catalonia. They are not companies that produce here, but they are responsible for the manufacturing offshore, and they are very aware of the impact they have on the industry, and they work on that. Maybe, since time is running, I would

like to introduce you, and I repeat, if it is on my side, I am used to this kind of conversation, collaboration with students, so I have no problem for a second meeting. Maybe you can review the materials, and if you are not in a hurry, we can also schedule another meeting for the beginning of January. But I would like to spend the last two minutes to introduce you to the concept with which we work in the field of circularity. In fact, a few years ago, we started to adapt a concept that was conceived by the same intellectual father of Cluster, Michael Porter, from Harvard University, which is the concept of shared value that I mentioned before. He wrote a paper, with another professor from the same university, Marc Ramer, that you can find on the net. It's called "The Competition of Shared Value and the New Economy." Something like that. But I can also send you the article directly, if I don't forget. You've already the article on shared value. If you put Porter, Ramer, shared value, it appears. This article is very interesting because it says that you can, at the same time, find projects that produce economic value and social environmental value at the same time. To give you some examples, this is the case, for example, of a company and in the article, there are many examples, a company that produces a food distribution company that opens an outlet in less populated areas where there are no one. So they provide social value, but at the same time, if they have a good business model, they get economic value. It's a bit of an evolution, even if it's not the same thing. Porter and Ramer make an effort to highlight the difference. But in a way, it is an evolution of the concept of corporate social responsibility that you are certainly familiar with. The difference is that with corporate social responsibility, you are trying to divide a little bit the cake in a different way, by having the company take on more responsibility, by renouncing a part of the profit for the society. That is sustainability, but in this case, it creates more value, and this new added value is shared by the profit for the company and at the same time for the society. This is a concept that Porter and Ramer use at the level of company, we take advantage of this concept and apply it at the cluster level. Let me give you an example that will immediately open your eyes. This was my case of the usefulness of the example. We have a cluster in the leather tanning industry in Igualada. It is a Harvard case that was written 30 years ago, in which, to be very simple, this cluster has an important issue of competitiveness, because with the entry of Spain into the European Union in the 80s, companies had to adapt to new environmental conditions that were stricter for members of the European Union than the ones they were used. Most companies were to closed because they were not able to adapt their production to this new standard of water pollution, because the activity of the leather

tanning the use of water. It is very polluting and contaminating. Basically, the solution to this situation was the creation of a more fascinating and interesting case, but I give you to the point. The solution to this problem was the creation of a water treatment plant built by a consortium formed by almost all the companies in the cluster and imitating a similar project that was already in work in Italy, in a similar cluster in the Venet region, in Ardignan, another laser tanning cluster. They built this water treatment plant and thanks to that, the cluster survived and is now very competitive. They work in a very high market. Most companies are suppliers of these luxury brands like Louis Vuitton, Hermès, Gucci. Thanks to this investment made thanks to the fact that they were in a cluster, and they could geographically share the infrastructure and all that, the cluster survived and became more competitive. This project, which is not spoken of as shared value because the concept was not invented, looking at it with a perspective it is an emblematic project of shared value because at the same time, at a qualitative level of the cluster, you have more money and more income because thanks to sharing these plants, the company has... It was an investment that was not possible to do individually by company and at the same time, there has been a huge upgrade in the environmental situation because now, the river and the environment in this small city in the center of Catalonia has completely changed. It's more sustainable, there's no more pollution. So, it's an example of creating shared value at the collective level of the cluster. And we use this example to translate it into a program that we carried out over the last 5 years in which we gave a testimony on each cluster to identify potential shared value business projects. Now, there are many... I also presented a paper in the last conference of the European Commission in Brussels this month, in May, which talks about the work of shared value in Catalonia. If you are interested, we can... And now, I see that there are 32, I have to go because I have another appointment that is exactly close to that. But I will send you some information.

And I also sent... You give me your email or...

I5: I think it's in my email but I can send it to you again. Okay, thanks. I'll answer that with some documents and maybe if you have any specific questions from my side, it's... Sorry, but this week, it's very busy for me. And also, we have a big event next week. So... It's kind of... Sorry about that. No, no, thanks for your time.

C.V. : No problem with that. Thanks for your time, it was very interesting. Ok, bye.

Abstract:

Urbanization continues to transform cities into dense and dynamic centers, presenting both opportunities and challenges. This thesis explores the integration of circular economy principles into smart city frameworks, focusing on the city of Barcelona, in order to answer the central question: How do smart city principles contribute to the development of circular cities?

The first part of the research establishes the theoretical basis, reviewing the two concepts and introducing a new framework that examines the intersection of these two approaches. The second part comprises qualitative empirical research using semi-structured interviews to analyze Barcelona's actions in integrating smart city and circular economy principles.

The main findings reveal that the objectives of the smart city have evolved from a technology-centric approach to a holistic people-centric approach, enabling the integration of CE principles. Government-led initiatives in Barcelona focus on the higher levels of CE, while businesses prioritize middle-loop strategies. This distinction highlights the complementary roles of government in defining visions and business in operational innovation. Citizen engagement, transparency, and stakeholder collaboration appear to be key factors in driving the transition to circular cities.

The thesis makes significant contributions by introducing a new framework, proposing a definition of circular cities, and providing an example of a successful application in Barcelona.

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