POLITECNICO DI TORINO

MASTER's Degree in ARCHITECTURE FOR THE SUSTAINABILITY DESIGN

MASTER's Degree Thesis

DEVELOPMENT OF SUSTAINABLE CITIES BY USING CIRCULAR ECONOMY: CIRCULAR CITIES

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Abstract

The world's population growth that occurred in the last decades is one of the main reasons behind the reduction of natural resources and the increase of pollution and environmental contamination. According to this fact, the role of sustainability has become a necessity, since the future perspective of the human settlements will be characterized by an urban scenario, with the majority of the people living in the cities. Therefore, the placement of the cities in a circular economy process can be considered as an interesting and strong tool in order to identify and exploit the available resources with a consistent potential and achieve relevant benefits from them. As a consequence, a model of a sustainable city can be thought of and realized in a circular economy frame. Several studies have been done in the last decades, in order to understand how to improve the cities in this sense. In this work, inspired from the main contributions from literature in the analysis of cities as circular urban centres, we apply a rigourous analysis methods to Turin, for the identification of the main indicators of circularity. The study has been completed with the fundamental contribution of a technical interview realized with an important expert in the topic of circular cities.

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Furthermore, my deep and sincere gratitude to my mother Esma and my father Ali for their continuous and unparalleled love, help and support. I am grateful to my brothers Mehmet Ihsan and Bahadır for always being there for me to support me. I am forever indebted to my parents for giving me the opportunities and experiences that have made me who I am.

I could never write this section without writing their names: Pelin, Tuğçe, Karen, Irem and, last arrived, Ayda. I always call them friends but my mind think them as sisters.

Finally, to my caring, loving, and supportive boyfriend Carlo, my deepest gratitude. Your encouragement and your help for my thesis was fundamental. Amore mio, grazie mille.

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Acronyms

ATP Association of Tennis Professionals

BGI Blue-Green Infrastructure

CAM Criteri Ambientali Minimi

CD Compact Disc

CE Circular Economy

CFC chlorofluorocarbon

CO2 Carbon dioxide

DWD Drinking Water Directive

EDP Electronic Data Processing

EEA European Economic Area

EU European Union

GBC Green Building Council

GBP Great Britain Pound

GHG Greenhouse Gas Emission

GPP Green Public Procurement

ICT Information Communication Technology

IoT Internet of Things

IUC International Urban Cooperation

LCA Life Cycle Assessment

LCC Life Cycle Cost

LPT Local Property Tax

LTZ Limited Traffic Zone

MAAS Mobility As A Service

NGO Non-Government Organization

PNR National Resilient Plan

PRG General Town Plan

OECD Organisation for Economic Co-operation and Development

QEOP Queen Elizabeth Olympic Park

REPOPP Re-design Project of Organic waste in Porta Palazzo market

RESOLVE Regenerate, Share, Optimise, Loop, Virtualise, Exchange

SDG Sustainable Development Goal

SFM Metropolitan Rail Service

SGIP Strategic Plan for Green Infrastructures

SEEA Environmental-Economic Accounting System

SRSP neighborhood of Stockholm

SMAT Società Metropolitana Acque Torino

SME Small and Medium Size Enterprise

SLDI Sustainable Land Development International

SUMP Sustainable Urban Mobility Plan

SWOT Strengths, Weaknesses, Opportunities, Threats

TPL Local Public Transport

UNEP United Nations Environment Platform

UNESCO United Nations Educational Scientific and Cultural Organization

UK United Kingdom

UV Ultraviolet

Chapter 1

Introduction

1.1 Aim of the research

In the contemporary period the concept of city changed and they are structured mainly as collection of elements, i.e. a global urban system, with strong synergic dependence between economy, environment and social part. In addition to urban development, which is one of the requirements of our time, cities that struggle for sustainability represent an invaluable source of opportunity as a global phenomenon. Nowadays, cities account for more than 70% of global CO2 emissions, unfortunately. Urban systems are the key issue that needs to be included to accelerate the energy transition without leaving anyone behind while gradually de-carbonizing energy consumption through electrification.

Indeed, the key point of cities is the most widely accepted element in reducing humanity's impact on the planet. Cities are living laboratories to tackle the criticalities of the Planet first.

Cities are complex systems and a paradigm shift is needed to design the cities of tomorrow. Cities need to be treated as living organisms for which the flow of energy, materials and information is necessary for their development. In recent years, a new model has emerged as an opportunity for sustainable development, based on circular flows, that is, similar to the fundamental laws of thermodynamics, and that is circular economy.

It is a set of new visions of the circular economy, which aims to eliminate waste in the system by closing the energy and material flow loops, to realize a fully developed vision of the city as a living ecosystem, where subsystem waste is used as input for other subsystems. For example, district heating systems based on

industrial heat recovery can be given as an example. The circular economy can be paired with some key themes: renewable materials and energy; increased use of assets through sharing, product-as-a-service and lifespan extension; we can say closing the loops by reusing the flow.

There is not only a semantic but also a conceptual distinction between a smart and circular city. While circular cities focus on a more holistic approach that includes all dimensions in terms of competitiveness, environmental sustainability and social inclusion, the concept of smart city mainly focuses on the role of information technology. Governance also plays a central role in this vision and must be twofold to allow the transition to the circular paradigm: both top-down and bottom-up. This is a strong inclusion of all elements of the urban ecosystem such as citizens, companies, start-ups, organisations, policy and decision makers. Ideas, proposals, projects and initiatives are the vital actions for the circular development in a city. Technology is also central to the circular city vision as a tool to support the achievement of economic, environmental and social goals.

The built environment, energy, mobility, bio-economy, and material flows such as waste, water, food, etc. could be considered some urban subsystems. All of these subsystems has a key role in supporting the transformation of the cities as circularity.

Infrastructures are common in the circular approach and represent the backbone on which circular cities operate, such as smart grids, smart lighting, ports, optical fiber. To support the smooth functioning of the circular city, all these infrastructures need to be redesigned and non-existent infrastructures need to be built from scratch. New technologies play an important role in circular development and the most relevant ones are renewable technologies, electrical appliances and digital and Artificial Intelligence solutions.

Distributed and integrated renewable energy sources such as electric vehicles and heat pumps describe a new paradigm that can improve the quality of life while eliminating global and local pollution emanating from existing technologies. Sensors, internet of things etc. Big data from digital technologies feeds the Artificial Intelligence application, which can provide maximum benefit not only from new physical technologies but also from old ones, as it allows new business models and uses. Solutions such as vehicle sharing, waste tracking, pay-per-use, peer-to-peer exchanges provided by block-chain technologies have been allowed by the strong digital evolutions of recent years.

Circularity is a completely new and different way of thinking and behaving, and it's not just about being a little more efficient. For example, a new petrol engine

that increases efficiency by 2% is not a circular evolution, but merely an refinement of a linear model. Integrating renewable energy and electric vehicles, using digital infrastructure to monitor flows, reusing deteriorated energy storage systems for cars, recovering heat from industrial processes, could instead represent a paradigm shift and a powerful contribution towards circularity[1].

Therefore, circular developments are invaluable for putting cities on a sustainable development path. And this is a powerful perspective for tomorrow's cities because all the necessary technologies are already in place and what needs to be done is to replace outdated and unsuitable linear model infrastructures with circular solutions.

The fundamental target of this research is characterizing rigorously the circular city and analyzing its requirements. Therefore, a focus on how to analyse a city is needed, in order to understand cities' approach as a circular development. Furthermore, these concepts are applied to study and characterize the city of Turin.

1.2 Definitions

This research will investigate in the context of a circular city and there are two key definitions which are essential for circular city: sustainable city and circular economy. Therefore, Once these two terms are defined, circular city will be much easier to understand.

1.2.1 Definition of the sustainable cities

The broad concept of sustainability has caught people's attention, among politicians and citizens around the world. However, the term has evolved over time, and much of what the term refers to today is quite different from what it conveyed a decade ago, and it is likely to evolve again in the future. As the broad concept of sustainability evolves, its derivatives proliferate, such as sustainable communities, livable communities and sustainable cities. However, defining these concepts is not easy or fast. In the 1997s, researchers wrote, "There is a general belief that sustainability is a good thing and unsustainable is a bad thing, but will we know it when we see it?" They argued over this question. Without providing a fully developed definition of a sustainable city at this point, suffice it to say that a sustainable city is a city that works hard to promote some operational version of sustainability. The conceptual foundations of sustainable cities inevitably can anticipate a very long-term process, perhaps taking decades to achieve significant results[2].

A sustainable city is a city with a controlled population in which sufficient and

meaningful employment is available. It suffices a governance scheme that can meet the needs of the people and ensure civic responsibilities, community participation, a sense of identity, transparency and equality in local institutions. The sustainable city should be productive basic urban amenities for a reasonably comfortable existence. For example, due to electricity shortages, more than 50% of electrical energy is consumed illegally without payment to the municipal authority, leading to corruption, astronomical financial losses and insufficient supply to those who pay for its consumption. The same is true for water, which is insufficient to meet the needs of the population[3].

Also, since transportation affects the environment, sustainable cities, housing colonies with a suitable transportation system with adequate infrastructure such as schools, parks, drainage system, local health institutions should be planned. Transportation planning should consider a wide variety of options and options such as adequate roads, parking lots, alternative transportation system, public transportation facilities. The aim should be to reduce the total mileage of vehicles driven in congested areas, thereby reducing the pollution and emission of greenhouse gases. This can only be achieved when the number of vehicles on the roads is reduced.

It is about untreated sewage and effective environmental infrastructure that is crucial to addressing the problems of waste polluting rivers, lakes and coastal areas. In addition, the empowerment of women and encouraging their participation in the political, social and economic life of a city and the adoption of urban policies that take into account women's needs and initiatives are another relevant issue for the improvement of the city with a sustainable approach. Develop an efficient urban private sector, both formal and informal, that reduces poverty by creating jobs and aiding economic growth, and an efficient health system that will also address nutrition, family planning and sanitation. It should also have a mechanism in the form of a policy initiative for industrial expansion into satellite counties where better employment opportunities are created[3].

1.2.2 Definition of the circular economy

The circular economy is a production and consumption model that involves sharing, lending, reusing, repairing, reconditioning and recycling existing materials and products for as long as possible[4].

This extends the life cycle of products, helping to reduce waste to a minimum. Once the product has finished its function, the materials it is made of are in fact reintroduced, where possible, into the economic cycle. Thus they can be

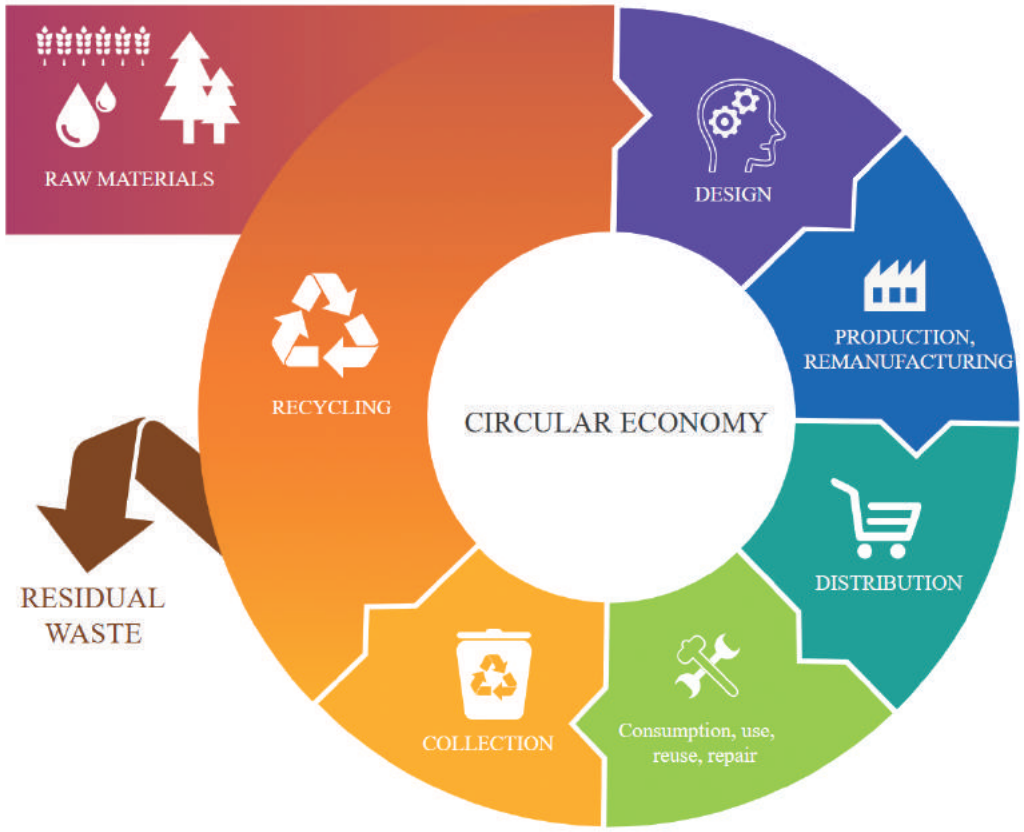


Figure 1.1: Diagram of circular economy reproduced from [4]

continuously reused within the production cycle, generating additional value[4].

The principles of the circular economy contrast with the traditional linear economic model, based instead on the typical "extract, produce, use and throw" scheme. The traditional economic model depends on the availability of large quantities of materials and energy that are readily available and at low prices[4].

Furthermore, in the European Union, more than 2.5 billion tons of waste are produced every year. The EU is updating waste management legislation to promote the transition to a circular economy, as an alternative to the current linear economic model[4].

In March 2020 the European Commission presented, under the European Green

deal in line with the proposal for the new industrial strategy, the action plan for a new circular economy which includes proposals on the design of more sustainable products, on waste reduction and on empowering citizens, such as through the 'right to reparation'. Resource-intensive sectors, such as electronics and information and communication technologies, plastics, textiles and construction, enjoy specific attention[4].

In February 2021, the European Parliament voted for the new circular economy action plan, calling for additional measures to achieve a zero-carbon, environmentally sustainable, toxic-free and fully circular economy by 2050. Stricter recycling regulations and binding targets for 2030 on the use and carbon footprint of materials are also included[4].

1.2.3 Definition of the circular cities

A circular city is a city that supports the transition from a linear economy to a circular economy in an integrated way with all its functions in collaboration with citizens, businesses and the research community. In practice, this means promoting business models and economic behavior that separates resource use from economic activity by preserving the value and utility of products, ingredients, materials and nutrients for as long as possible to close material cycles and minimize harmful resource use and waste generation. Through this transition, cities aim to improve human well-being, reduce emissions, conserve and enhance biodiversity, and promote social justice in line with sustainable development goals[5].

After 2014, circular cities began to appear in Europe. This followed the publication of a series of policy documents by the European Commission. As of 2016, the Netherlands, Scotland, Finland, and Germany had national strategies for CE.By 2018, France, Slovenia, Portugal, Greece, Italy, and Luxembourg have joined them. The New Urban Agenda for Europe has established a special partnership for the implementation of CE at the urban scale[6].

The relationship and difference between circular cities and sustainable cities seem to be understood in very different ways in cities across Europe. The two concepts have many similarities. For example, both aim at a responsible system rather than self-harm. They also tend to see collaboration between stakeholders and business model innovation as essential. However, there are also very important differences, such as the purpose with which they are associated. In the case of circular cities and the circular economy, the literature focuses on eliminating all resource inputs and waste and emissions leaks from the system, while in the case of sustainability the goals are very open-ended.

Similarly, the motives of the goals are also different, depending on the interests of the individual actors. Sustainability is often motivated by the idea of staying within planetary boundaries in terms of various past trajectories and environmental impact. In contrast, circularity is mainly driven by the idea that resources can be used better in circular rather than linear systems. In some cities, for example Amsterdam, the circular economy is a goal alongside a sustainable city. In other cases, it can range from being a strategic goal to being a niche concept consumed by smart city visions. I agree with the most common view that: transforming a city into a circular city and promoting a circular economy are necessary tools to achieve a sustainable city vision, but may not be sufficient if other tools and approaches do not complement them.

1.3 Working Methodology

First of all, the starting point and the most important keyword of the thesis is circular cities. In order to understand the concept of circular cities, two main topics that make up it are examined and these are sustainable cities and circular economy.

The literature review study was conducted on three main keywords: sustainable cities, circular economy, and circular cities.Furthermore, Prof. Giulio Mondini's lecture on circular cities in Politecnico di Torino in 2020 [7] was carefully followed and examined. then, Mondini's lecture on circular cities in politics in 2020 was carefully followed and studied. The literature review and Mondini's course together form the content of the first part of the thesis. Thus, a literature review was conducted for the subtitles in Mondini's course.

The research of Jo Williams's paper is called "Circular cities:what are the benefits of circular development?" is analyzed in the second part of the thesis. The main aim of this paper is analyzing the benefits of circular developments in cities. The main reason to examine this paper is to discover how the author analyzes the circular cities to understand the benefits of the circular developments by applying some sequence methods.

After thoroughly examining how the author analyzes the circular cities, general information about the city of Turin was collected. The information were obtained from mostly Municipality of Turin and some researches about Turin in order to analyze the city of Turin as a circular city. The main focuses were the urban development of Turin and transformation of mobility in Turin in order to investigate the generic information about Turin.

There were several good reasons for analyzing Turin as a circular city. One part of the thesis shows why Turin is valid to choose for analysing as a circular city. One of the reason, Turin follows the rules of The New Agenda for Europe,2017. The issues discussed and the decisions taken during the meeting about The New Agenda for Europe,2017 were analyzed in this thesis. Turin also joined International Urban Cooperation program (IUC).European Union and this is the another action in order to adapt the circular development from Turin. In the thesis, this cooperation program also has examined.

Turin has a powerful future plan for 2030. Turin Municipality has a lot of projects and a lot of improvements in order to adapt circular approach. The relevant future plan for 2030 of Turin was looked into details in the thesis. Lastly, Turin is finalist 2022 of European Green Capital. The reasons why Turin became the finalist of this competition are very vital also for adapting the circular approach in a city. These last two studies about Turin shows very clearly why Turin is better to choose to look into as a circular city.

In the research paper of Jo Williams, she prepared one relevant table to analyse the circular cities. In this table, there are the circular systems to see their ecological, social, and economic benefits. In this point, the method was analysing Turin by creating the table as in the research paper of Jo Williams. Circular systems in Turin was analysed to create this table for Turin.

At the end of the search, there was also one interview with Prof. Mondini in order to clarify the some relevant points related to his lecture and his opinion about the circular city. Some significant topics point out during the interview such as the relationship between sustainable cities and circular cities, eco-dynamic city, chaos theory and fractals, systems diversification and growth of the resilience, social participation, and multi-parametric evaluation so on.

1.4 Thesis outline

First of all, there are the literature reviews with the four main keywords. They are sustainable cities, circular economy, circular cities, and actions for circular cities.World population and the city capacities are the elements that can explain much more better the situation why cities should be sustainable. After that, there will be the transformation of the cities related to these parameters in the city in order to be sustainable.

Circular economy is the main backbone of circular cities and applied to the city. In order to understand the application of circular economy to the city, it is useful to focus on the key elements of the circular economy. Product life cycle is the main elements of the application of the circular approach in the city. Furthermore, the directors of the transformation are the natural, territorial, and social capitals in the product life cycle in the cities.

Secondly, there is one process from from sustainable development to circular cities. Sustainable development created sustainable community. Sustainable community developed circular development and allowed the creation of circular city. At this stage, examining the relation between circular economy and circular city reveals the transitions of this process.

Different cycles for the city should be closed in a circular city. This is the beginning of the circular adaption. Urban subsystems such as buildings and design, mobility and connections and products should have the approach of the circularity. Increasing awareness of the community of the city is very vital to develop the city. New ownership concept in other words sharing economy will be one of the solution to have circular economy. In this way, new business opportunities will appear in the system. Circular city need to have a multidisciplinary approach and collaboration of the different experts for the city as architects, environment engineers, city planners, etc.

Actions for the circular cities are regenerative urban systems and urban mining; the relation between the space and resource flows; environmental systems for circular cities; systemic approach, chaos theory, and concept of fractals; environment vs technology; an eco-dynamic city, systems diversification, and growth of the resilience; and social innovation and public, individual and social participation.

Furthermore, to characterize the circular city and for its application to Turin, it needed the examination of research paper:“Circular Cities: What are the benefits of Circular Development?”by Jo Williams[8]. The author used two main methods to identify the circular benefits. First one is the literature reviewing and second one is the interview with key stakeholders. The author created the table of circular development benefits by using this two methods. After that she examined the circular development benefits in the cities. There are three types of the benefits and they are ecological, social, and economical. In this research paper, she found the European example cities as a circular city and she analysed them. These European cities are Amsterdam, Paris, London, and Stockholm. She emerged the relevant circular systems and found out these systems in these four cities. At last, she also studies on synergistic benefits according to circular actions which are looping,

ecologically regenerating, and adapting.

Moreover, Turin is a very suitable city to analyse as a circular city. Fundamentally, urban development of Turin and transformation of mobility in Turin was needed to search in order to understand today's Turin. In addition, there are some relevant proof why is Turin better analyzed as a circular city in Italy. Firstly, Turin follows the roles of The New Urban Agenda for Europe,2017. Second, it joined International Urban Cooperation program (IUC) European Union. Turin Municipality has an action plan for the future and it is called "Turin 2030: Action Plan for the Turin of the Future"[9]. Lastly, Turin is finalist 2022 of European Green Capital[10].

At the end, Turin is analysed by creating the table as in the research paper of Jo Williams. Creating the examination of circular city's table, the circular systems in Turin could be found out. First one is the circular construction in Turin. In Turin, there is a project is called "Edilizia circulare" investigate very well the circular construction in Turin. Turin also respect the roles of "Green Building Council Italia" in construction. Second one is the circular food system in Turin and "REPOPP Project" is very successful project in Porta Palazzo for this topic. Third one is adaptive reuse of spaces/infrastructure in Turin and there are a lot of works in Turin about this system. The master plan for the liveable city produced from Turin Municipality, approach of the green resilient, ITS and mobility as a service, safe roads, and renovated public transformation are the most relevant examples of the circular reuse of spaces development in Turin.

Water recycling in Turin is the following circular systems and "SMAT" Water Points is the successful project from Municipality of Turin. There are a lot of projects such as plastic-free school canteens, Turin towards zero waste, and Big Belly for the waste management in Turin. Ecological Restoration in Turin is another circular system that Turin has some developments about this. Last circular system is about reuse of goods in Turin. The "TriCircolo" Reuse Center is the sale of goods and services related to reuse and the theme of eco-sustainability.

At the end of the thesis, interview with Prof. Giulio Mondini clarified most of the important points related to circular cities. There were some questions about circular cities, city analysing, Turin situation related to this topic. The second section of the interview was the related to the lecture and He explained the details of the lecture. Exposition of the interview emphasize the significant points about the interview. Characterising the circular city, example of the circular city, Turin as a circular city, the relation between sustainable cities and circular cities, an Eco-dynamic city, chaos theory and fractals, systems diversification and growth of the resilience, participation and multi-parametric evaluation are the topics.

Chapter 2

Literature Review

2.1 Sustainable cities

Sustainable cities are designed with social, economic, environmental impact and resilient living space for existing populations and future generations. Sustainable cities as cities committed to achieving green sustainability, social sustainability, and economic sustainability. It also includes minimizing the required energy, water, and food inputs and remarkably reducing waste, heat output, and air pollution (CO2), methane, and water pollution[7].

Most cities today should struggle with environmental degradation, traffic congestion, inadequate urban infrastructure, as well as a lack of essential services such as water supply, sanitation, and waste management. A sustainable city must foster economic growth and meet the basic needs of its residents while creating sustainable living conditions for all. Preferably, a sustainable city creates a permanent lifestyle in four areas: ecology, economy, politics, and culture.

Cities occupy only 3 percent of the Earth's land but account for 60 to 80 percent of energy consumption and at least 70 percent of carbon emissions. For this reason, creating safe, resilient, and sustainable cities is one of the top priorities of sustainable development goals. At the same time, socially sustainable cities must be equitable, diverse, connected, democratic, and offer a good quality of life. The priorities of a sustainable city include the ability to nurture itself with a sustainable trust in the surrounding natural environment and the ability to empower itself with renewable energy sources while creating the smallest ecological footprint imaginable and the lowest amount of pollution that can be reached. All of this will be achieved through efficient use of land, such as composting, recycling, and converting used materials to energy. The idea is that these contributions will reduce the city's

impact on climate change[11].

Humans are social creatures and thrive in urban areas that develop social connections. The social impact of sustainable cities states that cities need more than a competitive business environment; They must develop a wonderful human climate that appeals to all kinds of individuals and families. Therefore, the transition to more intensive urban life will provide an outlet for social interaction and conditions in which people can thrive. Such urban areas will promote public transport, walkability, and cycling, which will benefit citizens' health and the environment.

2.1.1 World population and the city capacities

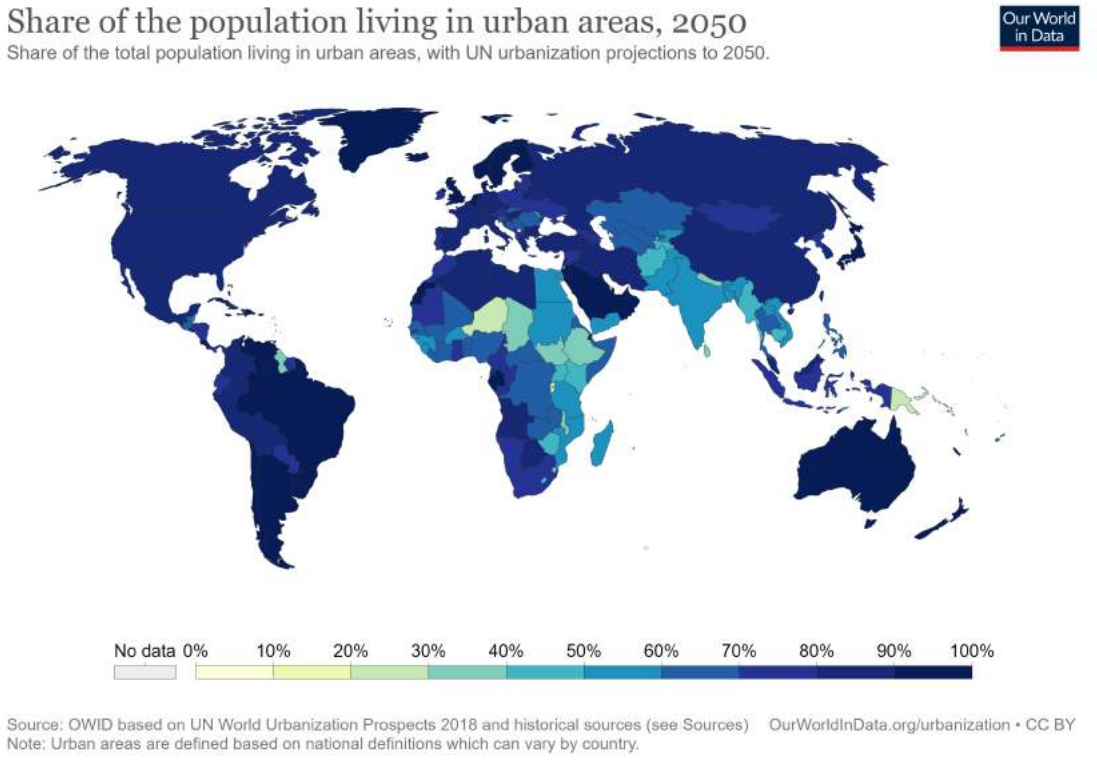


Figure 2.1: Share of the population living in urban areas, 2050 [10]

The world population in 2020 was 7,8 billion people and 55% of them were living in the city. Both the population of the world and the percentage of the urban inhabitants have been especially rapid during the past 50 years. Urbanization has shifted gradually in the residence of the human population from rural to urban areas. In addition, all the growth of the world's population could add another 2.5

billion people to urban areas by 2050, with approximately 90% of this increase taking place in Asia and Africa. People who live in the city went from 1.5 billion people in the first years of the 20th century to 6 billion. and probably there will be 9 billion people in 2050. Urbanization shifted, but the future cities' human population moved from rural to urban areas[11].

In the future, the world's urban population is expected to be concentrated in a few countries: India, China, and Nigeria. They will generate 35 percent of the growth of the world's urban population between 2018 and 2050. By 2050 India will have added 416 million urban dwellers, China 255 million, and Nigeria 189 million.

From 1950 to 2018, the world population has grown from 751 million to 4.2 billion. Asia is home to 54% of the world's urban population and Europe and Africa followed with 13% of it. Northern America (with 82% of its population in urban areas in 2018), Latin America and the Caribbean (81%), Europe (74%), and Oceania (68%) are the most urbanized regions and Asia has about 50% of urbanization. On the other hand, 43% of Africa's population live in urban areas while remaining mostly rural. The world's rural population has increased day by day since 1950 and is expected to reach its peak in a few years. The rural population is approximately 3.4 billion and is expected to rise for a little after that decrease to 3.1 billion by 2050. Africa and Asia are home to nearly 90% of the rural population of the world in 2018. India has an 893 million rural population that is the largest one in the world and followed by China with 578 million[11].

The largest city in the world is Tokyo with 37 million inhabitants, followed by New Delhi with 29 million, Shanghai with 26 million, and Mexico City and Sao Paulo with 22 million people. Cairo, Mumbai, Beijing, and Dhaka have around 20 million inhabitants. In addition, the population of Tokyo is predicted to decrease, while Delhi is predicted to grow up and become the most crowded city in the world around 2028. By 2030, the world is expected to have 43 mega-cities with more than 10 million inhabitants and mostly they will be in developing regions. In addition, some of the fastest-growing urban areas with less than 1 million inhabitants are mostly located in Asia and Africa[11].

Urbanization is predicted to be the fastest in low-income and lower-middle-income countries. These countries will face challenges in meeting the needs of their growing urban populations. Most of the city's capacities are not ready for their growing populations. Everything about a city like housing, transportation, energy systems, infrastructure, employment, education, and health care should be rethought and re-organize according to its new urban population. Strengthening the linkages between urban and rural areas will improve their existing economic, social, and

environmental ties.

Cities are already very well characterized from a territorial organization point of view but they are not ready for their growing population. The cities will approximately host 70% of the world population in 2050. So, these cities will need to be remodeled and re-thought again so that the cities of 2050 will be able to supply this situation. Now, we should project these cities, we cannot think of them only for this generation. There will be some small variations in the cities, but the future cities will be characterized by big changes in the features[11].

2.1.2 Transformation of the cities

The transformation of the cities in the last years is not spatial but is social, cultural, and economic. If we consider what is happening in the world, the transformations are not related to the territorial planning of the cities but it is about social actions. Some spaces of the city that lost usage or importance are not used in another way but to build another type of city. We should use these places for cultural actions. If one urban planner would think of these actions alone, they would not happen. More than one person should do brainstorming. These people should have different competencies: socialists, historians, experts of theatre and cinema, and psychologists. This group will discover new possibilities for the cities and will create multicultural and multi-ethnic[7].

The rapid increase in the proportion of the urban population is accompanied by growing concerns around the world such as affordable housing, social segregation, social mobility, inter-generational justice, social space, access to public goods, and traffic congestion. According to these facts, the transformation of the cities should be not only spatial but also social, cultural, and economic. The urban transformation should be built up at habitable standards, modern, safe, and energy efficiency-based buildings that are sensitive to the environment and increase the quality of life are constructed[7].

Quick industrialization, displacing agriculture as an economic activity of societies around the world, and brutal urbanization are the main issues of the last two centuries. They are not only the reason why there should be city transformation, but also the tools that can be used for the transformation. Urban centers are the dominant point of concentration for the world population and they also are a micro cosmos of global developments and challenges. National socioeconomic, demographic changes, and different cultures are reflected in the development of urban areas. From neighborhoods to cities with different scales of human settlement are becoming the foundations for social cohesion day by day. They should be

liveable, attractive, functional, and socially balanced[12].

But at the same time, socially stable cities, towns, and neighborhoods are increasingly being put at risk. Therefore, striving for socially and ecologically balanced urban development is extremely important for fast-developing countries such as Indonesia, as well as for industrialized countries. Promoting inter-generational justice, equal distribution, social mobility, social space, and family friendliness in urban neighborhoods are very significant to consider during urban transformation.

Urbanization is a complex process, and most urban transformation takes place at times when countries are low-income, without much of the institutional skills and funding required to synchronize urbanization with urban investment. However, these countries need to manage this mess and prioritize action to protect scarce corporate and financial capital and maximize return on investment to improve prosperity. The most important thing is that the national government should nurture institutions for well-functioning land markets and ensure the expansion of essential services such as water, sanitation, health, and education to improve living standards throughout the region. The good news is that these institutions can be developed early in development.

Facilitating economic concentration can enable us to benefit from economies of scale and specialization. While there is a desire to balance economic growth regionally across the country, international evidence clearly shows that economic concentration, reflecting the strengths of the market, helped economic growth in the early stages of development.

Investments in homes, offices, factories, and infrastructure will accelerate with increased incomes and rapid urbanization. People will come to cities and cities should serve them enough. In addition, there will be the risks of excessive commuting and natural disasters to get access to jobs. The key is to plan for urban expansion so that land use is coordinated between residential, commercial investment, and infrastructure, and pipes are laid before people arrive. Decisions on land use planning doing this early in development will generate dividends in productive, inclusive, and sustainable cities[12].

There is a complexity within the concept of urban transformation as planning history includes urban development, urban change, and urban conservation. Regardless of their content, issues of urban development and change in urbanization processes are ignored and underestimated under the general term urban transformation. The definition of the concept of urban transformation in planning theory changes in every period and the approach to urban transformation in planning practice differs

according to paradigm shifts in planning history. For this reason, to eliminate the change in conceptual definitions in planning theory and the difference in approach that emerged in planning practice, urban transformation in urbanization processes should be reconsidered in depth[13].

Paradigm changes in urban planning both persistently reform the content of theory and practice and reshape the context of the concept of urban transformation. Urban transformation can be reconsidered according to three main categories: heritage preservation, urban regeneration, and urban redevelopment. Heritage preservation in urban areas which have historical and cultural values in the human settlement is related to the protection of heritage based on historic preservation as well as urban restoration or renovation. Urban regeneration based on urban transformation is about reconstruction, redevelopment, restructuring. Urban areas which have economic and functional potential are investigated according to regeneration and they can have transformation. Redevelopment based on urban transformation is about degrading urban areas that require urban transformation based on re-development focused on urban regeneration and socioeconomic restructuring. It focuses on rejuvenation, rehabilitation, and adaptive reuse as methods of the process, as well as an urban renaissance. It develops plans, programs, and policy-based frameworks with public and private partnerships and practices related to urban space representing the spatial level of urban planning and design[13].

2.2 Circular Economy

Circularity contributes to a more sustainable world, but not all sustainability initiatives contribute to circularity. While circularity focuses on resource cycles, sustainability is more broadly about people, the planet, and the economy. Circularity and sustainability are based on a long tradition of relevant visions, models, and theories[7].

More waste brings more CO2 and waste of resources has grown day by day. All this is based on a circular economy. They came out from the linear economy and the pyramid that produces waste and CO2. The circular economy is based on the higher sensitivity of customers. A circular economy imagines products and energy flows. They are green flows. By 2050, the investment is expected to reach 7000 billion. These flows happen in buildings, renewable energy, services, mobility, food. We should work on these areas to make the economy circular[7].

The European Union generates more than 2.5 billion tons of waste every year. It is currently updating its legislation on waste management to encourage the transition

to a more sustainable model known as the circular economy.

In March 2020, the European Commission presented its new circular economy action plan, which includes proposals for more sustainable product design, reducing waste, and empowering consumers under the European Green Deal and in line with a proposed new industrial strategy. Particular focus is placed on resource-intensive sectors such as electronics and ICT, plastics, textiles, and construction. In February 2021, Parliament passed stricter recycling rules and material use and consumption by 2030 to achieve a carbon-free, environmentally sustainable, non-toxic, and fully circular economy by 2050[14].

The circular economy is a production and consumption model that involves sharing, renting, reusing, repairing, renovating, and recycling existing materials and products for as long as possible. This extends the life cycle of the products. In practice, it means minimizing waste. When a product reaches the end of its life, its materials are kept in the economy wherever possible. They can be used productively over and over, thus creating more value. This is a departure from the traditional, linear economic model based on the buy-build-consume-dispose model. This model relies on large amounts of cheap, easily accessible materials and energy. Also, part of this model has planned obsolescence, in which a product is designed to have a limited lifespan to entice consumers to buy again. The European Parliament called for action to be taken against this practice[14].

The world population is increasing, and with it, the demand for raw materials is also increasing. However, the supply of important raw materials is limited. Limited supply also means that some EU countries are dependent on other countries for their raw materials. In addition, the extraction and use of raw materials have a huge impact on the environment. It also increases energy consumption and CO2 emissions. However, smarter use of raw materials can reduce CO2 emissions.

Measures such as waste prevention, eco-design, and reuse can save all the companies money while also reducing their overall annual greenhouse gas emissions. The production of materials we use every day now accounts for 45% of CO2 emissions. Moving towards a more circular economy can bring benefits such as reducing pressure on the environment, increasing raw material supply security, increasing competitiveness, stimulating innovation, increasing economic growth (additional 0.5% of gross domestic product), creating jobs. 700,000 jobs in the EU alone by 2030)[14].

2.2.1 The key elements of the circular economy

In the current alarming growth rate of world consumption, the linear economy model of creating, using, and then disposing of products without considering environmental, social, and economic impacts and consequences is a flawed production approach and it is unsustainable. Therefore, to envision a future where nothing is wasted; a future where every "waste" becomes an asset and no value is taken back; A future where all products are recovered and reused, re-manufactured, or recycled for multiple generations at the end of their primary use is more than a reality, but it has become a necessity. This emerging concept of the circular economy, although attracting attention, lacks a technological perspective for effective implementation. The principles of sustainable production serve as the foundation and the technological elements to enable the creation of a circular economy. Important to achieve economic growth, environmental protection, and societal benefits. Additionally, there are some relevant disciplines about circular economy and they align circularity with the United Nations' Sustainable Development Goals (SDGs). [15]

The regenerative design was developed in the 1970s by American professor John T. Lyle, the idea behind the restorative design is that processes in all systems can reuse their energy and materials. The demand from society is also met within the limits of nature. Performance Economics developed by Walter Stahel a vision of a closed economy, including the principles of extended life, product repair, and waste prevention. Selling a service rather than a product is an important part of his thinking: everyone pays for the performance of a product. This leads to the concept of a performance economy[15].

In the cradle-to-cradle model developed by Michael Braungart, materials in industrial and commercial processes are considered raw materials for technological and biological reuse. The design literally varies from cradle to cradle - the entire life cycle of the product and the raw materials used are considered in the design process. Technical raw materials do not contain any components harmful to the environment; biological raw materials are fully biodegradable. Industrial ecology is the science of material and energy flows in which wastes in industrial cycles serve as raw materials for a further process. Production processes are designed to resemble ecological processes.

Biomimicry is an approach developed by Janine Benyus, where inspiration comes from nature. Biomimicry imitates designs from nature and applies them to solutions in human society. The Green Economy, as defined by the United Nations Environment Platform (UNEP), is an economy that results in increased prosperity and increased social equity while greatly reducing environmental risks and ecological

scarcity[15].

Developed by Günter Pauli, Blue Economy is an economic philosophy that takes its knowledge from the way natural systems create, produce and consume. This knowledge is applied to the challenges we face and translated into solutions for local environments with specific physical and ecological characteristics.

A bio-based economy runs on biomass as raw material, not fossil fuels. In a bio-based economy, it is about using biomass for non-food applications. Developed by Kate Raworth of Oxford economics, the donut economy is a model for measuring the world's well-being based on the Sustainable Development Goals and planetary boundaries. Most planetary boundaries are directly related to "unlocked" cycles such as greenhouse gases, toxic substances, eutrophication, freshwater, aerosols, and oxygen radicals[15].

2.2.2 Product life cycle

The product life cycle is the time from when a product is introduced to the market until it is removed from the shelves. The life cycle of a product is divided into four phases; introduction, growth, maturity, and decline. This concept is used by management and marketing professionals as a factor in deciding when it is appropriate to increase advertising, lower prices, expand into new markets, or redesign packaging. The process of creating a strategy to continuously support and maintain a product is called product life cycle management. The product life cycle concept helps make business decisions, from pricing and promotion to expansion or cost reduction. Newer, more successful products push older products out of the market[7].

Like people, products have life cycles. A product starts with an idea and is unlikely to go further within the confines of the modern business world until it has gone through research and development (R D) and is found to be viable and potentially profitable. At this point, the product is produced, marketed, and put on the market. There are four generally accepted stages in a product's life cycle: introduction, growth, maturity, and decline. The introductory phase usually includes a significant investment in advertising and a marketing campaign focused on making consumers aware of the product and its benefits. Conversely, if the product is successful, it moves into the growth phase. This is characterized by increased demand, an increase in production, and an expansion in its availability. After that, the production and marketing costs decrease, while maturity is the most profitable stage. Finally, a product takes on the increased competition while other companies imitate its success, sometimes with improvements or lower prices.

The product may lose market share and go into a decline phase[16].

When a product is successfully introduced to the market, demand increases, hence its popularity. These newer products are effectively replacing the old ones, pushing them out of the market. Companies tend to curb their marketing efforts as a new product grows. This is because the cost of producing and marketing the product is reduced. When the demand for the product decreases, it can be withdrawn from the market completely. A new product needs to be explained, while a mature product needs to be differentiated.

The stage of a product's life cycle affects the way it is marketed to consumers. When a new product needs to be announced, mature special considerations companies that master all four stages can increase profitability and maximize returns. Those that fail may experience an increase in marketing and manufacturing costs, resulting in limited shelf life for their products. In 1965, Theodore Levitt, a marketing professor, wrote in the Harvard Business Review that the biggest loser is innovation because so many truly new products fail at the initial stage of their life cycle, namely the introduction stage. Failure only comes after a significant amount of money and time has been invested in research, development, and production. And that fact, he wrote, prevents many companies from even trying anything new. Instead, he said, they waited for someone else to succeed and then cloned the success[17].

2.2.3 The directors of the transformation; natural, territorial, and social capitals

Human well-being and well-being depend on the integrity of natural systems, and it is vital to understand how our actions affect this source of natural capital. Natural capital supports other capitals considered essential for economic and social well-being, namely man-made, human, social, and cultural capital. While all forms of capital are needed to support human well-being, natural capital is arguably the most important as it supports and supports other forms of capital. For example, minerals, metals, and energy are required to form the components of the capital produced.

Human and social capitals are highly dependent on the physical health of individuals who depend on ecosystem services to maintain health. These services regulate ecosystem services from food, freshwater, timber, and fibers, for example; benefits from open lands and city parks that promote water purification, nutrient cycling, flood reduction, and recreation and well-being. Knowledge of how natural capital is used, depleted, or degraded is therefore essential to manage it sustainability.

Accounting is an effective way of organizing environmental information in a structured way and is also the main tool used to report on the wealth of nations. Therefore, the improvement of natural capital accounting is an important goal in building the knowledge base for better management of our natural environment.

Accounting systems are designed to bridge the gap between detailed environmental data and the information the public and decision-makers need to ensure long-term sustainability. They provide a structured framework for linking economic activities to their environmental impacts and bringing together different measures of natural capital across environmental issues and spatial scales.

The purpose of accounting may be limited to analyzing biophysical trends in a structured way, but many accounting approaches aim to support the valuation of natural capital such as ecosystem accounts that provide a form of valuation. state of the environment.

Evaluation of ecosystem conditions provides information about the ecosystem's capacity to continually provide services for human well-being. This information is necessary to document the ongoing loss and degradation of ecosystems and their services, the ensuing socio-economic impacts, and the identification of pathways to sustainable development to sustain the delivery of services.

As such, ecosystem assessments provide input for decision-making by addressing and integrating key information into sectoral policies, i.e. mainly regional planning, nature conservation, agriculture, forestry, freshwater, marine, climate change mitigation and adaptation, and air pollution reduction. Such information highlights major pressures on ecosystems and outlines expected results. It aims to describe the functional relationships between ecosystem conditions, the quality of their habitats, and their biodiversity. The approach can also be used in other environmental sectors such as water, agriculture, or forest management[18].

Enhancing the natural capital knowledge is significant to have awareness about transformations. There are three basic concepts and the first of them is the importance of the ecosystem approach. In order to develop knowledge of natural capital, we need to deeply understand and recognize biodiversity from an ecosystem perspective, in terms of the structure and condition of biological and physical components, functions, and spatial arrangement. Moreover, it is about data availability issues. Starting from ecosystem knowledge, we can translate components into stocks of natural capital, functions into the provision of ecosystem services, and spatial arrangement into expected flows of ecosystem services. However, we need to overcome the constraints of data usability. Lastly, the power of ecosystem mapping.

Ecosystem mapping allows assessment and monitoring of ecosystem coverage and distribution, recognition of their territorial context, and analysis of ecosystem services within appropriate ecological land units. (SEEA - Environmental-Economic Accounting System, 2013; UNEP 2014, a global map of natural capital: key ecosystem assets; EU Biodiversity Strategy 2020, MAES Working Group)[18].

Nature and territory will be the directors of the next transformations because cities will be transformed and the main element will be not economy but natural capital and territorial capital. In the last few years when evaluation societies produce reports, they also consider social capital. Recently these elements have been considered relevant. Today the main elements of transformation are the green economy and transformation. This element of territorial capital and natural capital is becoming more and more important. This element is dynamic because it is related to the transformations of the cities and the transitions to circular cities[7].

2.3 Circular Cities

A circular city supports the transition from a linear to a circular economy in an integrated way with all its functions in collaboration with citizens, businesses, and the research community. In practice, this means promoting business models and economic behavior that separates resource use from economic activity by preserving the value and utility of products, ingredients, materials, and nutrients for as long as possible to close material cycles and minimize harmful resource use and waste generation. Through this transition, cities aim to improve human well-being, reduce emissions, conserve and enhance biodiversity, and promote social justice in line with sustainable development goals[19]. [20]

Cities are the biggest consumers of energy and materials, but they also offer the opportunity to manage resources better and more efficiently. They are the cradle of innovation and socioeconomic transformation with enormous potential to lead the transition to a circular economy. Local and regional governments manage a number of key sectors such as mobility and waste management in urban areas and are ultimately responsible for controlling land use and urban planning. Public procurement and investment budgets can also play an important role in increasing demand for cyclical products and services[19].

2.3.1 Process of "sustainable development –> sustainable community to circular development -> the circular city"

When we think of sustainable cities, we should consider a process that started 50 years ago. In fact, in the '70s they started to think about this. In the beginning, the approach to sustainable development was based on this concept: we have a consumption of resources so that future generations can have enough resources. Then we passed from this concept of passing from one generation to another one to another concept: thinking about a sustainable community, where man is the element that forms the community. So, we passed from sustainable development to sustainable community and this passage was not easy. A circular city is the natural consequence of this passage. Now we should understand on what we base the circular city. It is not the circular economy that creates the circular city, this is important. The circular city has more characteristics that cannot be related only to the circular economy [7].

Circular development is a new normative model for urban development designed by the author and reported elsewhere, focusing on processes that create infrastructure and urban activities that support circular urban systems. These systems are natural, social, and artificial and support biospheric, and socioeconomic cycles. Circular development allows cities to adapt to shocks and long-term changes in the wider landscape with minimal ecological impact. It aims to reduce urban resource consumption (materials, land, water, infrastructure, and energy), waste, and greenhouse gas emissions (GHGs), while renewing the urban ecosystem and building urban resilience. Circular development ensures the healthy renewal of cities. It can also help achieve many of the sustainable development goals[8].

Circular development produces adaptable cities that evolve with changing needs, offering space and infrastructure such as scalable, portable, flexible to transform and grow. It also introduces processes that support learning within communities and promote self-organization like collaborative planning, procurement, tactical urbanism. Urban experiments provide an opportunity to test new circular supply systems and enable communities to quickly adapt to changing contexts. This adaptability enables infrastructure and communities to transform to meet the new demands placed on them, thereby increasing urban resilience[8].

Circular development also preserves and enhances urban ecosystem services that strengthen natural cycles and improve the health of those living in cities. Ecologically regenerative actions often include the incorporation of green and blue infrastructure into the urban fabric, the management of urban ecosystems such

as water management, conservation, farming, forestry, and biological remediation processes.

The process of implementing circular development in our cities can be costly and deathful. It will require a wholesale change in the way we plan, design, and manage our cities. It will require changes in social practices, lifestyles, and supply systems. To be successful, this transformation will require support from politicians, service providers, and the public. The benefits of taking this approach to gaining support need to be clear. Examples of circular urban development have already shown up in European cities. The introduction of the new Green Deal in Europe is encouraging more cities to join them. Therefore, there is an expanding evidence base that we can analyze to determine the benefits of adopting the approach. Doing so is also a must as funding is available to support this transformation[8].

2.3.2 The relation between circular economy and circular cities

The circular economy offers a perspective to reduce the costs resulting from the conversion of agglomeration economies to agglomeration economies and to make the principles of sustainable development work. The current economy can be considered largely linear as raw materials are taken from nature and used to produce goods that are then consumed and eventually disposed of. In a world characterized by limited resources, this model is useless in the long run and there is evidence that it has reached its limits. We need to move towards a more virtuous economic model, and we are only at the beginning of that journey now[21].

The circular economy model, which is based on the principle that nothing in nature is wasted and everything can be a resource, has been proposed to make sustainable development principles work. The circular economy can be defined as "the restructuring of industrial systems to support ecosystems through recycling and the adoption of methods to maximize efficient use of resources by minimizing emissions and waste". Expresses how resource flows can be closed[21].

To date, there are 114 definitions of the circular economy in the literature. It is a general model of development that creates new economic wealth and impacts natural and social contexts. This encourages an indefinite extension of the lifespan and use values of resources and encourages cooperative circuits between different actors. In 2016, the United Nations Environment Program (UNEP) recognized the role of the circular economy in achieving sustainable development. The circular economy represents a concrete set of solutions to achieve sustainable patterns of production and consumption. It affects the economy, jobs, and environmental

system.

The European Commission has adopted a package to support the European Union's (EU) transition to a circular economy, including legislative proposals aimed at promoting Europe's path to a circular economy. The aim of this package is to increase economic growth, making it more sustainable and competitive in the long run. It sees the circular economy as a way to contribute to innovation, growth, and job creation[21].

According to the definition of the Ellen MacArthur Foundation, the circular economy that provides multiple value creation mechanisms is based on three principles: conservation and enhancement of natural capital; optimization of resources by circulating products, components, and materials; promoting system efficiency by uncovering and designing negative externalities. The Ellen MacArthur Foundation also defines six business actions to support the three principles mentioned above: regenerate, share, optimize, loop, virtualize, exchange.

On the whole interpretation, the circular economy is basically referred to as waste cycle management. However, in order to increase urban efficiency, this approach must be overcome and transferred from a sectoral approach (waste management) to the comprehensive city organization, economy, social system, and management. It can be considered as a general development model that can transform the linear urban metabolism into a new urban circular metabolism where the input and output flows are closed. The circular economy produces sustainable growth, health, and decent work while protecting the environment and natural resources.

Most circular city definitions focus their concentration on material and energy flows. Strategic actions are mainly connected to the production of goods and services such as product design, eco-design and the use of eco-friendly materials, eco-friendly production processes, and etc, extending the use-value of resources like reuse, repair and waste management. Neglecting intangible resources, are called tangible resources. Specifically, they are referred to as a built environment designed in a modular and flexible way; renewable energy systems and efficient use of energy; an accessible, economical, clean, and efficient urban mobility system; recycling and recycling of waste to a source; production systems that encourage closure of local loops and minimization of waste[21].

Looping actions in circular cities are connected to different themes and different challenges such as socio-cultural, economic and financial, information, regulatory, political, institutional, technical, design, and environmental. The implementation of the circular city is not only about technical questions, but also about systemic

change in society and restructuring our economy and governance systems[8].

2.3.3 Closing different cycles for the city

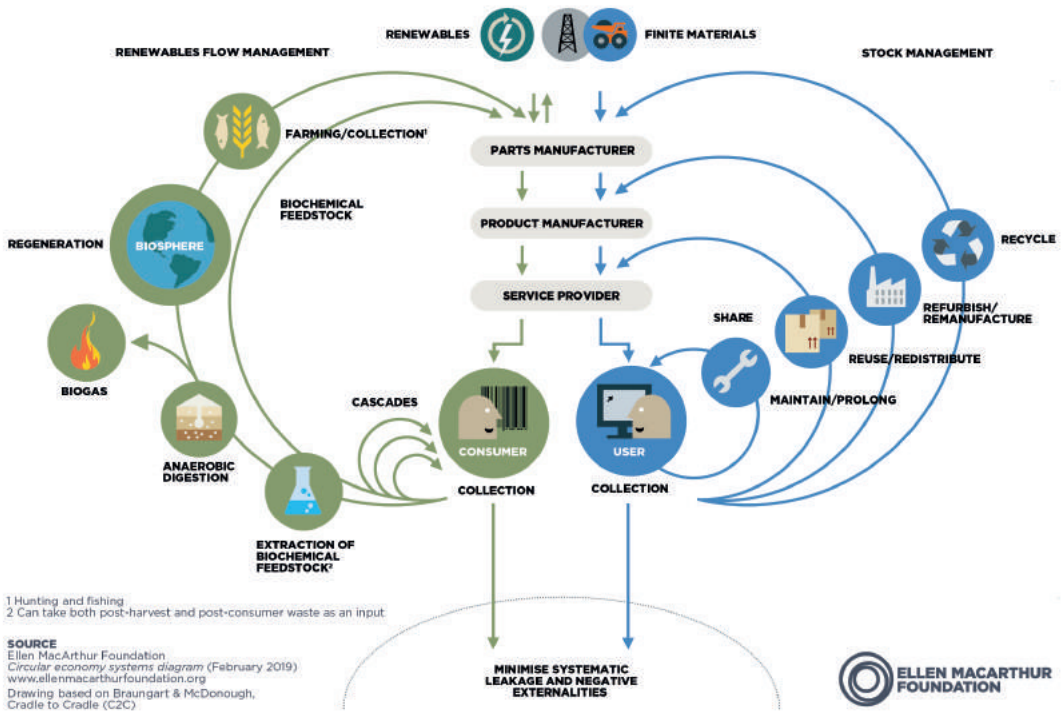


Figure 2.2: Circular economy systems diagram (February 2019) [22]

Not only is the small territory that we live in considered, but also we should think about all the planet's development. There are different cycles: water, air, energy, materials, and etc. Closing the air cycle means producing less CO2 or creating green areas that can compensate for the production of CO2, produced by agriculture or infrastructures. Recently the problem of the quality of the air has become more relevant and people are starting to develop awareness about this. Furthermore, the cycle of energy is important. We should think of one city that does not produce waste, but in reality, we produce a big amount of waste, and this waste contains energy. If we consider the rubbish in the rubbish dump, it contains a lot of energy and if we wanted to save this energy, we had to reuse it n times before putting it in the dump[7].

About the water, we should also consider its management and the fact that the distribution structures related to water are old and not in good condition.

There should be some actions to reduce water consumption. This is the best way to keep water for future generations. The water cycle is natural. But if they are interrupted (for example about the rivers), we cannot consider that water useful for men because of its pollution and we are not able anymore to carefully control the cumulative effect of water consumption[7].

The combined effects of urbanization, industrialization and population growth drastically alter landscapes and hence their continuous circulation in catchments and the hydrological cycle. The hydrological cycle encompasses various processes in the landscape (e.g., transport of pollutants, water chemistry, the pattern of nutrient flows, erosion, surface, and groundwater levels) and thus some characteristics of the ecosystem (e.g. productivity rate, weathering) and processes (e.g. rate and pathways of matter circulation).). The functioning of ecological processes in the entire basin depends on the water cycle, which is reflected in the quality of aquatic habitats and the ecological stability of their ecosystems[23].

Urban development is significantly changing the hydrological cycle and major changes in the physical pathways of water cycles due to urbanization include removal of natural plant drainage patterns; loss of natural depressions that temporarily store surface water; loss of the soil's ability to absorb precipitation; creation of impermeable areas (e.g. roofs, roads, parking lots, sidewalks, driveways); provision of man-made drainage systems (eg storm drains, canals, retention ponds).

Thus, although the hydrological cycle consists of the same elements, their proportions in urban areas are significantly different: reduced rainfall interruption due to uprooting of trees; precipitation is generally higher than in rural areas; evapotranspiration is much lower; runoff is much greater; less groundwater flow, seepage, and recharge; water storage is much lower; flow volumes and peak flow in rivers are higher and frequency of runoff increases[23].

Urban development significantly increases the amount of rainwater experienced in the city's water catchments and the frequency of extreme hydrological events. The increased runoff causes more intense local flooding, while droughts are deeper and longer in dry weather.

Closing cycles means not wasting. We should project cities that do not waste. First, we should not waste the land: all the urban projects should be considered an eco-dynamic and resilient city such as leaving some free soil or some specific green areas. Eco-systemic service is the ability to study the quality of green areas. In a while, the project will not have enough big areas to produce green areas, but if green areas will be created with high quality and intensive in the project, it can

be the solution. We will project every detail and action related to environmental engineering that can help us to improve the quality of the green areas[7].

2.3.4 Urban subsystems: buildings and design, mobility and connections and products

The city can be conceived as a dynamic and complex system that changes in space and time following hard-to-predict evolutions. These features of complexity and dynamic evolution represent the main critical factors for urban planning that are often involved in the preparation of closed and static forecasts of future urban layouts. Therefore, it is necessary to create new urban planning theories that take into account the systemic vision. [24]

As highlighted in some important contributions, the systemic approach allows the city to be taken in a dynamically complex system, and complexity is the strategic factor that can drive system evolution. One of the features of the system is that it permits component subsystems to think about a subdivision. Among the subsystems, we can separate some that can be considered the most important that characterize the system, mentioning certain features: economic system, transportation system, etc.

Specifically, we can identify five major urban subsystems. 1) The physical subsystem consists of cavities and channels connecting cavities; 2) the functional subsystem consists of urban activities carried out to spaces or through channels; 3) the psycho-perceptual system is made with the image of the city that each citizen prepares for himself; 4) the geomorphological system consists of environmental elements and regional areas such as continents, nations, hydrographic basins, macroregions, municipal areas, etc.; 5) the anthropic/human system is represented by the "biocenosis" component of the city, which is the community that gives meaning to the space. The components of this system are substitutes for clusters of people moving through urban space: actors and relationships; interactions between groups and/or individuals working for the development of the city [24].

There are the main milestones of this city: buildings and design, mobility and connections, and products. Buildings are objects that represent the functions of the city. You should plan how to divide the available space between different types of buildings (hospital, residential areas, etc. . .). Design should find solutions for sustainable buildings. Sustainable mobility is related to the connections to the networks. The city is one network of mobility. And we should have structures that allow sustainable mobility. Our cities are designed for cars. We always thought of our cities thinking that we should move with private cars. We should reduce

the roads and we are not able to have overlapped roads and we have to think of connections with integrated mobility and this will be an important challenge. The problem of mobility will be important also to have cities without pollution. We should renovate the parts related to cars and public transport, for example introducing electric cars. But we should also imagine that the energy produced for their mobility can create pollution[7].

Nowadays it can be specified in the bills the quantity of clean energy that is produced. In residential buildings, it is mandatory to have photo-voltaic panels to have energy. There are also solar panels, wind power systems, and geothermal systems to produce clean energy. We are not even at 50% of the energy request in terms of clean energy. There is something more to do. Coming back to mobility we should imagine cities for men, not for cars if we want to improve the quality of air. Then we have the products for the city, that are several. We should create sustainable products from the point of view of the production, not only as products during their usage. Urban regeneration, sustainable cities, circular economy, energy, and technological innovation are actions for a circular city. In your job, you should make sure that these 3 elements will find a place in the circular city that you design[7].

2.3.5 Increased awareness, new ownership concept-sharing economy, new business opportunities

A circular economy gives more awareness, concepts of ownership and these will produce new business opportunities. Seen this way, the sharing economy completely changes the context of how we own things. We are only just beginning to see the full impact of this change. I believe that in the coming years, products and services specifically created will emerge to help consumers evaluate their purchases based on their monetization potential[7].

The sharing economy is controversially one of the biggest changes that digital innovation has unleashed in the last 10 years. It transformed industries, changed the way we live and work, and spawned companies that skyrocketed to incredible wealth in a surprisingly short span of time. But the truth is, the changes go even deeper than that. The sharing economy isn't just about disrupting industries or creating new business arrangements. The technology driving the sharing economy is actually fueling a change in something much more fundamental: the concept of ownership[25].

To take an example, Airbnb is another classic example of how sharing economy technology has opened up a new channel to monetize any asset. Even home buyers

or apartment tenants can now turn an empty bedroom into a source of income, making any property potential investment property.

Another example is Uber. To understand the nature of this change, let's take a look at the billions of poster children of the sharing economy revolution. It transformed transportation in city centers by drastically reducing the need to own a car. The platform empowers any vehicle owner to provide transportation services for other users, effectively enabling a single vehicle to meet the transportation needs of many people. Therefore, the share users tag is not actually a share, but a single car is shared to meet the needs of a large number of people. In the past, they were required to own a car or use public transport. Now they can borrow a stranger's car[25].

The sharing economy has already disrupted major industries globally, but what we've seen so far is just the beginning. The real impact of the technology enabling the sharing economy goes beyond just sharing cars, homes or electrical appliances: It's a fundamental transformation of what it means to own something.

We are already seeing the emergence of new products and services designed to take advantage of this change, but as the market matures and consumers develop a deeper understanding, we can expect more. Whether it's a car, an apartment, or even an idea, the sharing economy can turn anything into money, and there are opportunities for entrepreneurs who can develop creative, effective solutions to help make this monetization easier[25].

2.3.6 Multi-disciplinarity and collaboration

Planners, architects, and urban planners must be committed to rethinking not alone the operation of naturally resilient urban systems in the long term to ensure a better and lasting quality of life for current and future generations. Multi-discipline and different groups of work are relevant and make us share the knowledge that will generate new knowledge. In this way, we will design circular cities as the last element of the process that brings us to sustainable development[7].

Multi-disciplinarity means dealing with a particular problem or observable phenomenon from different disciplinary perspectives. This involves confronting different scientific approaches such as concepts, models, methods, findings in the hope that eventually the multidisciplinary research team will together manage to produce a coherent picture of the problem concerned, possible explanations of it, and potential and solutions. A multidisciplinary team's greatest hope is that they can create a common, comprehensive definition of the problem, a descriptive view of the

mechanisms and processes involved, and a manageable set of problem solutions. However, to the extent that the team is successful, they will find themselves in an interdisciplinary effort where relevant parts of different scientific disciplines are brought together and properly integrated. Thus, for example, a natural science model of the spread of air pollution can be combined with a behavioral model using motorized transport; or an economic model of consumer utility maximization can be combined with a psychological model of habit formation and social status-seeking. This will broaden the scientific basis for effective policy-making[26].

Sustainability is a multidimensional concept that includes economic security, social welfare, and environmental quality. Key items on both research and policy agendas related to sustainability are the resource intensity of human production and consumption patterns, the assessment and management of natural resource stocks and flows, and societal transitions in various fields of human activity. Examples are energy supply and demand, agriculture and livestock production, availability and consumption of drinking water, mobility and transport, recreation, and tourism. Environmental impacts associated with these areas of activity are urban air pollution, greenhouse gas emissions, environmental noise, soil drying, and natural degradation. These burdens contribute to a reduction in environmental quality and may include threats to human health and well-being[26].

Collaboration between the natural, social and environmental sciences is essential to understand the complex nature of the problems, to experience how different contributions from different disciplines can be made, and to provide policymakers with a more complete understanding and a corresponding set of solutions. technical and behavioral, individual, and organizational tools to address and prevent policy issues in real-life practice.

On the other hand, it is often difficult to implement multi-discipline. Researchers from different backgrounds need to find and meet each other. They must learn to understand and appreciate each other's perspectives. They need to derive a common motivation from the idea that the whole can be more than the sum of its parts. What should bind them together is to focus on a single problem area, such as energy use, environmental noise, or external security. But this draws them into a fair amount of practical problem-analytic homework before both they and their collective can make their scientific contribution and reap the extra benefits of collaboration that crosses disciplinary boundaries. The next section presents a number of practical experiences[26].

The difference between mono-parametric and multi-parametric evaluations

Mono-parametric valuations such as cost-benefit analysis are set solely on the market price and are unlikely to be able to adequately assess natural capital and its role in the economic, productive, social and environmental system. Evaluations are based on the market price. They will not be able to evaluate these transformations. Because they cannot consider territorial and natural capitals adequately, they speak only the language of the market. Now economists are starting to speak the environmental language. Through dynamics, we can catch transformations and we can define indicators related to the new city[7].

2.4 Actions for the circular cities

2.4.1 Regenerative urban systems and urban mining

A regenerative urban system is based on the elimination of the concept of waste, refusal, waste to keep goods at their highest value. In this way, we imagine operating in regenerative urban systems. We should delete the concept of waste. We think we are rich and we waste, but we do it also when we are poor. We should sensibilize people about this. How many people are sensitive to keeping the territory safe? We should be able to communicate. The city should communicate about this problem[7].

The linear economy produces waste. We should communicate to young people that one material reaches the top of the pyramid on the left and then we throw it and go into the dump. But in the future, we should use products and services until their maximum value, and then we should not make them fall from the pyramid but should reuse them to give to it again the maximum value. Circular economy means to make the material go again onto the top after being reused because it is a new material, with less energy but the amount of energy that has been lost is not necessary anymore. Circular cities should not waste and we should think of a reuse system. This is difficult and still not achieved[7].

The analysis of the matter flows allows the circular city to become an urban mine. Urban mines are places that have lost their original function, becoming areas that allow resources to be extracted. Today we should imagine one urban mining. This is not far from reality. Places that originally had one function, like some industrial areas, can have a new function. Automatic factories reduce spaces of industrial areas. Both the number of employers and the surface have been reduced. In these areas, we can find a lot of resources that can have a useful life. There are also some areas where useful goods are not exploited. There is one company that

takes abandoned materials, checks their condition and regenerates them, and sells them as second-hand products. They are doing a selection of the waste of society because this waste can be reused. So, cities are open-air mining. Green economy and circular economy make us understand the relation between space and resource flux. You should think of space as a flux of resources. This changes the concept of the city. Cities are fluxes of energy, cars, infrastructures, open-air, underground, and so on. Think of your city as positive fluxes or interrupted fluxes. A lot of people are working on this concept[7].

Electronic products can be viewed as resources that already exist in the global economy. It has been revealed that their importance for the economy has increased exponentially, especially in developing economies. Today, a lot of international electronic waste reaches India illegally and is recycled through an unorganized sector in the country's major cities. Recycling e-waste has tremendous value and the whole process works like a mini economy. However, there is a clear dilemma between the efficient economic model and the severely damaging effect of the unorganized recycling of e-waste on workers' health and the environment[27].

The realities on a global scale are that the stock of metals in use in cities and society is increasing every year. More people need more homes, more transportation, and more electrical devices such as cell phones, computers, kitchen appliances, and other consumer goods. Most end-of-life products contain higher concentrations of metals and minerals than primary sources. Resource stocks in this use are the urban mines of the future. Denmark- based company Averhoff and Belgium-based company Umicore are among the world's leading precious metals recyclers. The recycling market is growing rapidly and an efficient urban mining policy can save billions of Euros each year by maximizing returns from waste. Recycling rates are less than 1 % for 34 special metals mostly found in electronics and recycle metals are 2-10 times more energy-efficient than smelting metals from pure ores[27].

2.4.2 The relation between the space and resource flows

A circular city is possible by shifting the focus of the project to the product life cycle. We should pay attention to the life cycle of the product. We have the life cycle assessment, which tells us the life cycle of that material, that can go to the dump, or it can enter a new product cycle. The design of buildings should consider and study the life cycle of materials. This will allow us to use the materials with the longest life cycle. İf we did a building in metal and glass. It would be perfectly recyclable.

Nowadays, there are also new techniques for cement to recycle. But in the past,

we took the material, we put it into the waste dump. We did not differentiate the demolition. In the future, we should demolish materials by differentiating them. We should go towards one situation where we study the life cycle of one product. We should think of products that should be recycled. Materials should not go to the dump, but they should occur in another production.

Urban politics are based on design and project. In reality, planning is extremely dependent on political decisions. Do urban politics define planning or the opposite? Generally, I think the design enables urban politics. It can be useful to think of a city with rules for a sustainable city. We still do not have these rules. Also about design. Design is the ability to activate processes. We are interested in the reuse and recycling of waste. We think of products that are recycled to obtain sustainability. We should face biology and technology. They should speak to each other and produce new circularity that will be the main element of some objects of the future. It should be transferred to the design schools. In the sustainability of the products, we should find some circularity. We should discuss what a circular economy is. The project becomes an enabling element for urban policies. The product design allows the activation of reuse and waste recycling processes[7].

Traditional thinking about the relationships between cities, infrastructures, and resource flows is primarily concerned with the impact of infrastructures on places, the provision of networked services for places, network failures related to places, shortages or uncertainties in resource provisioning, etc. takes over. Often, plans, images, maps, and diagrams representing the relationships between cities and different networks do this, in part out of necessity, in ways that simplify and reduce it to a fixed absolute space[28].

Yet these ways of thinking about such relations say little about why they are organized as they are and how the representation of absolute space is produced relationally and relatively. The politics, struggle, social interests, and negotiation processes that support not only such representations but also the realities they try to represent are lost or hidden. The point here is that the relationship between cities, infrastructure and the organization of resources produced, consumed, and flowing through cities is not smooth and deeply political. Managing these politics involves understanding the interactions and negotiation of a range of institutional and social interests and the formation and ability to act of such governance coalitions. Such interactions are informed and informed by the relationships between cities, infrastructures, and resource flows. The politics of these interactions are mediated by the struggle between keeping things as they are, finding out why they are the way they are, and thinking about how they can be redesigned on another level[28].

The organization of cities, infrastructures, and resource flows and the relationships between them are complex, deeply political, and rooted in ideological struggle. Since the 1980s, neo-liberal competition, innovation, liberalization, etc. in the West. Market-driven economic activity and growth remain a key mediator of relationships between places and infrastructure, but increasingly serious in regulating these relationships is the strategic direction of national state actors, both in predicting the effects of climate change and also in regulating and disciplining spaces. It also contributes to a broader array of pressures and debates about oil, gas, and water geopolitics, as well as waste management questions, which have both geopolitical and more regional implications, resource management, and, in particular, ways to restructure and restructure systems. Relationships between systems and places can effectively handle resource constraints[28].

2.4.3 Environmental systems and circular cities

Dynamic modeling of environmental systems is a start in using models to understand environmental problems. Environmental problems with their many natural, economic, political, and technical aspects require a systems approach. Sections on modeling terminology, use of models, the model creation process, and interpretation of output provide the basis for detailed applications. It is vital to analyze various environmental issues, including surface water pollution, matter cycle disruptions, and global warming.

Our environment is facing several problems, and many of them seem to deteriorate over time, putting us in a period of true environmental crisis. It is therefore increasingly important to raise awareness of the existence of these problems and what can be done to reduce their negative impact. Some of the main problems are:
1) Pollution: Air, water and soil pollution is caused by toxins and toxins such as plastics, heavy metals, and nitrates, caused by factors such as toxins and gases released from factories, burning of fossil fuels, acid rain, oil spills, industrial wastes.
2) Global warming: Emissions of greenhouse gases from human activities cause global warming, which in turn causes a rise in temperature leading to rising sea levels, melting of polar ice caps, flash floods, and desertification.
3) Overpopulation: We face a shortage of resources such as food, water, and fuel to sustain the growing global population especially in developing countries. Intensive agriculture trying to reduce the problem is actually causing more damage through the use of chemical fertilizers, pesticides, and pesticides.
4) Waste disposal: An excessive amount of waste is produced and dumped into the oceans. Nuclear waste is particularly dangerous alongside plastic and electronic waste.

5) Ocean acidification: The increased production of carbon dioxide by humans causes the acidity of the oceans to rise, which adversely affects marine life.
6) Biodiversity loss: Species and habitats are disappearing due to human activities. This causes an imbalance in natural processes such as pollination and poses a threat to ecosystems – the destruction of coral reefs is particularly affected.
7) Deforestation: To make room for residential, industrial, or commercial projects, the loss of trees means less oxygen is produced, and temperature and precipitation are affected.
8) Depletion of the ozone layer: Pollution caused by chlorofluorocarbons (CFCs) in the air creates a hole in the ozone layer that protects the earth from harmful UV radiation.
9) Acid rain: Pollutants in the atmosphere, such as sulfur dioxide and nitrogen oxides, cause acid rain, which has negative consequences for humans, wildlife, and aquatic life.
10) Public health issues: Lack of clean water is one of the leading environmental problems today. Airborne pollutants also cause problems such as respiratory disease and cardiovascular disease[29].

The ecological system as a dynamic system will be the real driving force towards the circular city. Then we should be able to discuss dynamical ecology. The ecological system is dynamic because we should consider them to improve, for example, the quality of the air. An Eco-dynamic system is the main element of future cities. Which environmental systems do we have? 6 are the most important. Mitigation of climate change and adaptation to climate change are the two most relevant. This action will be done in the next 2 years. The other ones are water protection, transition to a circular economy, control of pollution, defense of ecosystems, and biodiversity. This has been told by economists[7].

2.4.4 Systemic approach, chaos theory, and concept of fractals

-Systemic approach
-Need to activate circular innovations as knowledge producers
-work on SMEs on cooperation and networking at different levels of the development model
This circular innovation has one feature: it is based on a systemic approach. İn this society we can not operate with single elements but through one system. Systems are elements ruled by subsystems. The representation is fractal. The systemic approach comes from chaos theory. Fractal is one subsystem that reproduces itself until it becomes a big system. We should activate circular systems that have different features: recycle, natural capital, reuse, design. In this way, we produce

knowledge, which is fundamental for future generations. In order to do this, we should work for small-medium companies. We should do this at different levels, to imagine one city that is structured as a circular city[7].

We know that human health and behavior (humans) are driven by the laws of fractal geometry. We also know that our natural environment (planet) works according to the laws of fractal geometry. And we know that the world of finance and economics (profit) obeys the laws of fractal geometry. Thus, if the individual people, planet, and profit components of triple-based sustainability depend on the laws of fractal geometry, their combination will be self-similar. A closer examination reveals that this is the case[7].

By following a set of instructions or codes designed to describe our sustainable situation in the world, all human endeavors, whatever their size, scope, and scale, can produce sustainable results by following a set of instructions. It is this universal code that we must model to produce repeatable and scalable results. Whether we're dealing with land development, food production, or wellness, the same basic set of instructions applies if sustainable results are desired. In 2002, William McDonough and Michael Braungart introduced the Cradle to Cradle Design™ Framework, which uses the concept of "fractal ecology" symbolized by the fractal equilateral triangle model of sustainability to illustrate how the three ecology-economy-equity needs should be integrated. Built on a fractal foundation laid by others and functioning like life itself, SLDI Code™ is the world's first and only model that graphically and conceptually defines instructions to achieve sustainable results regardless of application[30].

Like life itself, sustainable development is built on a self-similar (but not identical) model that repeats itself on increasing and decreasing scales based on a basic "code". Not surprisingly, the underlying code for sustainable development consists of three elements. For anything to sustain itself over time, it needs to optimize or balance each of the following.

1. Benefit as satisfaction, encouragement, desire, or purity to be achieved.
2. Effectiveness doing the right things with accuracy and completeness.
3. Efficiency achieving the lowest possible input/output ratio.

At its most basic level, sustainable development unifies these directions through the broad concepts of People, Planet, and Profit. Profit represents the benefit to be achieved; The planet represents efficiency and an understanding of limited resources; People represent the opportunity to be influential[30].

2.4.5 Environment vs Technology

it is necessary to consider the reaction times, considering the geological times of the material systems and those much more rigid of the technological evolution. We have a system on which we base our actions. Our element is the earth. We can only work on what comes from the earth. The earth has some rhythms. How can we imagine harmonic evolution between geology and technology? Technology has rapidly evolved. But we should have technology that has progress in agreement with the territory and environment. İn this way we can have sustainable development[7].

Technology as a term refers to scientific knowledge's application for practical purposes and the resulting machinery and devices. We are lately living in a period of rapid change where technological advances are revolutionizing our way of life, while also taking us deep into the catastrophe in the form of climate change and resource scarcity. The negative impact of technology on the environment is caused by some of the world's most severe environmental concerns and then its potential to save the planet from the same problems. It should explore the specific environmental technology of the gas sensor and discuss how it plays a role in reducing negative environmental consequences[31].

The industrial revolution brought with it new technologies of enormous power. This was the transition to new production processes in Europe and the United States approximately between 1760 to 1840. This was followed by continued industrialization and further technological developments in developed countries around the world and the impact of this technology on the world. The environment includes the misuse and damage of our natural world.

In spite of technology's negative impact on the environment, the recent rise of global concern about climate change has led to the development of new environmental technology aimed at helping solve some of the biggest environmental concerns we face as a society and sustainable low-carbon economy. Environmental technology, also known as green or clean technology, refers to the development of new technologies aimed at protecting, monitoring or reducing the negative impact of technology on the environment and resource consumption.

The Paris Agreement signed in 2016 forced almost every country in the world to undertake ambitious efforts to combat climate change by keeping the global average temperature rise below 2°C below pre-industrial levels. There is a positive impact of technology on the environment as a result of the development of environmental technology such as renewable energy, smart technology, electric vehicles, and carbon dioxide removal[31].

Renewable energy or called clean energy is energy harvested from naturally regenerative renewable sources such as sunlight, wind, rain, tides, waves, and geothermal heat. Modern environmental technology has qualified us to seize this naturally occurring energy and modify it into electricity or useful heat through devices such as solar panels, wind, and water turbines, which reflect the extremely positive impact of technology on the environment.

Renewables, which overtook coal in 2015 to become our second largest electricity generator, currently produce more than 20% of the UK's electricity and EU targets mean this will rise to 30% by 2020. Large-scale renewable technologies are also suitable for remote regions and developing countries where energy is often crucial to human development[31].

The cost of renewable energy technologies such as solar panels and wind turbines is falling and government investment is increasing. This has contributed to the amount of rooftop solar installations in Australia, which grew from around 4,600 households to over 1.6 million between 2007 and 2017.

Smart home technology uses devices such as connected sensors and other devices connected to the Internet of Things (IoT) that can be remotely monitored and programmed to be as energy-efficient as possible and respond to users' needs. The Internet of Things (IoT) is a network of internet-connected objects that can collect and exchange data using implanted sensor technologies. This data enables devices on the network to make autonomous decisions based on real-time information. For example, smart lighting systems illuminate only the areas where it is needed, and the smart thermostat reduces waste by keeping homes at certain temperatures at certain times of the day[31].

This environmental technology has been allowed by increased connectivity to the internet as a result of the increased availability of WiFi, Bluetooth, and smart sensors in buildings and cities. Experts predict that the cities of the future will be places where every car, phone, air conditioner, light, and more will be interconnected, giving rise to the concept of energy-efficient 'smart cities'[31].

2.4.6 An eco-dynamic city, systems diversification, and growth of the resilience

Systems diversification = growth of the resilience
Resilience happens if we have a diversification of systems. In this case, we can evaluate the re-use of materials. We can do this at home, in the street, or it can be done by regional or local, or planet administrators. We will have an increase in resilience. A lot of models have been studied about cities. Milan has done a government plan based on resilience. The main element was resilience. Planning, resilience, and circular cities are close to each other[7].

The term resilience is to describe both a system that remains in a state of equilibrium under extreme conditions (an ecosystem, society, or organization) and how dynamic systems behave under stress and how dynamic systems behave. out of balance.

The idea of looking for causes of vulnerability in the structure and behavior of the system, including the link between vulnerability and urban metabolism, is not entirely new, since urban metabolism can be seen as an important component of urban ecosystem health; it has been involved in urban resilience research. A healthy ecosystem and urban environment can reduce people's vulnerability to natural hazards. Urban flows are properly organized in terms of energy and material flows, and well-structured infrastructure to provide these flows, helps cities to withstand and cope with catastrophic disasters. For example, urban metabolism was used in the much faster rebuilding of New Orleans after Hurricane Katrina. John Fernandez and students at the Massachusetts Institute of Technology (MIT) are using material flow analysis to help produce more ecologically sensitive designs for the city[32].

The city is a multidimensional system consisting of various sub-systems that change in time and space. Since the resilience assessment method largely depends on the structure of the system and the behavior resulting from this structure, the resilience assessment method should consider the properties of complex systems. It is possible to examine the effects of alternative programs and policies on the city as a whole, with simulation analysis of Urban Dynamics models. The system's approach is holistic because it focuses not on a detailed understanding of the parts, but on how key components contribute to the dynamics of the entire system[32].

Despite increasing interest in the analysis of urban processes and urban dynamics through the application of system dynamics modeling, current studies still lack representation of the concept of urban resilience. From the literature review, it can be concluded that researchers still do not dare to construct detailed multidimensional

models on a large metropolitan scale. Most of the models are very general and the scale of the system is usually limited to the size of a village or small town. However, the metropolitan scale represents complex feedback loops and influences between the internal components of the system and the system and its environment, as well as the much more diverse elements and interactions between them; modern modeling of dynamical systems[32].

2.4.7 Social innovation and public, individual and social participation

Public, individual, and social participation are very important so that transformations will happen in harmony with the community. Communication is culture and social participation. The technological and economic development of the last fifty years has not corrected social gaps or solved the serious problems of unsustainable development already known half a century ago. On the contrary, they are getting worse. Even in the most developed western countries, attempts to respond to the demand for more sustainable lifestyles and overall better quality of life have been ineffective or have not found sufficient diffusion to date, undermining social cohesion.

Changes in the social and economic ecosystem provide a key to understanding the increasing incidence of governance failures among both companies and institutions. While rethinking its paradigms and value system, the management discipline should abandon the traditional techno centric approach and pollute itself with the contributions of human and social disciplines in order to place people and society at the center of its value system[33].

There are some significant points to consider. The first one is raising awareness of the social and environmental challenges left unresolved by traditional management. Furthermore, providing the basic concepts of entrepreneurship and leadership-oriented development towards socially sustainable innovation and then describing the latest models of social innovation, smart communities, and smart cities, and the link between these models and the value systems of communities. Finally, it is to teach the basic theoretical and practical tools for studying people's behavior, to understand the psychological determinants of choices, and ultimately to adopt the most appropriate policies to spread the adoption of smart and sustainable lifestyles[33].

At a time of climate emergency and rapid loss of biodiversity, transformation to a more sustainable economy and society is needed. The rapid change needed requires social innovations of different types and at different scales. It is important to examine how social innovation and social entrepreneurs can contribute to this

profound transition, as well as the challenges facing social innovation.

The need for more research in this area is growing rapidly as some governments call for net-zero emissions and citizen movements campaign to further accelerate change. Innovations to address the climate emergency range from technological solutions through changes in consumption and pro-environmental behavior to more direct forms of political-social innovation. Such a transformation also requires different ways of thinking about the economy and growth, with social innovations focused on living well within the boundaries of the planet. While these challenges assumptions of endless economic growth, it also requires scaling of beneficial innovations and transitions in many industries. The climate and biodiversity emergency requires a greater understanding of innovation that breaks down the silos of thought between social and environmental goals, while also bridging the worlds of academia, practice, and policy[34].

2.5 Conclusion

Most cities today must contend with environmental degradation, traffic congestion, inadequate urban infrastructure, as well as a lack of essential services such as water supply, sanitation, and waste management. A sustainable city must support economic growth and meet the basic needs of its inhabitants while creating sustainable living conditions for all. A preferably sustainable city creates a permanent lifestyle in four areas: ecology, economy, politics, and culture.

To mitigate the impact of those of us who are already here, especially the richest, who have the greatest environmental impact, we need to take many actions, including reducing consumption to sustainable levels and systemic economic changes. One of the most effective steps we can take to reduce our collective environmental impact is to choose a smaller family size and empower those who cannot make that choice freely.

Empowering women and girls, removing barriers to contraception, quality education for all, and global justice and sustainable economies will be the solution to the world population growth. Lifting people out of poverty is a significant step in ending population growth, as well as a necessary step in ensuring that people live a dignified and secure life. To achieve this, we must address the drivers of poverty and inequality.

Nowadays, the transformation of cities is not only spatial but also social, cultural, and economic. If we examine all over the world, the transformations are

not only about the regional planning of cities but also about social actions. Some places of the city that does not have function anymore should be designed and reintroduced to the city. It can be used for cultural activities. Only a city planner is not enough to plan the cities. There should be one collaboration with socialists, historians, theater and cinema professionals, and psychologists. This group can explore new possibilities for cities and create multicultural and multi-ethnic.

Several activities are involved in the circular economy as, for instance, sharing, renting, reusing, repairing, renovating, and recycling, making this production and consumption model allows an extension of the product's life cycle.

A future where every waste becomes an asset and all products are recovered and reused, remanufactured, or recycled for multiple generations at the end of their primary use is more than a reality, but a necessity. Products have a life cycle and they are produced, marketed, and put on the market. There are four generally accepted stages in a product's life cycle: introduction, growth, maturity, and decline.

In the future, as cities are transformed, the main factor will not be the economy, but nature and territory will be the main capital. Social capital has already begun to be taken into account today. The main elements of transformation are the green economy and transformation. All of these elements are dynamic and the transition to circular cities.

We must design cities whose waste-free loops close. For example, while planning the land in the city, it can be ensured that the city is eco-dynamic and durable by leaving particular green and free areas. Eco-systemic service is the ability to examine the quality of green spaces in the city. If it is not possible to design large green areas during the city project, it is also a solution to design the existing ones with high quality and density. Collaboration with environmental engineering will be important for details and actions.

Buildings and design, mobility and connections and products are the main milestones of a city. Buildings are objects that represent the functions of the city, and the necessary divisions should be designed for different types of buildings, such as the existing area of hospital, residential areas.

The city is a mobility network and we must have structures that allow sustainable mobility. Cities have been designed for cars until now, and cities have always been thought to be moved by private vehicles.Roads should be reduced in the city center. Thinking about connections with integrated mobility may be a solution. The mobility issue will also be important to have cities without pollution. Parts related

to cars and public transport should be renewed, for example, electric cars should be introduced. However, it should not be overlooked that the energy produced for mobility can create pollution.

To have energy in residential buildings, it must be mandatory to have photovoltaic panels. There are also solar panels, wind power systems and geothermal systems to produce clean energy. If it is necessary to improve air quality, cities must be imagined for people, not cars. In addition, products should be sustainable and cyclical not only during the use phase but also during the production phase. Urban transformation, sustainable cities, circular economy, energy and technological innovation are actions for a circular city.

A circular economy gives more awareness and different ownership concepts and these will create new business opportunities. The sharing economy completely changes the context of how we own things. Specially created products and services should be introduced to help consumers evaluate their purchases based on their monetization potential. But as the market matures and consumers a deeper understanding will be developed. Everything can be monetized in the sharing economy, and there will be opportunities for entrepreneurs who can develop creative, effective solutions to help facilitate monetization.

Architects and urban planners alone will not be enough to design the functioning of naturally resilient urban systems over the long term to ensure a better and lasting quality of life for current and future generations. They should overcome this situation by producing new knowledge with multi-disciplinary and different working groups. In this way, the circular cities paradigm can be reached at the end of this sustainable development process.

Chapter 3

Examination of research paper of Jo Williams and City Examples

3.1 "Circular Cities: What are the benefits of Circular Development?" by Jo Williams[8]

Joanna is the director of the Circular Cities Hub. She is also an Associate Professor in Sustainable Development at the Bartlett School of Planning, UCL. She has 23 years of research experience, working closely with industry, governments, and cities. She also advises International bodies (European Commission, EEA, OECD, and United Nations) on the delivery of circular cities, low carbon cities, circular, sharing, pop-up, and bio-economies. Jo is on the steering panel for several large European research projects. She has published widely including her books Zero Carbon Homes - A Road Map and Circular cities: a revolution in urban sustainability, both published by Routledge.

This research paper was published by Jo Williams in May 2021. The author's aim is clearly to clarify and provide a clear definition of the normative concept of circular development. In this way, it will start to make the case support if the benefits of taking such an approach can be identified.

If cities could become renewable and adaptable urban ecosystems, where resource cycles are closed and waste is obsolete, their ecological footprints would decrease. In addition, urban resource security will increase, the health of the urban population will improve, and urban greenhouse gas emissions will be reduced. These are the

main goals that form the basis of the circular city.

Circular cities emerge in the process of circular development. Circular development changes the supply systems of cities to enable the development of circular practices of city dwellers. This manifests as circular food systems and construction, water and nutrient recycling; adaptive reuse of fields and pop-up activities; bioremediation of polluted areas, and integration of blue-green infrastructure between cities. Transforming our cities will require significant investment, political support, and public participation.

The author used two main methods in order to identify the circular benefits. They are based on inductive and deductive content analysis of the relevant literature and interviews with those implementing circular projects in European cities (London, Paris, Amsterdam, and Stockholm). The author examined these two works and created some circular benefit coding frameworks and benefits of adopting circular development in cities.

In this paper, there is a brief description of the four cities(London, Paris, Amsterdam, and Stockholm) and the circular systems they have adopted. Although there are a lot of similar circular developments in these four cities, all of them have different levels and different scales of improvements. The table that was created for analyzing the cities is more understandable to the differences between each other.

The author points to the synergistic benefits that emerge from circular development. Furthermore, the assessment of these benefits highlights the problems associated with the unintended consequences of circular development and inequalities in access to benefits across society[8].

3.1.1 Identification of the circular benefits by using two main methods

The author used two different methodologies for the identification of the circular benefits. Firstly, the author made a systemic analysis of the publications and researches. Secondly, the key stakeholders were interviewed from the example circular cities which are Amsterdam, Paris, London, and Stockholm.

A systemic analysis of publications and researches

A systematic analysis was made of Scopus' indexed papers over 300 documents. This systematic analysis of publications was completed in 2020. The author uses three significant criteria in order to review all the documents. They are relevance,

language, and validity. The author chose the papers related to some relevant keywords such as circular development actions in cities. All the documents' language was English and they were peer-reviewed articles or technical reports published by a reputable consultancy.

The articles seemed to fall into three categories, reflecting three circular actions: looping actions and circular economy; ecological regeneration and nature-based solutions; urban resilience and adaptation with some overlap. Two groups of search terms were used to identify related articles. The first group referred to the urban focus cities and urban. The second group referred to circular development actions as in the table of search terms for circular development.

Circular Action		Definition	Search Terms
Loop	Reuse	Where resources are used again without any further processing	reuse; repurposing; change in use; refurbishment; grey-water reuse; repair
	Recycle	Where resources are reprocessed for the original or other purposes	recycling; composting; landfill mining; urban mining; infrastructure recycling; black-water recycling; waste-water treatment; circular economy; circular construction; bioeconomy;
	Recover	Energy is produced from the reprocessing of resources	waste-to-energy; gasification; pyrolysis; landfill gas collection; anaerobic digestion; heat recovery; biogas; thermal hydrolysis
Ecologically Regenerate	Infrastructure	Infrastructure which helps to regenerate the urban ecosystem and the ecosystem services it provides	green infrastructure: blue infrastructure: sustainable urban drainage systems
	Ecosystem management	Activities which help to regenerate the urban ecosystem and the ecosystem services it provides	urban agriculture; urban forestry; conservation; water management; soil management, phytoremediation; bioremediation
Adapt	Infrastructure	Infrastructure which adapts to changing needs in the city.	Adaptable; expandable; flexible; moveable; pop-up; scalable; refitable; convertible; versatile; adaptive reuse
	Communities	Communities which can organise and adapt to changing needs	Pop-up economy; pop-up enterprises; co-provision; community farming & energy; farming & energy cooperatives; transition towns; co-building; cohousing & cooperative housing.
	Urban form	Urban form which can adapt to changing needs	Pop-up spaces, meanwhile spaces, temporary urbanism, temporary uses, temporary planning permissions; multi-use spaces

Figure 3.1: Search terms for circular development. Reproduced from [8].

In the Figure 4.1, there are three main search terms. The circular actions are loop, ecologically regenerate, and adapt. Looping mainly is related to reusing, recycling, and recovering. The first one of them, the definition of reusing is where resources are used again without any further processing. For example grey water reuse, refurbishment, etc. Furthermore, the definition of recycling is where resources are reprocessed for the original or other purposes such as landfill mining, urban mining, wastewater treatment, circular construction. The last is that recovering is about energy. It is produced from the reprocessing of resources such as waste to energy, landfill gas collection, heat recovery, thermal hydrolysis.

Ecologically regenerating is about infrastructure and ecosystem management. Infrastructure helps to regenerate the urban ecosystem and the ecosystem services it provides such as green or blue infrastructure and sustainable urban drainage systems. Ecosystem management is what helps to regenerate the ecosystem and the ecosystem services it provides. For example urban agriculture, urban forestry,

water or soil management, bioremediation.

Adapting is distinguished into three sections and they are infrastructure, communities, and urban form. Infrastructure is which adapts to changing needs in the city and its search terms are adaptable, expandable, flexible, moveable, pop-up, scalable, profitable, convertible, versatile, and adaptive reuse. Communities are which can organize and adapt to changing needs. For example pop-up economy, community farming energy, transition towns, co-building, co-housing cooperative housing. Urban form is which can adapt to changing needs such as pop-up spaces, temporary urbanism, temporary uses, temporary planning permissions, multi-use spaces.

Afterward, an inductive content analysis by using NVIVO was completed to identify the benefits of adopting circular development in cities. Open coding was used to identify utility categories and clusters in the literature. The first full-text readings immersed the researcher in the literature and gave it an insight into all the benefits that come from circular enhancement. The second read was used to derive the first set of codes. These codes were divided into categories and a coding tree diagram was created. Three benefit categories are ecological, economic, and social benefits. These categories were used to organize and group the codes. In total, 33 coding themes emerged: 12 ecological, 10 economic, and 11 social benefits. The social category is divided into two themes: health and community benefits.

In the table of coding frameworks for benefits of circular development, there are three categories and they are ecological, social, and economic benefits. The codes of ecological benefits are reducing water, material, energy, and land consumption; ecosystem services such as regulation provisioning, support, and culture; reducing greenhouse gas emissions; resource sufficiency; adapting to the environmental change, and increasing environmental awareness.

The codes of social benefits are distinguishing two main benefits and they are health and community. Health benefits codes are physical health, mental health, stress, nutrition, obesity, and longevity. The coding of community benefits are building local symbiotic capital; empowering communities; the opportunity to socialize; accessing resources for the excluded such as affordable heat, food, goods, accommodation, and energy; and increasing community resilience.

The codes of economic benefits are creating jobs; avoiding health, insurance, and landfill costs; creating economic value; new industrial sectors and businesses; removing redundancies such as vacancies, undeveloped sites, waste, inefficiencies in production processes; reducing supply and production costs; activating vacant and

unused spaces; increasing value of properties and land; localizing value chain, and localizing production[8].

Categories	Sub Themes	Codes	Sub-Codes
Ecological Benefits		Reduce consumption	Water, material, energy, land
		Ecosystem Services	regulation provisioning, support, cultural
		Reduce greenhouse gas emissions	-
		resource sufficiency	-
		Adapt to environment change	-
		Increase environmental Awareness	-
Social Benefits	Health	Health benefits	Physical health, mental health, stress, nutrition, obesity, longevity
	Community	Builds local symbiotic capital	-
		Empowers communities	-
		Stabilizes existing communities	-
		Opportunities to socialize	-
		Access to resources for the excluded	Affordable heat, food, goods, accomodation, energy
		Increases community resilience	-
Economic Benefits		Creates jobs	-
		Avoid costs	Health, insurance, landfill
		Creates economic value	-
		new industrial sectors and businesses	-
		removes redundancies	Vacancies, undeveloped sites, "waste", ineffieciencies in production processes
		Reduces supply and production costs	-
		Activates vacant and unused spaces	-
		Increases value of properties and land	-
		Localized value chain	-
		Localized production	-

Figure 3.2: Coding framework - benefits of circular development. Reproduced from [8].

Interviews with people who had implemented circular systems or providers

In the second phase of the research, the author identified the benefits of adopting circular urban systems in four European cities. They are Amsterdam, Paris, London, and Stockholm. These cities were chosen because they are pioneers in the implementation of circular supply systems and provide well-established examples. They have been involved in the practice for a longer period of time and therefore have a richer understanding of the resulting benefits. For this reason, the author collected the data is better informed. Cities presented a variety of circular urban systems, including circular construction and food systems; adaptive reuse of spaces and infrastructure; water and nutrient recycling systems; waste heat recovery and

waste-to-energy systems; ecological restoration systems (bioremediation, environmental management, integration of blue-green infrastructure). These represent the most common circular systems found in European cities. Thus, they provide a representative sample.

Furthermore, the author interviewed stakeholders from these cities who service and infrastructure providers implementing circular systems in these cities to understand the benefits of circular development in the adopting cities. A range of representative stakeholders from the private, public, and community sectors was less interviewed. These interviews were held between June 2017 and June 2019 and lasted between 40-60 minutes. In addition, the interviewees were asked to identify situations in which synergistic benefits from adopting circular actions occurred. The interviews were recorded and transcripts were created. Where possible, responses were supplemented by studies measuring the real benefits of circular systems provided by white papers.

There are three main key stakeholders for interviewing from these four cities with

Group	Type	Number Stakeholders Interviewed	Amsterdam	Paris	London	Stockholm
Private	Developer	4	X	X	X	X
	Construction manager	2	X		X	
	Engineering/planning consultant	3	X		X	X
	Architect	1				X
	Landscape architect/green infrastructure consultant	3		X	X	X
	Water and waste water engineer	4	X	X	X	X
	Industrialist	2	X		X	
	Temporary use consultant	2		X	X	
	Property consultant	2		X	X	
Public	Local politician	4	X	X	X	X
	Strategic planner	4	X	X	X	X
	Economic development officer	4	X	X	X	X
	Circular economy officer	2	X		X	
	Sustainable development officer	3	X		X	X
	Ecologist	1			X	
Community	Academic	4	X	X	X	X
	Circular economy/waste recycling foundations	1			X	
	Conservationists	1			X	
	Social enterprises	2		X	X	
	Urban farmers	2		X	X	
Total		52	11	11	19	10

Figure 3.3: Key stakeholder interviews. Reproduced from [8].

different numbers of participants. One of them is from the private sector and they are developer, construction manager, engineering, planning consultant, architect,

landscape architect, green infrastructure consultant, water and wastewater engineer, industrialist, temporary use consultant, and property consultant. 25 of the interviews are coming from the private sector.

The second group is the public sector. Local politicians, strategic planners, economic development officers, circular economy officers, sustainable development officers, and ecologists constitute the public sector and from this sector, there are 18 interviews. The last group is the community sector. They are academic, circular economy or waste recycling foundations, conservationists, social enterprises, and urban farmers. 10 of the interviews are from the community sector. From the table, most of the participants are from London with the numbers of 19 compared with other cities. From every type of the stakeholders interviewed in London except the architect. The participants of Amsterdam, Paris, and Stockholm are around 10-11. From the table of key stakeholder interviews - themes, codes, and search terms, we

Theme	Code	Sub-Code	Search Terms
Ecological Benefits	Reduce consumption	Water, material, energy, land	"reduce consumption" AND "water" OR "material" OR "land OR "energy"
	Ecosystem Services	regulation provisioning, support, cultural	"ecosystem services" AND "regulation" OR "provisioning" OR "support" OR "cultural"
	Reduce greenhouse gas emissions	-	"greenhouse gas emissions" OR " climate mitigation"
	resource sufficiency	-	" resource security" OR "resource sufficiency"
	Adapt to environment change	-	" urban adaptation" OR "climate adaptation" OR "adaptive systems"
	Increase environmental awareness	-	" environmental awareness" OR "pro-environmental behaviour"
Social Benefits	Health benefits		" health benefits" OR "physical health" OR "stress relief" OR "obesity " OR " good nutrition" OR "mental health" OR "increased life-span"
	Builds local symbiotic capital	-	" local capital" OR "social capital" OR human capital" OR "financial capital" OR "physical capital" OR "natural capital"
	Empowers communities	-	" community empowerment"
	Stabilizes existing communities	-	Community AND "stabilisation" OR "retention"
	Opportunities to socialize	-	"social events" OR "social opportunities"
	Access to resources for the excluded	-	"social solidarity" OR "affordable" OR " affordable warmth" OR "affordable food" OR "affordable accommodation"
	Increases community resilience	-	"resilience" OR "adaptive capacity" OR "community organisation" OR "community learning" OR " sufficiency"
Economic Benefits	Creates jobs	-	"jobs" OR "employment"
	Creates economic value	-	" valorisation" OR "economic return"
	new industrial sectors and businesses avoid costs	-	"new industries" OR "new businesses"
	removes redundancies	-	"redundancies" OR "vacant" OR "waste"
	Reduces supply and production costs	-	" supply costs" OR "production costs"
	Activates vacant and unused spaces	-	"site reuse" or "regeneration" or "renewal"
	Increases value of properties and land	-	"land values" OR "property values"
	Localized value chain	-	"local value chain"
	Localized production	-	"local production"

Figure 3.4: Key stakeholder interviews themes, codes and search terms. Reproduced from [8].

can see that the stakeholders made a mention of some significant ecological, social, and economic benefits' codes from the previous work of the systemic analysis of the publications. The table of interviews' themes, codes, and search terms should be created in order to evaluate and compare with previous work. In this way, it is understandable which research terms are already adopted in these cities[8].

3.1.2 Creating the table of circular development benefits by using this two method

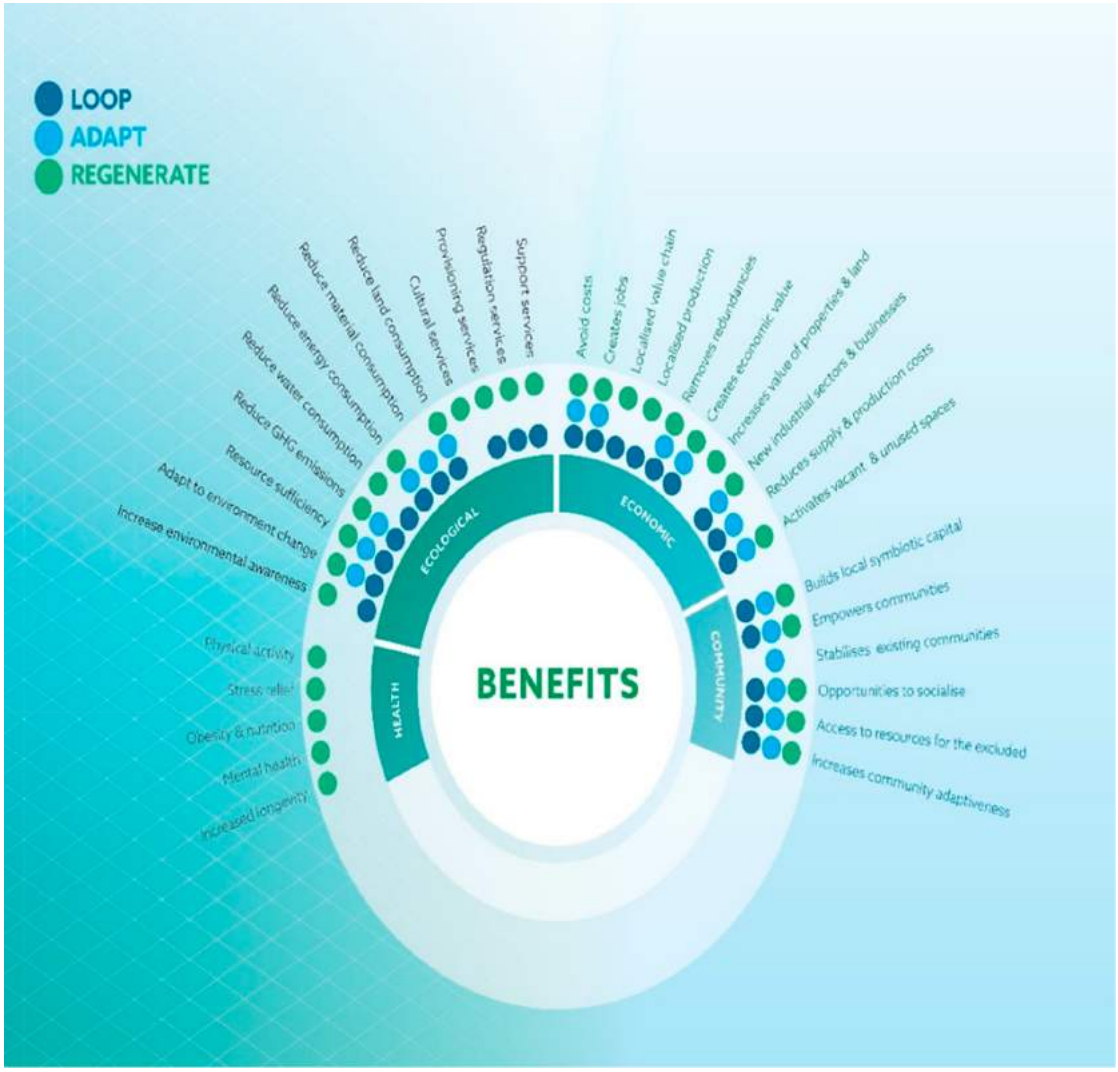


Figure 3.5: Benefits of adopting circular development in cities. Reproduced from [8].

This led to an understanding of the perceived benefits of circular development among those who practiced it. Interview transcripts were read by the researcher to get an overview of the responses. Notes of reported benefits were made for each transcript. The author made a comparison between the first codes that emerged from the interviews and the codes obtained from the literature. She discovered that the same categories were emerging. For this reason, the results from the interviews

confirmed the utility framework generated by the literature's first inductive content analysis. The interviews were examined with NVIVO using the coding framework developed from the first phase of the analysis again and the various search terms were used to examine the transcripts. At the end of these methods, the author summarizes the benefits of adopting circular development in cities. They are:

Health benefits: physical activity, stress relief, obesity nutrition, increased longevity.
Ecological benefits: increase environmental awareness, adapt to environmental change, resource sufficiency, reduce GHG emissions, reduce water, energy, material, and land consumption, cultural services, provisioning, regulation, and support services.
Economic benefits: avoid costs, creates jobs, localized value chain, and production, removes redundancies, creates economic values, increases the value of properties-land, new industrial sectors business, reduces supply production costs, activates vacant unused spaces.
Community benefits: builds local symbiotic capital, empowers communities, opportunities to socialize, access to resources for the excluded, increases community adaptiveness. Additionally, the author categorizes the benefits of adopting circular cities according to looping, adapting, and regenerating[8].

3.1.3 Circular development benefits (ecological, social, and economical)

In this section, the author wishes to illustrate how the findings of inductive content analysis of the literature highlight the benefits of circular development, using examples from key texts. The analysis suggests that adopting a circular development path will provide many sustainability benefits.

Ecological benefits

According to inductive content analysis, 12 ecological benefits are highlighted related to adopting circular development in cities. These are distinguished into five categories:
- reducing resource consumption (energy, water, materials, and land);
- restoration of urban ecosystem services;
- reduction of greenhouse gas emissions;
- increasing urban capacity to adapt to climate change; and
- to increase environmental awareness among the public.

The author asserts three circular actions, they are looping, regenerating, and adapting. All of them contributed to the reduction of urban resource consumption

such as energy, materials, water, and land. There are different types of examples when we examine the cities which are good examples for the circular actions. Some of the examples are:
- Reuse of heat emitted from buildings and anaerobic digestion of organic wastes reduce fossil fuels consumed.
- Adaptive reuse of buildings bypasses the wasteful demolition and rebuilding process while saving energy.
- Green infrastructure can reduce air and surface temperature in cities, thereby reducing the energy used for air conditioning.
Gray water recycling and reuse in combination with storm water collection and storage in blue-green infrastructure reduce drinking water consumption for non-potable purposes.
Overall, a reduction in resource use can also improve resource security in urban systems.

Circular actions have an improving effect on the health of urban ecosystem services. Circular and ecologically regenerative actions have been instrumental in restoring the urban ecosystem services necessary to combat pollution. Supporting carbon sequestration; regulation of the local climate; managing hydrology; Increasing biodiversity and producing fertile soils in cities are examples of these. Local resource production, such as food and fuel, increases through the restoration of ecosystem services. It provides clean water and air necessary for a healthy population. It also provides access to recreational areas.

The author claims that these three circular actions reduce greenhouse gas emissions. He explains this as follows; The cycle designs waste and reduces greenhouse gas emissions throughout the value chain. Thus, the reuse of steel in construction can reduce the carbon footprint of buildings, and the reuse of food can reduce the amount of methane emitted from landfills. Adaptation keeps infrastructure and materials in use to conserve the energy embodied in both. For example, adaptive reuse of infrastructure avoids emissions from demolition, production, transportation, and construction of buildings. Renewing urban ecosystems helps sequester carbon in soil and vegetation. It also increases urban capacity to adapt to climate change.

Local cycling such as local circular food systems, community energy; and regenerative actions like community gardening, conservation projects, urban agriculture raise environmental awareness among the public. However, increased resource efficiency and consequent reduction in procurement costs can also have a backlash effect[8].

Social benefits

The author distinguished the social benefits into two; health, and community benefits. The inductive content analysis highlighted that ecological regeneration produces significant health benefits in urban populations. Green infrastructure regulates the local climate, water, noise, and air pollution, all of which have a direct impact on the mental and physical health of those living in cities. It can also increase the resilience of the urban population to pandemics by addressing health-related comorbidities such as respiratory, heart problems, type II diabetes, and obesity that increase mortality rates among those with the disease.

However, green spaces must be accessible to have a significant impact on the mental and physical health of urban residents. This is especially important for children, the elderly, and people from lower socio-economic groups who spend most of their time close to home. However, there are still large disparities in access to green space among socio-economic groups in cities.

Providing green infrastructure can also promote active lifestyles among the wider population. Green corridors with integrated active transport networks strengthen walking and cycling in cities. Active lifestyles reduce obesity, stress levels, and improve the mental health of city dwellers, helping to build long-term health resilience.

Circular actions include community projects such as energy and agricultural cooperatives; Help strengthen local communities through the operation of food reuse and repair plans. These projects build stronger social capital, in other words, social networks, and human capital, skills, and experience, through people's participation in circular actions. For example, repair cafes: develop technical skills; reduce the cost of goods for low-income groups; provide meeting places and increase social cohesion within communities. The author emphasizes that similar benefits were found among those engaged in community farming cooperatives. However, community projects often encounter significant barriers to scaling up.

Through community projects, it can also generate local economics such as financial returns and physical capital like infrastructure systems that support circular activities that increase the resilience and adaptability of communities. For example, renewable energy cooperatives provide new infrastructure and generate economic capital, as well as foster greater social cohesion and pro-environmental behavior. Adaptively reused buildings also provide spaces for new pop-up events. This form of tactical urbanism increases adaptability, creating more resilient and stable communities.

Circular actions can increase access to resources in communities such as goods, accommodation, heat, clean air, green spaces. For example, furniture reuse schemes have been shown to reduce challenges and help build human capital. In practice, however, there is also evidence to suggest that the benefits of circular actions may not be experienced equally across communities. For example, green space is often less accessible to the urban poor. Low-income households are also less likely to participate in and benefit from urban agriculture projects[8].

Economic benefits

According to the paper, there are 10 economic benefits of circular development in circular, bio, and pop-up economies. They can be divided into four main sections and they are:
- supply and production costs to manufacturers;
- economic value creation;
- diversification of the economy;
- create employment.

By reducing waste, using recycled products, and localizing supply chains, circular actions can minimize procurement and production costs. With the new approach that the circular economy will bring, it is usual for it to create new economic sectors, industries, and businesses, thus creating new job opportunities. Valued construction and organic waste streams seem particularly viable in urban areas.

Research indicates that the circular economy will require a heterogeneous skill base with opportunities for everyone. However, experience with the informal waste recycling sectors in India and China shows that poorer groups will tend to be employed in these less safe, low-paying, and potentially dangerous jobs. There is also disagreement over the scale of economic opportunities provided by the circular economy. The OECD suggests that opportunities may be more modest than originally anticipated and differ between countries. Research shows that the economy has the potential to support many sustainability goals. Urban bioeconomy uses hidden urban assets in the form of biological models and processes for various direct or indirect economic benefits. The two processes are an integral part of the bioeconomy. The first involves utilizing biological assets provided by ecosystem services such as carbon sequestration, resource generation, pollution and flood reduction, and biological remediation. This ecological renewal process improves land and property values. It can also bring brownfield sites back into use.

Ecological regeneration can be a source of value creation if ecosystem services

are valued appropriately. The author says ecosystem services will also help avoid health, flood, and pollution remediation costs. Managing these living assets generates new resources and creates local employment opportunities in areas as diverse as urban forestry, conservation, agriculture, energy, water management, carbon sequestration, recreation, health, and tourism.

The second phase focuses on the evaluation of biological waste. This is the circular urban bioeconomy, which overlaps with activities in the circular economy. Biological waste is evaluated through biological exploration or biological processes that reduce waste. In the bioeconomy, new industrial sectors and businesses are already emerging and creating jobs. More than 17 million people were employed in the European bioeconomy in 2017. This added 614 billion Euros to the European economy. Growth areas included bio-based electricity, biochemicals, and forestry.

According to the author, the pop-up economy can also make a significant contribution to economic growth. For example, pop-up activities are estimated to be worth more than GBP 2.3 billion for the UK economy alone and employ more than 26,000 people. The ephemeral nature of urban pop-up events also increases a city's ability to adapt to changes in the landscape. Pop-up activities remove excesses that are created by economic shocks in the urban system, such as vacant spaces, properties, underutilized utilities.

The author suggests that pop-up events reactivate unused areas, increasing local vitality, increasing local land values, and stimulating the local economy. This action strips the hidden value from temporarily unused sites. Tactical urbanism is a valuable urban model that reduces economic risk, unlocks the potential of sites, and creates a capital flow. However, the author adds that the gentrification process associated with increased value can also result in social exclusion[8].

3.1.4 European example cities: Amsterdam, Paris, London, Stockholm

After 2014, circular cities began to appear in Europe. This followed the publication of a series of policy documents by the European Commission. As of 2016, the Netherlands, Scotland, Finland, and Germany had national strategies for CE. By 2018, France, Slovenia, Portugal, Greece, Italy, and Luxembourg have joined them. The New Urban Agenda for Europe has established a special partnership for the implementation of CE at the urban scale (Circular Economy Partnership, 2017).

Initially, London, Paris, and Amsterdam were the first cities to announce their intention to adopt a circular approach to urban economic development. These were

soon followed by Peterborough, Copenhagen, Rotterdam, Glasgow, The Hague, Maribor, Almere, Birmingham, Brussels-Capital region, Düsseldorf, Genoa, Ghent, Ljubljana, Lyon metropolitan area, Munich, Oslo, Strasbourg, Turin, Rome, Marseille. Then Porto and Utrecht. More recently, Lisbon and Berlin have begun to develop their circular strategy.

There is great variation in how these cities define circularity. Some focus on the application of CE principles in the city area. This may include all six actions presented within the framework of RESOLVE implemented in different combinations. Other cities focus on supporting circular business models (London), promoting industrial symbiosis (Rotterdam), or managing municipal material waste (Lisbon). Some recognize the importance of implementing the CE strategy as part of an integrated approach to sustainable development alongside policies for ecological regeneration, adaptation, and resilience (e.g. Amsterdam). Others have adopted a circular development path but do not have a formal circular strategy (e.g. Stockholm). The motivations for adopting circular development in cities also vary considerably.

Figure 3.6: ReSOLVE framework six action areas for businesses and countries wanting to move towards the circular economy. Reproduced from [22]

These motivations include city marketing and urban innovation export (ex: Amsterdam, London, and Stockholm); social solidarity and redistribution of resources (ex: Paris, Lisbon, and Berlin); business development and job creation (London, Amsterdam, Paris); regeneration of the local industrial base (ex: Paris); resource security (ex: Amsterdam, Lisbon, Paris) and combating climate change (Paris, Berlin, Amsterdam, Lisbon, and Stockholm). These various motivations will influence the ways in which cyclical developmental pathways manifest. The author visited four cities Amsterdam, Paris, London, and Stockholm to observe how circular development has manifested in practice. This provides the evidence base for the benefits of circular development. In this way, defining circular development (common characteristics, variation, and typologies); determining the dynamics between circular actions and other urban strategies; examining the levers for implementing circular development; identifying the reasons for adopting a circular development approach in cities; and exploring the challenges to circular urban transformation.

Amsterdam

-the strong connection between waste producers and users
- looping of construction and organic waste
- smart data about wastes (circle scan, puma) as resource banks
- waste separation and locally recovery by food banks and restaurants
- encouraging pop-up circular experiments (ex: De Ceuvel (Buiksloterham)
- reusing houseboats for workshops, offices, and cafe
- producing fertilizer from urine and toilets collectors for local food crops
- halophytic filtration systems (gray water cycling and capturing waste heat)

Amsterdam promotes a strategic, city-regional approach to the resource cycle, construction, and organic waste. Waste producers and users are interconnected throughout the city district. Smart data and online marketplaces are used to empower the exchange of construction waste. Material passports, databases such as circle scan, which maps material flows, and puma, which identifies buildings where precious metal reserves can be found; and resource banks (space for the storage of recyclables) facilitate the circular construction process. Public recycled building materials, circular actions, and land release also created a demand for recycled materials in construction.

Organic waste is also circulated within the city area. Waste separation, intelligent reverse logistics, and cascading organic waste streams ensure that residual streams maintain their peak value. The development of bio-refineries in the city area allows for the recycling of organic materials or the recovery of energy locally and at scale. Additionally, nutrients are recovered from leftover food for reuse (by

restaurants or food banks) or for composting. Amsterdam also supports the rise of pop-up circular experiments on a neighborhood scale. Empty, often contaminated, municipal areas are temporarily made available for circular experiments. De Ceuvel (Buiksloterham) is one example experiment, built on a polluted area in the Port of Amsterdam. It adopts all three circular actions.

The houseboats were adaptively reused for workshops, offices, and a cafe. Phyto-healing plants decontaminated the soil in the site. Off-grid, surface infrastructure is integrated into the development to prevent underground infrastructure from being buried in polluted land. Dry compost toilets and separated urine collectors are used to produce fertilizer for local food crops. Helophytic filtration systems recycle gray water on-site, while waste heat from houseboats is captured and reused. In addition, the site is ecologically regenerated, resources are cycled and a temporary home is provided for businesses adopting the circular development model[8].

Paris

- looping construction materials, food, and water
- the provision of material flow data, online marketplaces, and resource banks for construction materials
- the reuse of food waste and the regional production of food legally enforced
- covering the city's roofs and walls with 100 hectares of vegetation by 2020 by Parisculteurs
- food reuse cafes like Freegan Pony and community fridges like les Frigos Solidaires
- greywater recycling system
- replacing the existing gray infrastructural system with a blue-green alternative
- adaptive reuse of sites and buildings with Paris Reinvented and Paris Culteurs

Paris has also taken a city-regional approach to the building materials, food, and water cycle. It has the similarity with Amsterdam in facilitating circular construction about the provision of material flow data, online marketplaces, and resource banks. It is particularly successful in dealing with the soil removed from construction sites by using a sol-dating app.

Paris has a target to create a local circular food system through the reuse of food waste and regional food production both in the city and in the surrounding districts. Paris aims to cover the city's roofs and walls with 100 hectares of vegetation by 2020 by the Parisculteurs initiative. One-third of this area will be devoted to urban agriculture. There is a stronger narrative of solidarity in Paris than in Amsterdam that suggests feeding the urban poor is a priority. Food reuse is also legally enforced and examples of food reuse schemes are public service contracts

with food markets; food reuse cafes for example Freegan Pony and communal refrigerators such as les Frigos Solidaires. Any food that cannot be reused in the city is converted to biogas, supplementing the local energy supply. In addition, there has been a gray water recycling system for two centuries in Paris. 98% of this gray water is consumed by the municipality to protect public infrastructure. Gray water is used in large quantities and is very inexpensive. But Paris is considering replacing the existing gray infrastructure system with a blue-green alternative to allow the city to adapt to climate change. Reducing water consumption and pollution and regulating urban temperatures are some of the city's distinctive goals today.

Furthermore, initiatives such as Paris Reinvented and Paris Culteurs have been undertaken to coordinate adaptive and strategic reuse of sites and buildings. It is Paris Reinvented that has formalized the strategic adaptive reuse of sites and buildings in Paris since 2014. Temporary planning permits, space brokers, and online marketplaces, including urban farming, help facilitate tactical urbanism that fuels many pop-up events in the capital. Various projects emerged, including Les Grands Voisins, Freegan Pony, Friche Miko, and Jardin d'Alice. Les Grands Voisins, a pop-up social enterprise project among them, was successful enough. It was particularly successful because it provided a hostel for the homeless, workshops for artisans, pop-up shops, start-ups, allotments, and recreational facilities[8].

London

- Examples of circular systems such as The Queen Elizabeth Olympic Park (QEOP)
- QEOP is the biggest urban park in Europe in the last 150 years
- QEOP has a process of ecological restoration
- QEOP has bioremediation, local clean-up programs, and conservation schemes because of previously industrial area
- QEOP has sustainable urban drainage systems integrated into the public realm
- QEOP has circular construction systems such as soil-washing, materials exchange platforms, resource banks
- QEOP has adaptive infrastructure like repurposed post-games
- QEOP has been designed for adaptability from the outset, buildings, products, and materials
- QEOP has contractors reuse items and materials after the Olympic Games by selling or gifting them
- The twin goal of tackling climate change and resource depletion in Brixton
- Sustainable communities such as Pop-up Brixton, Brixton Café, Loughborough Farm, and Remakery in Brixton
- Local food reuse (Brixton Café) and urban farming schemes (Loughborough Junction Farm), supported by the local currency (Brixton Pound) in Brixton

London provides an important example of circular supply systems. Queen Elizabeth Olympic Park (QEOP) is a new eco-region built for the 2012 London Olympics, integrating three circular actions into its construction and operating processes. QEOP is the largest city park created in Europe in the last 150 years. It undergoes an ecological restoration process to create a healthy urban ecosystem. Bioremediation, local clean-up programs, and conservation plans have helped to ecologically regenerate this formerly industrial area. Residents live within 300 m of at least two hectares of green space. Various, native species have been planted throughout the park. Waterways were improved, while sustainable urban drainage systems were fully integrated into public space.

Circular construction systems such as soil washing, material exchange platforms, resource banks have limited material waste from the field and adaptive infrastructure integrated into Olympic development that is reused after the games. For example, the nine modular cabins that make up the High Street in Athletes Village are now used as a community hub in Hackney Wick. QEOP provides an example of how buildings, products, and materials continue to deliver high-value returns beyond their original purpose by designing for adaptability from the start. An Asset Disposal scheme was introduced at QEOP to help contractors reuse items and materials after the Olympic Games by selling them or giving them to charities and good causes.

Brixton, on the other hand, provides an example of tactical circular urbanism despite being an existing urban neighborhood. Brixton is a transit city with the twin goal of tackling climate change and resource depletion. There are a number of sustainable community-led schemes in this neighborhood that are integral to circular development and some of them are Pop-up Brixton, Brixton Café, Loughborough Farm, and Remakery. These are facilitated by the issuance of temporary planning permits to release municipal sites.

Local food reuse (e.g., Brixton Café) and urban farming schemes (e.g., Loughborough Junction Farm), supported by the local currency (Brixton Pound), have been established which help to reinforce a circular food system. The Remakery provides a space in which the community can learn to repair or recycle unwanted or broken goods and materials. Pop Brixton provides employment opportunities for local people in the pop-up economy[8].

Stockholm

- there are circular principles for 25 years that is Ecocycles 1.0
- city-wide infrastructural systems (district heating system; the Högdalen combined heat and power plant and the Hammarby thermal power station)
- converting sludge into fertilizer and biogas with new technologies
- purifying wastewater is used by the thermal power station
- burning the refuse to provide heating for homes and businesses
- organic waste from seaports used to feed the waste-to-energy system
- storing the stormwater in retention ponds or caverns to limit flash flooding and reduce the damage of aquatic environments
- The stored water used for watering vegetation in the port
- Bioremediation to restore soil, caverns, and waterways

For 25 years in Stockholm, circular thinking has been incorporated into development decisions. Circular principles first appeared in Hammarby in Stockholm as Ecocycles I.0. The region has developed the necessary infrastructure to create a closed-loop waste-to-energy system. The system includes existing city-wide infrastructure systems such as district heating; He used it together with new technologies to convert sludge into fertilizer and biogas, such as the Högdalen combined heat and power plant and the Hammarby thermal power plant. The heat generated from the wastewater treatment process is used by the thermal power plant. Biogas is used for cooking and powering the public transport system. Garbage is burned to heat homes and businesses. So, sewage, waste heat, and wastes are used to generate energy.

Nowadays, circular developments occur in Stockholm's Royal Harbor. Ecocycles 2.0 was designed by developing Ecocycles 1.0 to cover resource cycles from both living and port environments. Organic waste generated from the maintenance of green spaces on ships and in the port is used to feed the waste-to-energy system. It is also used to produce compost that can replace fertilizers made with petrochemicals.

Added reuse system to the gray water system in Ecocycles 2.0. The system stores rainwater in retention ponds or caverns, which limits flash flooding in the SRSP. The system reduces the damage to the aquatic environment caused by the discharge of wastewater into the port. The stored water can be reused to irrigate the vegetation in the port. The green-blue infrastructure protects the gray infrastructure in the port. Finally, bioremediation has been used to restore soil, caves, and waterways[8].

3.1.5 City Analysis

The sustainability benefits of adopting circular systems in these cities were explored through interviews with key stakeholders. In the research paper, the author schematically created the table which is coming from the inductive content analysis. Then, She analyzed the four cities with the collective information from the key stakeholders' interviews. She summarizes the benefits of circular systems identified by service and infrastructure providers in the table.

In the table, she put the main eight circular systems and they are circular construction, circular food system, adaptive reuse of spaces infrastructure, water and nutrient recycling, waste heat recovery, waste to energy, ecological restoration, and reuse of goods. Then, she analyzes the four cities of European examples of the circular development related to the main circular systems. For example, according to the author's analysis, there are five circular systems in Amsterdam and London. Furthermore, Paris and Stockholm have four circular systems in the table. All the cities have a different distribution of circular systems. The author also places the city scale in the table in order to emphasize the importance of the circular development transmission in the city. She underlines if the city has circular systems in the city region or includes only one part of the neighborhood. For example, The Queen Elizabeth Olympic Park (QEOP) is in London and it is a very beautiful example of circular development and it has important effects on the city. Another relevant example from Stockholm is that circular principles called Ecocycles 1.0 were first manifested in Hammarby, one part of the city.

In the table, there is one column about circular actions coming from the systematic literature analysis of search terms. The author examines the circular systems related to three main circular actions in the cities that are looping, adapting, and ecologically regenerating. Because some of the circular systems do not include all the circular actions. For instance, the circular action of looping is related to all of the circular systems but adapting excludes some circular systems such as waste heat recovery, waste to energy, and reuse of goods. On the other hand, Ecologically generating includes only circular food systems, adaptive reuse of spaces, water and nutrient recycling, and ecological restoration.

The author analyzes the circular systems according to ecological, social, and economic benefits indicated by interviews with the key stakeholders from Amsterdam, Paris, London, and Stockholm. This part of the table is only related to information that comes from interviews. In the table, mainly ecological benefits are reducing material and land consumption, reducing GHG emissions, reducing food waste, increasing resource sufficiency, restoring ecosystem services, increasing

Circular Systems	City	Scale	Loop	Adapt	Ecologically Regenerate	Benefits Indicated by Interviews		
						Ecological	Social	Economic
Circular Construction	Amsterdam London Paris	City-region Neighborhood (QEOP) City-region	✔	✔		Reduce material consumption; reduce GHG emissions	Reuse of structures for community projects	Creates economic value; localized value chain; creates jobs; avoids landfill costs.
Circular Food System	Paris London	City-region Neighborhood (Brixton)	✔	✔	✔	Reduce food waste; reduce GHG emissions; increases resource sufficiency; restores ecosystem services, increase in environmental awareness	Empowers communities; opportunities to socialize; offers access to affordable food for low income groups; builds new skills in the community; increases community resilience	Creates economic value; localized value chain; creates jobs; activates vacant and unused spaces; avoids landfill costs
Adaptive Reuse of Spaces/Infrastructure	Amsterdam Paris London	Neighborhood (De Ceuvel) City-region Neighborhood (QEOP & Brixton)	✔	✔	✔	Reduce material and land consumption; reduce GHG emissions; restores ecosystem services; increases resource sufficiency; provides cultural services;	Stabilizes existing communities; increases community resilience; builds local symbiotic capital; builds new skills in the community; access to affordable accommodation; provides affordable accommodation	Reduces accommodation costs; creates economic value; localized value chain; creates jobs; activates vacant and unused spaces; increases value of property and land
Water and Nutrient Recycling	Amsterdam Paris Stockholm	City-region & Neighborhood (De Ceuvel) City-region Neighborhood (Hammarby &SRSP)	✔	✔	✔	Reduce potable water consumption; reduce GHG emissions; increases resource sufficiency; restore ecosystem services; increase in environmental awareness, increases resilience to climate change; increase food security		Creates economic value; localized value chain; creates jobs; reduces cost of water purification for non-drinking uses, increases value of property and land, avoids costs of grey infrastructure to present flooding.
Waste Heat Recovery	Amsterdam Stockholm	Neighborhood (De Ceuvel) Neighborhood (Hammarby &SRSP)	✔			Reduce fossil fuel consumption; reduce GHG emissions; increase in environmental awareness	Provides affordable heat	Reduces energy costs
Waste to Energy	Stockholm	Neighborhood (Hammarby &SRSP)	✔			Reduce fossil fuel consumption; reduce GHG emissions; increase resource sufficiency		Creates economic value; localized value chain; creates jobs.
Ecological Restoration	London Stockholm Amsterdam	Neighborhood (QEOP) Neighborhood (SRSP) Neighborhood (De Ceuvel)	✔	✔	✔	Reduce land consumption outside the city; restore ecosystem services; increase in environmental awareness; reduces GHG emissions; increases resilience to climate change	Health benefits; opportunities to socialize and for recreation.	Activates vacant & unused spaces; increases value of property & land; avoids costs of grey infrastructure to prevent flooding; avoids health costs; avoids chemical remediation costs
Reuse of Goods	London	Neighborhood (Brixton)	✔			Reduce material consumption and waste; reduce greenhouse gas emissions.	Empowers communities; opportunities to socialize; access to affordable goods for low income groups; builds new skills in the community	Creates economic value; localized value chain; creates jobs; avoids landfill costs

Figure 3.7: Benefits of circular systems identified by service and infrastructure providers. Reproduced from [8].

environmental awareness, providing cultural services, reducing potable water consumption, increasing resilience to climate change, increasing food security, reducing fossil fuel consumption, and reducing waste. In the table, Social benefits are reusing of structures for community projects, empowering communities, opportunity to socialize, offering access to affordable food and goods for low-income groups, building new skills in the community, increasing community resilience, stabilizing existing communities, building symbiotic capital, accessing to affordable accommodation, providing affordable accommodation, providing affordable heat, and health benefits.

Lastly, the economic benefits are creating economic value, localizing the value chain, creating jobs, avoiding landfill costs, activating vacant and unused spaces, reducing accommodation costs, increasing the value of property and land, reducing the cost of water purification for non-drinking uses, avoiding costs of grey infrastructure to present flooding, reducing energy costs, avoiding health costs, and avoiding chemical remediation costs in the table.

The author analyses the circular systems and recognizes their ecological, social, and economic benefits by using inductive content analysis that is created with systematic literature analysis and interviews.

The first system in the table is the circular construction and Amsterdam, London, and Paris have maintained different city scales. Amsterdam and Paris have a range of city-regions but London only has this system neighborhood scale in QEOP. The circular construction emerges from the circular actions of looping and adapting. Its ecological benefits are reducing material consumption and reducing GHG emissions. Secondly, its social benefit is reusing structures for community projects. Lastly, economic benefits are creating economic value, localizing the value chain, creating jobs, and avoiding landfill costs.

The second system is the circular food system in the table and it appears only in Paris with the city region and London with neighborhood scale in Brixton. Circular food systems include all the circular actions which are looping, adapting, and ecologically regenerating. Its ecological benefits are reducing food waste, reducing GHG emissions, increasing resource sufficiency, restoring ecosystem services, and increasing environmental awareness. Its social benefits are empowering communities, opportunities to socialize, offering access to affordable food for low-income groups, building new skills in the community, and increasing community resilience. Last, its economic benefits are creating economic value, localizing the value chain, creating jobs, activating vacant and unused spaces, and avoiding landfill costs.

The third system is an adaptive reuse of spaces infrastructure that emerge in Amsterdam with neighborhood scale in De Ceuvel, Paris with city region, and London with neighborhood scale in QEOP Brixton. This circular system includes all the circular actions. Reducing material and land consumption, reducing GHG emissions, restoring ecosystem services, increasing resource sufficiency, providing cultural services occur ecological benefits of this system. In addition, social benefits are: Stabilizing existing communities, increasing community resilience, building local symbiotic capital, building new skills in the community, accessing affordable accommodation, and providing affordable accommodation. The economic benefits of the adaptive reuse of the spaces are reducing accommodation costs, creating economic value, localizing the value chain, creating jobs, activating vacant and unused spaces, increasing the value of property and land.

The circular system of water and nutrient recycling emerged in Amsterdam both city region and neighborhood of De Ceuvel, Paris with city region, and lastly Stockholm with the neighborhood of Hammarby SRSP. This circular system includes

all the circular actions such as looping, adapting, and regenerating. The ecological benefits are reducing potable water consumption; reducing GHG emissions, increasing resource sufficiency, restoring ecosystem services, increasing environmental awareness, increasing resilience to climate change, and increasing food security. This system does not have any social benefits and finally, it has economic benefits and they are creating economic value, localizing the value chain, creating jobs, reducing the cost of water purification for non-drinking uses, increasing the value of property and land, and avoiding costs of grey infrastructure to prevent flooding.

The circular systems of the waste heat recovery appeared in the neighborhood of Amsterdam which is De Ceuvel, and the neighborhood of Stockholm which is Hammarby SRSP. The waste heat recovery has only one circular action that is looping. Its ecological benefits are reducing fossil fuel consumption, reducing GHG emissions, and increasing environmental awareness. Providing affordable heat is the only social benefit of this system. Then, reducing energy costs is also the only economic benefit.

The circular system of waste to energy is only in Hammarby SRSP neighborhoods of Stockholm and the system has only looping circular actions. Reducing fossil fuel consumption, reducing GHG emissions, and increasing resource sufficiency are the ecological benefits of the system. These are not social benefits of the waste to the energy system. Lastly, economic benefits are creating economic value, localizing the value chain, and creating jobs.

Ecological restoration is before the last circular system in the table. The neighborhood of London (QEOP), a neighborhood of Stockholm (SRSP), and the neighborhood of Amsterdam (De Ceuvel) have ecological restoration. The system includes all the circular actions such as looping, adapting, and regenerating. Reducing land consumption outside the city, restoring ecosystem services, increasing environmental awareness, reducing GHG emissions, and increasing resilience to climate change are the ecological benefits. Then, social benefits are health benefits, opportunities to socialize, and recreation. Finally, activating vacant unused spaces, increasing the value of property land, avoiding costs of grey infrastructure to prevent flooding, avoiding health costs, and avoiding chemical remediation costs are the economic benefits of ecological restoration.

The last circular system is the reuse of goods and there is only one in the neighborhood of London which is Brixton. It has only the looping circular action. The ecological benefits are reducing material consumption and waste and reducing greenhouse gas emissions. Social benefits are the most relevant and they are empowering communities, opportunities to socialize, accessing affordable goods for low-income groups, building new skills in the community. Lastly, the economic

benefits of the reuse of goods are creating economic value; localizing the value chain, creating jobs, and avoiding landfill costs.

3.1.6 Synergistic benefits

The author emphasizes that through case studies stemming from the cited interviews and technical reports, he provides some evidence that the three circular actions can work together synergistically to reinforce or multiply the benefits of circular development. For example, circular actions help regenerate urban ecosystems. Recycling soil, organic waste, gray, and wastewater removes pollutants and regenerates the local ecosystem. At SRSP, stormwater storage and greywater recycling reduced local flooding and the spread of pollutants into the port, which helped restore the marine environment. At QEOP, soil recycling schemes improved soil quality and ensured successful planting in the park. This has helped reduce air pollution, reduce runoff, and ensure local carbon sequestration. Energy recovery from organic waste, as operated in Paris, or without heat capture, as used at De Ceuvel, reduces greenhouse gas emissions. Recycling leftover nutrients to provide food protein helps regenerate ecosystems by reducing the land needed to grow food and emissions from transport, as in Amsterdam.

Urban ecosystem regeneration can also increase support and regulatory ecosystem services that enhance natural cycles for water, organic waste, and nutrients. Providing blue-green infrastructure softens water flow and storage; it limits the overflow from the sewer and thus reduces the contamination of the drinking water supply, an approach adopted in the QEOP. This technique also produces organic waste that can be composted and used to improve local soil quality, as seen in the SRSP. It also reduces greenhouse gas emissions associated with the landfilling of fertilizers and organic waste. Bioremediation increases the potential for the reuse of contaminated areas in cities. Phytoremediation enabled the polluted area in De Ceuvel to be reused for commercial and leisure activities. Naphtha microbial remediation in caves at SRSP enabled it to be reused for rainwater storage, which was then used locally to irrigate vegetation[8].

Ecologically regenerative actions also increase the adaptability and resilience of urban ecosystems. Healthy urban ecosystems support the production of resources that increase urban resource security. The clearest example of this is urban agriculture. In both London and Paris, urban agriculture is seen as part of the solution to improving local food security. Local food production increases access to fresh food and can thus improve human health. More broadly, the integration of BGI into cities will improve population health and increase urban resilience to pandemics. All interviewees at SRSP, Paris, and QEOP emphasized the link

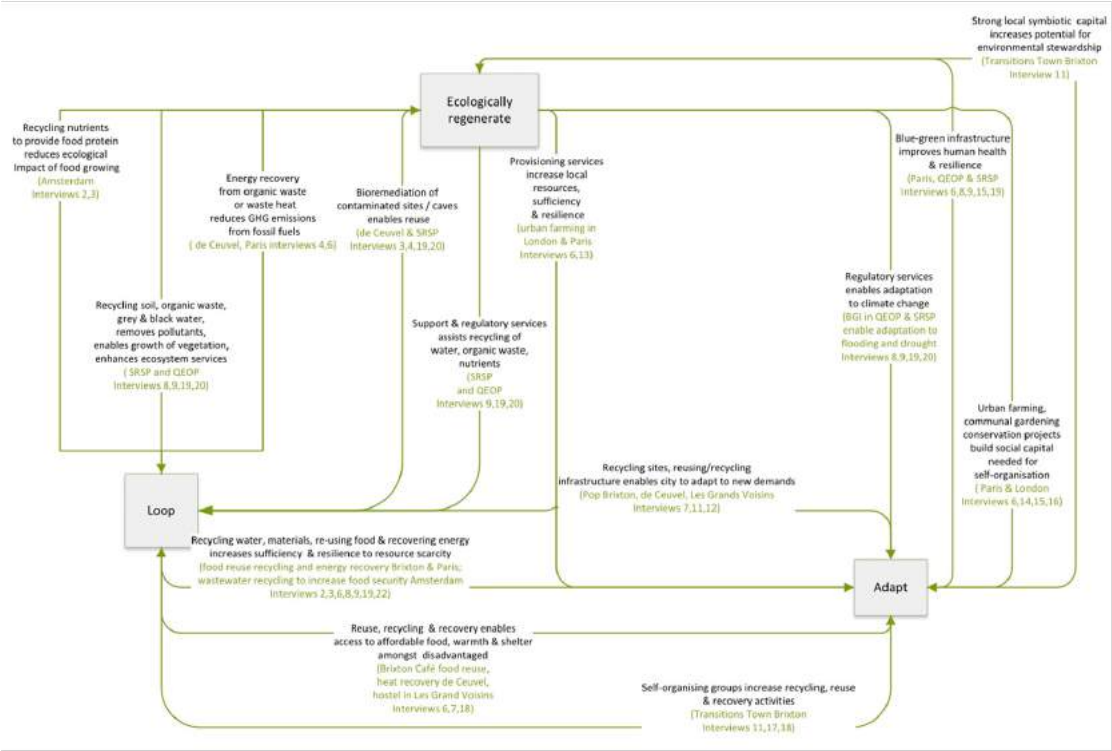


Figure 3.8: Synergistic benefit. Reproduced from [8].

between a healthy ecosystem, a healthy population, and urban resilience. BGI also helps regulate local climate and water cycles, allowing urban systems to adapt to climate change. This was an important motivation to include BGI in SRSP and QEOP developments.

Circular actions can also help increase the adaptability of urban ecosystems, which helps build urban resilience. Recycling sites and infrastructure allow the city to adapt. The use of temporary planning permits and leases allows cities to react quickly to rapid changes in the landscape, such as economic and health crises. This process provides temporary spaces for pop-up circular events, as seen in London and Paris. It also provides space for events reflecting local needs, for example by providing a hostel and allotments at Les Grands Voisins. This flexibility in the use of space in cities increases urban resilience.

Recycling water, reusing food and recovering energy can help increase local sufficiency and resilience to resource scarcity. Blackwater recycling was introduced at the QEOP to mitigate drought problems in the region. This is a problem that is expected to be exacerbated by climate change. Food reuse in Paris is part of the

capital's food security strategy. Energy recovery from waste materials and heat in Stockholm reduces dependence on fossil fuels. Thus, the city is more energy safe.

Circular actions also increase urban resilience by providing affordable resources for low-income groups. This is especially important when there are rapid economic changes and the proportion of low-income groups in the population is increasing. For example, repair cafes and food reuse schemes in Paris and London have increased access to affordable food and goods among the urban poor. Temporary reuse of buildings to provide affordable shelter was also emphasized. Capturing waste heat from buildings such as in de Ceuvel or wastewater treatment such as in Stockholm can also potentially provide affordable heating for low-income households.

Public participation in all the circular activities helps build local human, social, physical, and economic capital for example local symbiotic capital. This increases the adaptability and resilience of society. The Brixton case illustrates this best. Here, local expertise has developed in growing food, generating renewable energy, repairing old furniture, and reusing empty spaces. Necessary infrastructure and spaces have emerged to support these activities. In this process, some economic capital was produced and social networks were strengthened. The creation of these local capitals provides the infrastructure needed for the community to remain agile and resilient to external pressures. It also provides resources to enable environmental management. Thus, the evidence suggests the need to take a more holistic approach to circular development to reap the synergistic benefits noted. However, these findings are largely based on anecdotal evidence. It is important to monitor the synergistic benefits of circular development if there is to be a strong justification for its adoption[8].

3.2 Conclusion

Every city is unique and every city has different characteristics. These features greatly affect the systems and subsystems of the city. Therefore, each city should be carefully analyzed with its pros and cons. It should be examined how the circular actions that are looping, adapting, and ecologically regenerating are located in city systems.

There will be benefits that the city will have after the circular developments in the city. These benefits are primarily ecological, social, and economic. All these benefits should be foreseen after analyzing the city. Adjustments and improvements should be made according to these benefits for the city.

Each city must discover its own circular actions that enable ecological benefits to emerge. Ecological benefits such as reducing resource consumption, reduction of greenhouse gas emissions, and increasing urban capacity to adapt to climate change.

Local cycling such as local circular food systems, community energy; and regenerative actions like community gardening, conservation projects, urban agriculture can increase environmental awareness among the public.

Circular actions should increase access to resources in communities such as goods, accommodation, heat, clean air, green spaces. For example, furniture reuse can reduce challenges and help build human capital. However, it should be noted that the benefits of circular actions may not be experienced equally across communities. For instance, low-income households have less access to green spaces.

Circular actions should result in economic benefits such as supplying and production costs to manufacturers, economic value creation, diversification of the economy, and creating employment.

Pop-up events allow the city to reactivate unused spaces, increase local vitality, increase local land values and stimulate the local economy. Therefore, pop-up events in the city can be a significant circular action for the economic benefits to emerge.

The concept of the circular city began to emerge in Europe after 2014, and the European Commission followed the publication of a series of policy documents. This was followed by the Netherlands, Scotland, Finland, and Germany having national strategies for CE as of 2016. As can be understood from this, there are some circular developments in some European cities. Therefore, cities such as Amsterdam, Paris, London, and Stockholm, which are on the way to becoming circular cities, can be taken as examples. These cities should be examined as a case study.

Every city defines circularity in a different way. Such as focusing on the application of CE principles with the framework of RESOLVE of six actions, supporting circular business models like London, promoting industrial symbiosis like Rotterdam, or managing municipal material waste like Lisbon.

Furthermore, Amsterdam recognizes the importance of implementing the CE strategy as part of an integrated approach to sustainable development alongside policies for environmental regeneration, adaptation, and resilience. As seen in these examples, the motivations for adopting circular development in cities also differ significantly. Each city needs to find its own motivation to adopt circularity in

accordance with its own urban systems and urban character.

Amsterdam took into consideration the connection between waste producers and users, looping the construction and organic waste by creating the smart data about wastes, encouraging the pop-up circular experiments, reusing the houseboats for different activities, gray water cycling as a circular action.

Paris has circular actions such as looping construction materials, food, and water, particularly, covering the city's roofs and walls with 100 hectares of vegetation, replacing the existing gray infrastructural system with a blue-green alternative.

London instead of other cities has a strong example of a park with circularity. The Queen Elizabeth Olympic Park (QEOP) has a process of ecological restoration such as bioremediation, local clean-up programs, conservation schemes, sustainable drainage systems, circular construction systems such as soil-washing, materials exchange platforms, resource banks.

Stockholm has the circular principles for 25 years is called Ecocycles 1.0. There are thermal power stations, purifying wastewater, organic waste from seaports used to feed the waste-to-energy system, the stored water used for watering vegetation in the port for circularity.

As can be seen from these sample cities, the main issues are the waste management in the city, looping the construction, organic, food, material, and water, reusing the public spaces, greenery, etc. The integration of all these phenomena with each city should be studied in order to enter the path of being a circular city. In addition, applying circularity in only one part of the city, examining that region, and starting the applications can be a solution for the beginning.

Chapter 4

A method to characterize the circular city and its application to Turin

4.1 Turin as a circular city, general overview of Turin

The history of Turin stretches from Roman times to the birth of the Italian state and to the present day. For much of the 20th century, Turin was the industrial capital of Italy and home to an enormous array of automotive and mechanical manufacturing firms and related industries that fueled Italy's post-war "economic miracle".

Today, Turin is known for its technological, engineering, higher education, design, and manufacturing professions, a strong legacy of social activism, a progressive political and intellectual tradition, and an important artistic and cultural heritage that drives a growing tourism industry. As the regional economic engine, Turin has extensive infrastructure, including an international airport, intermodal cargo port, and high-speed rail links to Milan and the rest of Italy. (green capital)

4.1.1 Urban development of Turin

There are two main factors that are vital to understanding Turin's urban development:
The first one is that all the central city was developed from the mid-1500s through the 1800s. While the Baroque style is very well preserved, it adapts the urban core

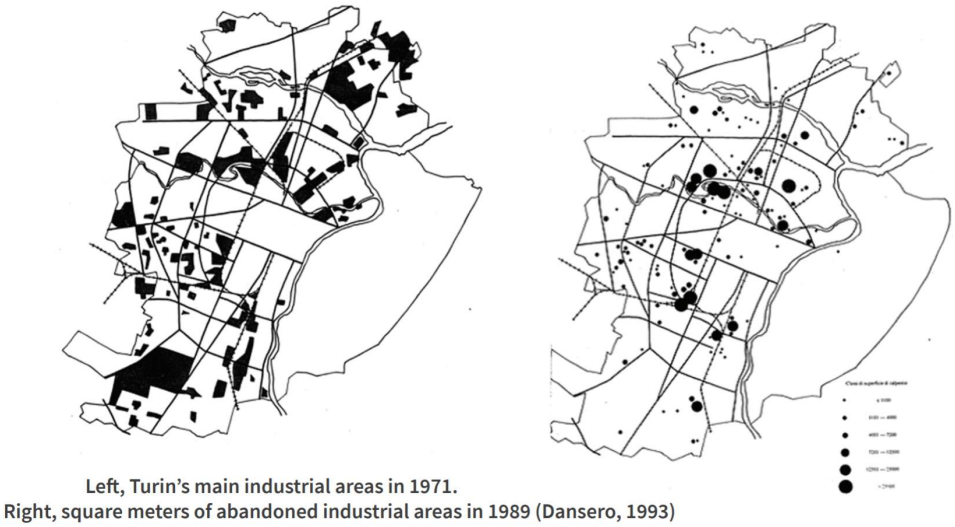


Figure 4.1: Turin maps 01. Reproduced from [10]

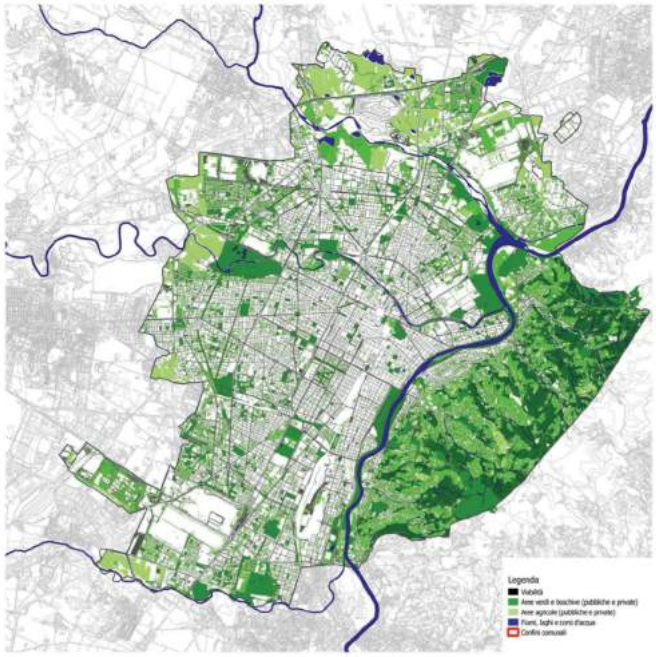


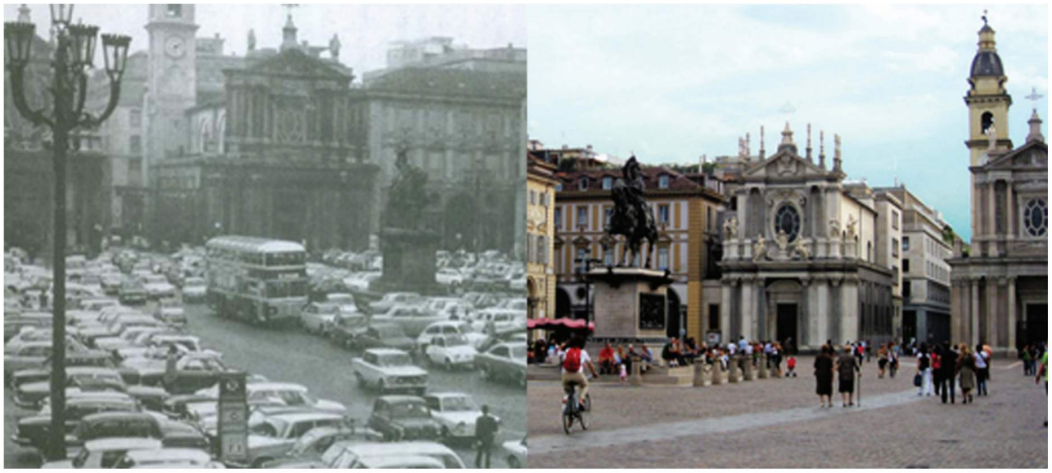
Figure 4.2: Turin maps 02. Reproduced from [10]

to modern challenges and develops new infrastructure within it.
The second one is the absolute centrality of the industry as the driver of the major expansion of the city from the 20th century to the 1970s.
The city expanded furiously to accommodate industrial growth and a massive influx of migration from southern Italy, fueling extremely rapid urbanization in the span of just a few decades[10].

Turin is one of the greenest cities in Italy with 50 m2 of green space per capita. While the city has been fortunate to inherit large parks and greenways from its baroque past, its targeted efforts to transform brown areas into green spaces, turn river corridors into ecological green belts, and create neighborhood green spaces with every redevelopment project have yielded highly successful results.

4.1.2 Transformation of mobility in Turin

On the mobility front, Turin has gone to great strides to overcome a cultural infatuation with the private automobile to public transformation. Even Turin's most prestigious public squares were completely overrun by the automobile. In



Left, Piazza San Carlo prior to pedestrianization. Right, Piazza San Carlo after being pedestrianized.

Figure 4.3: Turin transportation. Reproduced from [10]

addition to major improvements in the transportation sector, which have reduced greenhouse gas emissions significantly, Turin has made enormous strides in the heating sector as well and is now the most district-heated city in Italy with over 50% of the city connected to district heating systems.

4.2 Why is Turin better analyzed as a circular city in Italy?

The municipality of Turin has adopted the circular city approach and it is very clear when we examine the projects of Turin. Turin already has future plans in order to adapt the circular city approach. There are the actions for the Turin of the future and the evaluation of the ecosystem services of the green areas of Turin.

As part of the development policies of green infrastructure and to combat climate change, the City of Turin has chosen to undertake the project "Evaluation of ecosystem services in public green areas of Turin": a study that aims to enhance ecosystem services products from the public parks currently present in the city and the relative methods of implementation to cope with the changed climatic conditions.

The ecosystem services considered are related to the storage of atmospheric carbon, the removal of atmospheric pollutants, temperature regulation, hydrogeological protection, the infiltration capacity of rainwater, biodiversity and habitat quality, social benefits, agricultural production, and pollination.

The project also provides for the economic evaluation of the ecosystem services produced by the public green areas present in the territory of the Municipality of Turin to provide a concrete element of comparison and enhancement of the same. Furthermore, the most suitable nature-based solutions will be identified to mitigate the negative impacts on climate risk areas. Furthermore, defining scenarios that will in turn be subjected to a cost-benefit analysis with the aim of delivering to the Municipality a climate-proofing strategy that allows it to correctly address the investments and planning actions of the City[9].

Turin has more than two millennia of history and, over time, has experienced great transformations that have allowed it to rethink its identity and vocations. This long history is reflected in a varied and stratified territorial and cultural identity. The transformation processes, whether they are oriented towards the realization of the Roman fortified settlement, of the capital of the Savoy kingdom or of the capital of Italy, of the capital of industry and, more recently, of an international city, of events, design and 'innovation, have constituted moments in which the energies of the city have been channeled towards a development project and a precise vision of the evolution of the city.

Aware of the great efforts made over the years, especially recent ones, to combine

other vocations with the industrial one, and to redevelop and enhance the urban fabric, today we are called to further develop this path by imagining and creating a city that puts the well-being of the citizens and citizens and the quality of life.

Maximizing well-being and guaranteeing a high quality of life means achieving a positive balance between the different dimensions of the life of citizens and the city itself, the social, economic, and environmental ones so that synergies, complementarity, and stability are created that allow citizens and citizens to build their own life projects, a future for themselves and their children[9].

A city that takes care of and promotes these dimensions in balance is a far-sighted city, capable of building its own future. And it is this balance that makes the fabric of a city solid, a balance that allows a community to overcome even emerging challenges, sometimes unpredictable because they are able to sustain them, regenerate, and restore that balance. It means being resilient.

High quality of life and the urban environment, widespread well-being and a territory full of opportunities, the dynamism of the townspeople, the institutions, the availability of stimulating talents and minds, the attractiveness of lifestyles, are qualities increasingly sought after by those who are willing to move and adopt a new city where they can launch a business or build their own life project. It is the combination of these qualities that make cities increasingly attractive and competitive, capable of retaining young people and attracting families and talents.

To strengthen this balance, it is necessary, in addition to maintaining what has been built over the years, also to rethink the city for an increasingly dynamic future. Let's imagine an administration that listens and is capable of responding to the needs of citizens, through participatory paths. A city that has as its priority the right to housing, health, work, food, culture, a healthy and clean environment, the development of economic opportunities, safety, space to play, create, express oneself. A city that is inclusive for vulnerable people, in which access to welfare and basic services, the right to education, is guaranteed.

4.2.1 Turin follow the roles of The New Urban Agenda for Europe, 2017

Circular cities began to emerge in Europe at the end of 2014 and then some important publications and policy documents about CE were produced by the European Commission. Some European countries had relevant national strategies for CE and they started to pioneer the circular city approach. Year by year, European countries have joined them. By 2018 Italy was one of the countries that participated with

them[6].

The New Urban Agenda for Europe set up a particular partnership for the implementation of CE at the urban scale that is called Partnership for Circular Economy, 2017. Turin was one of the cities that declared their intention to adopt a circular approach to urban economic development and Turin has begun to develop its circular strategies[6].

"The Urban Agenda for the EU is an integrated and coordinated approach to dealing with the EU's urban dimension and national policies and legislation. The Urban Agenda aims to improve the quality of life in urban areas by focusing on concrete priority themes within dedicated Partnerships. In 2016, the Amsterdam

Figure 4.4: Timeframe in Urban Agenda Partnership of circular economy, 2017. Reproduced from [35]

Pact, adopted by EU Ministers for Urban Issues on 30 May 2016, established the Urban Agenda for the EU. Based on the principles of relevance and proportionality, the Urban Agenda focuses on the three pillars of EU policy-making and implementation: Better regulation, Better financing, and Better information[36].

So far, 12 partnerships have been identified. In 2016, four Partnerships were launched on Migrant and Refugee Inclusion, Air Quality, Housing, and Urban Poverty. Four more people started their work on the Circular Economy, Digital Transition, Urban Mobility, and Jobs and Skills in the Local Economy in February 2017. Four more will be launched before summer 2017 on Energy Transition, Climate Adaptation, Innovative and Responsible Public Procurement, and Sustainable Use of Land and Nature-Based Solutions.

Every Partnership includes voluntarily and equally cities, Member States, the Commission and stakeholders such as NGOs or businesses. They work together to develop and implement concrete actions to successfully tackle the challenges of cities and contribute to smart, sustainable, and inclusive growth.[36]"

In the table of timeframe, we can see that there was a plan of the evaluation of the action year by year. By 2017, they agreed to stocktaking, developing scoping fiches based on the topics chosen, identifying bottlenecks, and possible actions. By 2018 they had planned to draft an action plan, fix public consultation and feedback, and finalize the action plan. Finally, by 2019 there was a plan to implement the action plan and evaluation of the partnership. After this timeframe, they discussed

Figure 4.5: 12 Priority Themes in Urban Agenda Partnership of Circular Economy, 2017. Reproduced from [35]

the 12 priority themes for the circular city. They distinguished them into three groups and they are smart, green, and inclusive. The priority themes are innovative and responsible public procurement, circular economy, urban mobility, jobs and skills, digital transition, affordable housing, air quality, climate adaptation, energy transition, the inclusion of migrants and refugees, urban poverty, sustainable use of land, and nature-based solutions.

There were six criteria to choose among several potential actions, a set of six criteria function as guidelines and they are; 1. Cities' needs, 2. Fit the concept

of the Circular Economy, 3. Potential for improvement, 4. Reality check, 5. Expertise, 6. Added value. There are four main topics and working groups in the

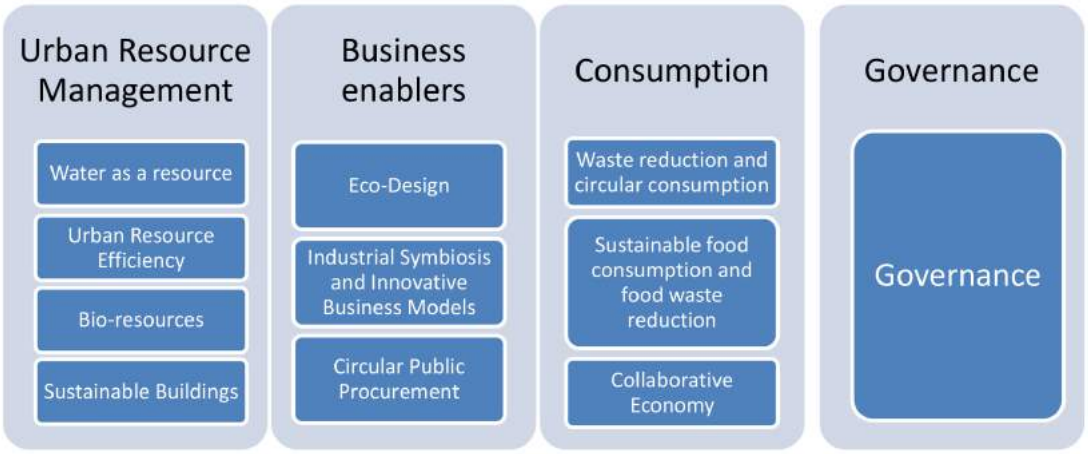


Figure 4.6: Topics and working groups in Urban Agenda Partnership of Circular Economy, 2017. Reproduced from [35]

Urban Agenda Partnership of Circular Economy. The first one is urban resource management and its subtopics are water as a resource, urban resource efficiency, bio-resources, sustainable buildings. The second one is that business enablers and their subtitles are eco-design, industrial symbiosis and innovative business models, and circular public procurement. The third one is about consumption. Water reduction and circular consumption, sustainable food consumption and food waste reduction, and collaborative economy are the subtopics of consumption. In the end, governance is the last working group[35].

Finally, they also produced the list of the draft actions in November 2017. They are:
1. Proposal for revised water, waste, fertilizer, etc sector legislation
2. Circular Economic incentives
3. Mainstreaming Circular Economy dimension into impact assessments
4. Mainstreaming Circular Economy thinking into ISO 14000
5. Circular Economy funding map
6. Mainstreaming CE as an eligible area in the new structural funding program
7. Circular City Repository ("one-stop shop for the circular city")
a)Including food waste prevention and measuring methodology
8. Promote the use of «brokerage» at the city level
9. Elaborate the concept of "resource centers" (including social economy aspects)[35]

4.2.2 Turin joined the International Urban Cooperation program (IUC) European Union

Turin has joined a competitive application process by the IUC program to pair between European Union cities and the United States. The aim of this study is that the paired cities needed to work together for a minimum of 14 months to mutually sustainable urban development challenges. Turin was paired with Baltimore, Maryland in December 2017[37].

"Cities today are the laboratories where many innovative solutions emerge to address the biggest economic, social, and environmental challenges facing our societies," said David O'Sullivan, the European Union's Ambassador to the United States. "The European Union is proud to support the IUC program so that EU and US cities can work together on sustainable urban development initiatives that will benefit citizens on both sides of the Atlantic.[37]"

As cities around the world face increasing challenges such as migration, social inclusion, quality of life, climate change, and globalization, the program supports pairings to foster collaboration, share experiences, and exchange knowledge. At the same time, they are part of a larger international community of colleagues and stakeholders involved in sustainable urban development. IUC contributes to the UN 2030 Agenda Sustainable Development Goals, New Urban Agenda, Sendai Framework, and Paris Agreement goals that improve the quality of life in urban areas.

IUC program is available to make up the information on each of the components that are: City to city cooperation on sustainable urban development: By pairing up EU with non-EU partner cities, the IUC boosts access to expertise in urban development policy, helping cities promote smart, green, and inclusive growth. Working with like-minded partners, it fosters better ways to plan, finance, develops, govern and manage cities, and supports the New Urban Agenda decided in Quito.

Sub-national action under the Global Covenant of Mayor's initiative: Cities consume two-thirds of the world's energy. The Covenant of Mayor's initiative promotes local actions and facilitates city-to-city cooperation to reduce CO2 emissions, adapt to climate change and ensure access to clean and affordable energy.

Inter-regional cooperation on innovation for local and regional development: Cities and regions can generate growth by innovating and sharing expertise on clustering, global value chains, and Smart Specialisation Strategies. This is important in

Latin America where governments are trying to diversify their commodity-driven economies[37].

4.2.3 "Turin 2030: Action Plan for the Turin of the Future"[9]

Participative (A city of active towns, citizens, and neighborhoods)

The actions are: The Town Plan for the participated city; Turin digital | Civil planning Co - City / AxTO; Turin Performing Arts; New Central Civic Library; Turin Educational City; New regulation for common goods; The green I would like; Decide Turin

Participation is one of the cardinal principles of a sustainable and resilient city. Thanks to the involvement of citizens in the construction of city policies, the Administration responds to the increasingly evolving needs of its communities. It is actual participation that more easily ensures the right balance between the social, economic, and environmental dimensions, especially when participation is broad and transversal, not sectoral or privileged.

With the active participation of citizens, it is also possible to anticipate structural changes in communities, prepare for future and evolving scenarios, thus creating the conditions for resilience. The Participated City listens, communicates, involves, and collaborates internally and externally, and in this way it senses and reacts in time to social, economic, and environmental changes.

In the Participated City, the transparency of administrative and decision-making processes is guaranteed, the data are shared, accessible, and easy to understand so that all citizens are informed and aware and can take action for their own interest and for the common good. Transparency, information, and accessibility of the Administration are therefore essential prerequisites for active citizenship, capable of interacting constructively with the Administration.

In the Participated City, on the one hand, the involvement is aimed at the development of public policies and the improvement of services, through the collection of opinions, ideas, projects, indications, and recommendations. Participation allows intelligent integration between policies from different sectors, ensuring not only greater sharing, but also more effective policies and services for citizens and citizens.

On the other hand, the Participated City puts citizens in the conditions to be proactive and to get involved in the development of civic life, in the design of public

spaces and in the management of structures, in launching their own initiatives, developing new projects, networks, services, and businesses, organizing solidarity activities in the neighborhoods in the car[9].

Dynamic (A city rich in culture, innovation, opportunities, and talents)

The actions are: The master plan for the dynamic city; Turin City Lab; Agile Administration Open for Business; the City of Research for Innovation and Development; Tourist Turin; University City; UN Campus Century 21; Turin City of food; ATP Finals Turin 2021-2025

Torino Dinamica is an attractive city, both for talents and for capital, for the quality of the economic fabric that characterizes it, for the ecosystem of innovation it has developed, for the cultural offer it knows how to express, and for the strong propensity towards new technologies that distinguishes it. By enhancing the industrial, technological, and cultural vocations of the area, Torino Dinamica invests in local knowledge and encourages innovation. It is a curious city, which experiments, supports, and grows skills and projects by acting in a corrective and agile way when necessary. It has adequate technological infrastructure for the development and demand for innovative projects. Identify new opportunities, anticipate and react promptly to events. Torino Dinamica is a laboratory city, where the most advanced technologies are developed and tested, where each district becomes a place of experimentation, which allows projects to overcome the start-up phase by generating services with perceived economic and social repercussions.

Torino Dinamica invests in knowledge and supports its vocation as a university city, culture, scientific research, also in relation to industrial production and work. It is a city that is home to around 110,000 students who work, live, study, have fun. It is a city within a city, an extraordinary wealth to be promoted and planned to attract more and more talents, to make them grow, creating strong links with the territory, giving them new opportunities for work and life in the city. In Dynamic Turin, the University City and the innovation ecosystem feed and reinforce each other in a virtuous cycle capable of always generating new opportunities.

Vocations, in fact, also find expression in a logic of urban development oriented around innovation poles, in particular in the fields of energy and industry 4.0, the circular economy, aerospace, and automotive.

The Dynamic City, full of opportunities and talents, stimulating and at the forefront of innovation, attracts those looking for a fertile place to do business because in Turin they find the right skills and conditions to get their idea off the ground. But

not only that, it also attracts those who are looking for innovation and are willing to invest to accelerate their landing on the market. The Dynamic City knows how to dialogue and intercept these resources and supports them in the settlement phase on the territory[9].

Liveable (An accessible, circular, healthy, and green city)

The actions are: The master plan for the liveable city; Turin towards zero waste; Green resilient; Sustainability laboratory; Renovated public transport; ITS and mobility as a service; Turin Open Center; Safe roads

The Livable City is a city in which to enjoy a high quality of life, on a par with the most attractive and welcoming cities in the world. It is a city for all ages, for all communities, for those who visit it for a few days, for those who live it daily, for a few months, for a year, or for a lifetime.

If the quality of life can be defined as a set of characteristics that, on the one hand, make daily life pleasant, usable, and efficient, on the other, make it feasible to carry out complex life projects for each citizen because the urban environment facilitates their choices. The Torino Vivibile possesses these characteristics.

It is a beautiful city, with an urban quality that responds to contemporary lifestyles, capable of evolving to accommodate the needs of today's citizens as well as of the new generations. It is a clean city, where the environment and public spaces are decent and respected.

The Livable City promotes physical activity, but also comfort, which allows citizens and visitors to express themselves freely, to adopt healthy lifestyles, to grow and move with full respect for everyone. This means creating spaces for dynamic, collective, and individual mobility, mobility that focuses on the well-being of people, capable of making young and old alike independent, in every part of the city.

In the Livable City, sport is for everyone and everyone, it is a moment of aggregation and collective fun, it is a civic right with a strong inclusive value and a recognized social attitude. It is a city where sports also become a tool for integration and socialization, for the promotion and protection of health and psychophysical well-being, and prevention of the main pathologies related to a sedentary lifestyle.

The Livable City is a green city, rich in natural and landscape-attractive environments, which favors contact with nature and progressively the renaturalization of highly urbanized areas, preserving the environment and the territory. It is a city

that has natural systems capable of coping also with risks and problems related to the climate, it is an environment resilient to changes.

The Livable City is also a sustainable city, capable of rethinking its urban metabolism with a view to efficiency and circularity, reducing consumption, and producing waste. It is a city that changes its paradigm, thinking in an innovative way about the production of materials, products, energy, mobility, trade, culture, and also social exchanges with less impact on natural resources. The Livable City acts in a circular way, so as to maximize resources and not waste them.

Realizing this vision means adopting a holistic and listening approach, developing structured and integrated strategies, for example on air quality, the waste cycle, the circular economy, the well-being and safety of citizens, green infrastructures, animal protection, and more sustainable lifestyles. It means overcoming the perspective of environmental emergencies in favor of forward-looking planning of interventions[9].

Supportive (A city of rights)

The actions are The Town Plan for the solidarity city; Social inclusion plan; Special project for nomad camps; Capital of rights; Coordination guidelines policies for interculturality and participation; Work for everyone; Reorganization of access to the educational service 0-6 years.

The cardinal principle that guides the Solidarity City is the centrality of the person and the promotion of processes of autonomy and growth of individuals. The goal is to give people concrete tools to play an active role in the exercise of their fundamental rights: the right to work, inclusion, education, equal opportunities. The challenge maximizes resources for investments and active policies in support of welfare and education while keeping the accounts in order.

Human rights and respect for them, the fight against all forms of discrimination, and a positive approach to ensure equal opportunities for all citizens and all citizens represent the heart of the action of the Solidarity City. A Solidarity City opposes zero-sum logic and facilitates dialogue, mutual understanding, and mutual respect between the various parts of society, building spaces to promote and strengthen aggregation, protagonism, and the active involvement of citizens.

Torino Solidale promotes mutual knowledge and respect between citizens and citizens, communicates with the social fabric of the city, with those who bring wealth to it, who enter into a relationship with the city, whether they are residents,

students, commuters, tourists, care, and every other person. The approach of Solidarity City is the intercultural one, assuming the comparison and exchange between cultures and placing citizenship and participation at the center of its work. The Solidarity City responds to existing conflicts in society, avoiding their destabilization and the struggle between its components. Integration and inclusion mean thinking of the city as a set of communities that communicate, listen to each other and are attentive to the processes of knowledge.

Torino Solidale safeguards and promotes the rights of the most vulnerable, guaranteeing social and health care, providing more opportunities and attention to disabled citizens, increasing integration, working to cope with the criticalities of the nomad camps.

School is one of the main tools of equal opportunity. Investing to guarantee a quality educational path to all girls and boys is the best bet to reduce inequalities, fight prejudice and improve social cohesion. Torino Solidale looks to young people by including them in decision-making and political processes and in support of their personal, professional, and social growth, favoring their full realization and complete inclusion in the social fabric. Torino Solidale invests in scholastic and educational institutions capable of giving due recognition to every type of intelligence, respecting the times, inclinations, and attitudes of each one, allowing the growth of capable and aware adults.

Torino Solidale monitors the evolution of needs and the effectiveness of the responses that public services are able to provide. With this information, the City is able to respond to the needs of its communities and accompany them on a long-lasting path of self-determination[9].

4.2.4 Turin is finalist 2022 of European Green Capital

Turin has applied to be recognized as the European Green Capital for several reasons; at least one of them was the opportunity to take a comprehensive stock of the major strides Turin has made over the past 25 years towards a more sustainable and resilient city.

As is often stated, Turin began this journey in an era of dramatic post-industrial transition and economic, social, and environmental crises. The scale of the transformation over the last 25 years has been enormous, especially considering the starting point: from 10 million square feet of abandoned industrial land to green open space that has nearly doubled; transport, from a system largely built around private cars to a public transport system where more than 50% of passengers ride purely

electric vehicles; from inefficient and polluting heating systems to one of Europe's largest district heating networks; from a historic building stock to an innovative energy efficiency regulation; From public spaces used as parking lots to nearly half a million square meters of pedestrian areas and more than 200 km of private bike lanes.

In all these areas, Turin has made tremendous strides not only in achieving what many cities are still struggling to achieve but also in a time of crisis, innovating at every opportunity and leveraging transformation to create new conditions for growth. and improving the quality of life of the entire community[10].

Climate Change: Mitigation and Adaptation

Turin's medium-term goal is to reduce its CO2 emissions by 60% by 2030. The long-term goal is to further reduce emissions to achieve net carbon neutrality by 2050. To achieve these goals, the City of Turin will seek to implement existing relevant planning documents and tools and to implement them in collaboration with local stakeholders and residents. To this end, the City, in cooperation with the Polytechnic University of Turin, is working on the establishment of an Energy Center that will be in direct contact with citizens and professionals working in the energy and environmental sectors.

Other planned actions include:
- revision by 2021 of the General Urban Master Plan, a planning tool that regulates urban development and land use to meet stringent energy consumption and emissions targets;
- revision of the Energy Efficiency and Sustainability Code with tighter standards for both public and private real estate, and greater incentives for major renovations and new construction;
- Development and approval by February 2021 of the Metropolitan City of Turin Sustainable Urban Mobility Plan, a medium and long-term strategic plan to improve mobility and transport by opting for public and clean modes of transport;
- Completion of the 5.3 km extension of the existing metro line 1 to the south and west by 2023, with a total of 6 new stations, with a total cost of 464 million euros
- Construction of the second metro line of the city with a total investment of approximately 3.7 billion euros until 2028. So far, the City has approved a preliminary project for the construction of new infrastructure that can handle more than 284,000 passengers per day and more than 34,100 passengers per morning rush hour. With the opening of the second line, it is expected to carry 75 to 85 million passengers per year. In terms of mod share, in 2028 this line will meet 13.1% of the mobility demand during rush hour and significantly reduce the mod share of private vehicles (from 67% to 59%);

- Infrastructure and technological investments to increase the efficiency of the Metropolitan Rail Service (SFM)

The City's Climate Adaptation Plan aims to reduce the impacts of climate change on human health and comfort, as well as the environment and urban infrastructure, in accordance with the following objectives:
- reducing the occurrence of a critical event (ex: heat islands, regular flooding)
- adapting the urban environment and services to reduce exposure and manage emergencies;
- adapt existing buildings to improve quality of life and limit energy demand;
- managing the evolution of urban ecosystems;
- develop a culture of climate risk when planning public works;
- preparing citizens to face new conditions.

The Climate Adaptation plan will be integrated into other planning and policy instruments, in particular the General Urban Master Plan, the Sustainable Urban Mobility Plan, the Emergency Management Plan, and the Strategic Green Infrastructure Plan[10].

Sustainable Urban Mobility

Turin's new Sustainable Urban Mobility Plan will promote intermodality, strengthen metropolitan public transport, develop electric and shared mobility, reduce public spaces for parking, and encourage remote working, as well as cycling and walking. In addition, it will make urban areas more livable, including greener infrastructure and safer, more walkable neighborhoods, in line with the vision of the newly revised General Urban Master Plan (which is currently underway). The main actions will include:
• extension of metro line 1 by an additional 5.7 km, adding 6 new stations at a cost of approximately 464 million euros;
• Construction of 2 metro lines with 26 km and 33 stations until 2028. The total cost is estimated to be 3.7 billion euros;
• completion of the metropolitan rail service (SFM) network with the creation of new Dora, Zappata, and San Paolo train stations and parking and driving areas linked to the LPT;
• new intermodal nodes in the metropolitan area (park and boarding areas and intercity, interregional, national, international bus line terminals)[10].

Sustainable Land Use

Green infrastructure in cities will continue to be increasingly important, both for its recreational value and for its ability to generate ecosystem services that will

become more valuable than ever in the face of climate change and more frequent extreme weather events. Turin wants to be not only the greenest city in Italy but also the largest greenest city in Europe. The development and evolution of the city's Green Infrastructure system will follow the main objectives set in the almost completed Strategic Plan for Green Infrastructures (SGIP):
1. Meeting the needs of a population in transition
2. Reduce climate gaps through ecosystem services
3. Increase ecological health and biodiversity
4. Build more connections than ever between green spaces
5. Leverage green infrastructure for greater social inclusion and participation
6. Take advantage of green infrastructure in the development of cultural and outdoor tourism

The digital management tools, including the precise mapping of every centimeter of public green space on QGIS and the Atlas of the Digital Tree of Turin (Albera TO), will progressively increase the efficiency of management and maintenance operations. Moving from fragmented maintenance contracts to the Global Service model will also increase efficiency. The city is currently developing an approved sustainable urban forest management plan for all public forests in the eastern hills of Turin and this will be expanded into ecological corridors in a second phase. The city's green code and revised master plan will continue to simplify the management of existing private green infrastructure, encourage the installation of additional green infrastructure in all new developments and major renovations, control sprawl, and prevent the development of areas green.

The annual budget is allocated over 10 million euros per year (excluding personnel costs) for the maintenance and construction of green spaces. Additional funding comes from municipal incinerator operations and environmental compensation from private development. New public-private partnerships are giving rise to new forms of financing both for the construction and maintenance of green infrastructures. The city's priorities are established in the SGIP and negotiated directly with specific stakeholders as well as national intermediaries committed to bringing private stakeholders together with public stakeholders. The overall Master Plan review process requires an environmental review of the overall impacts of the proposed plan. The changes to be made to the plan will affect the city in terms of mobility, CO2 emissions, air quality, noise pollution, brown areas, green/open space, water quality, waste management, and energy efficiency.

Sustainable use of land of view is that the revised master plan aims at zero net losses in unsealed land. The long-term goals of uncovered net loss of soil, brownfield remediation, and treatment of existing sites are specifically designed to

meet the environmental goals. These goals are part of the city's climate resilience strategy and are geared towards increasing ecosystem services at the city level, in particular, to compare the climate deficits of urban heat islands, which tend to be exacerbated by enclosed surfaces lacking green infrastructure for shade and cooling, and for natural infiltration from unsealed surfaces, containment and expansion areas from extreme rainfall events to reduce the load on existing gray infrastructure by introducing NBS enabling[10].

Nature and Biodiversity

The City of Turin will continue to implement the existing Conservation and Management Plans for the two Specially Protected Areas of the Natura 2000 Network located within the City of Turin. These will be updated regularly by local and regional authorities as required by the national monitoring and management system in accordance with the Habitats and Birds Directives.

The city is actively seeking opportunities to promote greater conservation awareness and management initiatives in areas outside of specially protected areas. In particular, the Strategic Plan for Green Infrastructures identifies ecologically sensitive areas in line with metropolitan and regional plans that will further enhance biodiversity and nature, particularly through urban forestry initiatives and other renaturation strategies. The municipality will continue to implement these strategies and has allocated 1.3 million euros over the next three years. An example of the implementation of this strategy is the urban forestry campaign of 20,000 trees, which will take place between November 2019 and March 2020, to re-naturalize areas along the Sanguine River corridor at the southern end of the city at a cost of €300,000. In 2018, the budget allocated for the development and maintenance of green infrastructures (€5,702,344) is also gradually moving towards supporting renaturation.

In addition to the city budget for renaturation, the administration has participated in two national campaigns by NGOs to match businesses seeking to offset their carbon emissions with public administrations seeking to increase or improve existing natural areas through urban forestry. [insert notes] Through these initiatives the Municipality aims to attract additional resources for renaturation projects in sensitive areas and adjacent areas. To this end, the city is currently preparing a sustainable urban forest management plan that will include both new forest opportunities for the wooded hills east of the city and sustainable management practices for existing woodlands. This plan will allow the Municipality to increase forest cover as well as develop management techniques to improve forest quality and promote biodiversity[10].

Air Quality

The City of Turin aims to integrate its air quality policies with the city's Climate Mitigation and Adaptation Plans. While Turin has made remarkable progress in improving local air quality, given the geographic scale of the phenomenon affecting the Po Plain and its contribution to local pollutant concentrations of the wider region, full resolution of both policy directives and infrastructure investments at the national and regional levels must be coordinated. . To this end, Turin hosted a Clean Air Dialogue last June between the European Commission, 6 Italian Ministries, and four Italian Regions, where concrete commitments were made at the national level, including a financial commitment of 400 million euros for three people, to align the relevant policy. made. Between 2019-2021 (total 1.2 billion).

Turin's role in hosting this event demonstrates its willingness to lead the way in developing solutions. As policy initiatives become widespread at the national and regional levels, Turin will continue to implement more restrictive emergency air quality measures than those adopted by the surrounding Regions, as has been the case since 2016. Meanwhile, the administration is advancing its air quality agenda:

• New SUMP – Sustainable Urban Mobility Plan – updated by February 2021 with stronger measures to promote public transport use, promote electric mobility and achieve a 15% bicycle mode share.
• Expansion of public transport infrastructure
- Extension of metro line 1 to neighboring municipalities by 5.7 kilometers by 2023 and 6 new stations costing around 464 million Euros;
- Construction of the 2nd Metro line, with 26 km and 33 stations, by 2028, which will be able to meet 13.1% of the mobility demand during rush hour, thereby significantly reducing the mode share of private vehicles (59.1% compared to 66.9%). The total cost is estimated at 3.7 billion euros. In addition, a geothermal energy system is currently being worked on to meet all the energy needs of the new line;
- Completion of the Turin-Ceres rail link by 2021 to connect the city center with Turin Caselle airport by 8 trains per hour, with an investment of 175 million euros;
- expansion of existing SFM Metropolitan Suburban Rail Network lines with an additional line and further expansion to the metropolitan area. All service will be covered by the latest generation trains with e-bike charging capability;
• Development of electric mobility
- Expanding the charging network of electric vehicles with gradual installation by 2020, approximately 400 streetside charging stations and an increase in the number of charging stations mandatory for all new developments (according to the updated General Urban Master Plan);
- incentives for the inclusion of electric vehicles in the free-floating ride-sharing

fleet;
- pilot project regulating electric micro-mobility (scooters, hoverboards, segway, monowheel) will start by 2020;
• Extending and improving the Limited Traffic Zone (LTZ) from the current 7:30-10:30 to the all-day system (7:30-19), as well as remote sensing of emissions and use of parking spaces, including the introduction of vehicle-based pricing policies and road pricing. an advanced technology package capable of queue remote monitoring and ticketing;
• Expanding pedestrian areas and "low-speed zones" in Turin's neighborhoods to favor walking and cycling, and to transform a neighborhood into an area for vehicular cyclists and pedestrians and significantly reduce road traffic. In 2020, 330 thousand euros were committed for this project[10].

Noise

The main focus of the measures taken by the Municipality of Turin will continue to focus on nightlife, concerts, and noise from school grounds. Stakeholders will continue to engage with the Monica project to find solutions to complex phenomena such as nightlife noise. In addition, the City of Turin has initiated the approval process of the new Acoustic Improvement Plan or special Action Plan whose aim is to reduce people's exposure to noise and limit harmful effects. It will gradually reduce perceived noise levels and disturbances in nightlife areas in the medium and long term.

The plan is designed as an experiment with periodic updates and is organized into operational lines that coordinate possible mitigation actions according to criteria of priority, effectiveness, and proportionality in response to different noise conditions. There will be a high density of people that will affect all urban areas with a high concentration of food and beverage outlets, using the open public space in the evening and at night to consume alcoholic beverages, which tends to lead to long periods of idleness. your time[10].

Waste

The Piedmont Region, through Regional Law No. 1/2018, has adopted the principle of circular economy, introduced by the resolution 1386/2013/EU of the European Parliament and the Council, which promotes sustainable waste management. The Regional Law 1/2018 sets waste management targets for the City of Turin, in particular for the amount of unsorted waste per year (not to exceed 190 Kg per capita until 2020 and 159 Kg per capita until 2022) and 65% of the total waste. As a target for materials sorted and recycled by 2020. To achieve these goals, the City of Turin is implementing an expansion of its door-to-door waste collection service,

which has proven to be much more effective in terms of quality and quantity of separated waste. Waste compared to collecting through bins.

The recent EU Circular Economy program has set a strict target of over 10% of total municipal waste to landfills by 2035. The City of Turin is well ahead of this target as it left the landfill completely in 2011.

In the future, the aforementioned BANCO ALIMENTARE DEL PIEMONTE [2] and PROGETTO REPOPP projects will be further strengthened and expanded. In particular, the Council is negotiating the expansion of the Piedmont Food Bank's activities in the wholly-owned General Product Wholesale Market to increase the amount of food recovered and donated from the market, while also creating possibilities. transforming this food in situ for longer-term preservation[10].

Water

The fragility of water resources due to climate change affects water availability both qualitatively and quantitatively, water demand management, and infrastructure system planning. Adaptation to climate change is one of the main challenges that integrated urban water management will face in the near future. Climate change impacts integrated urban water management as a whole:
• Water supply: impacts of climate change on the quantity and quality of surface and groundwater resources (aquifer recharge, reduced river flow, water availability, and storage);
• Drinking water treatments: impacts of climate change on water resource quality (cyanobacterial algae blooms, natural organic matter, nitrates, emerging pollutants, pollutant concentration, suspended sediment);
• Water distribution: impacts of climate change on water demand;
• The sewer system: the effects of extreme events on the sewer system.
New design criteria for sewage, sanitation, and wastewater treatment infrastructures are needed to increase resilience and compliance with differences in quality and quantity, along with diversifying the sources of supply used and improving reservoir management. In a climate change scenario, it is imperative to develop infrastructures that can sustain long-term essential services despite political cycles. Short-term goals to face climate change challenges focus on the research activities carried out at the SMAT Research Center. The use of new data sources, better models, and more powerful data analysis methods, as well as the design of adaptive management strategies, can help respond effectively to changing and uncertain conditions (UNESCO, 2015).
Green Growth and Eco-innovation
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4.3 Analysing Turin by creating the table as in the research paper of Jo Williams Circular Systems in Turin [8]

In the research paper [8], the author has analysed the cities by checking eight circular systems. In this section of the thesis, there are the examination of the circular systems in Turin.

4.3.1 Circular Construction İn Turin

“Edilizia circolare”

Construction can be the subject of circular economy projects. This is demonstrated by the "Edilizia circolare" initiative, created with the contribution of AxTO, presented on 10 December 2019 in the session of Commissions VI and II, chaired by Federico Mensio. It is a way - as explained by Marco Mangione of Emmegi srl,

who promoted the project - to combine cultural and entrepreneurial aspects. And in order not to waste resources, not only material, but also human.

An exciting challenge that made it possible to recover construction "waste" (tiles, insulators, paints, chandeliers, etc.), avoiding their disposal in landfills, to reuse them or to create "new" objects and furnishings.

At the same time, a network of partners developed - individuals, associations and companies - who provided free materials and participated in “design sprint” workshops and dissemination meetings.

The project was developed by Emmegi srl with the Paradigma cooperative and the Tablò association at "Casa Paradigma" in the former Chinino Factory, in via Montevideo 41, where for ten years the cooperative has been carrying out activities in favor of people with disabilities for the ’social inclusion and where an environment of 100 square meters has been renovated, in compliance with the "3 R" (renewable, reusable, recyclable) and the basic criteria of sustainability (social, environmental, economic)[38].

Final evaluations and materials of the circular building project:

The Edilizia circulare has come to an end and there are some informations not only on the project but also on its evolutions.
Briefly recalling the phases of the project:
Phase 0: Participation in the call
Phase 1: Pre-design
Phase 2: Scouting and Harvesting
Phase 3: Chinino Dehor project
Phase 4: Realization
Phase 5: Final Evaluations
In the pre-design phase, the Design Sprint method was used, a process organized in steps to quickly find solutions to complex problems. During the 2-hour workshop, 4 team members and 4 cooperative members made a needs analysis of Casa Paradigma (client).
In the scouting and harvesting phase, resources and raw materials were sought through a mapping of the neighborhood. The mapping also allowed the construction of a network (of donors, material resources and manuals, collaborators and contacts).

Then the team moved on to the design of the Chinino Dehor. All interventions on the walls, finishes and coatings, furnishings and flooring have been designed with reused and recycled materials or renewable material. Results obtained from the

Figure 4.7: Before then project the fabbrica del Chinino. Reproduced from [39]

circular building project.

Environmental indicators
27 tons of total materials, 13% of materials reused on site quinine, 40% materials reused in other construction sites, 37% of materials sent for recycling, 8% of recovered materials donated, 2% materials disposed of in authorized landfills.

Social indicators
21 local businesses, 12 associations, 19 team members, 15 private individuals, 167 network nodes, 30 total donors, 1 degree thesis.

Economic indicators
Economic variation: 2%, Other active construction sites: 3, Evolution of the circular building project.

A format dedicated to the regeneration of abandoned urban areas, which makes you discover the faces of sustainability in a practical and attractive way. It does so

Figure 4.8: Activated construction site. Reproduced from [39]

by entertaining, training, and educating citizens on sustainable living.

The project was born in the framework of an agreement between the Municipality of Cambiano (TO), the Department of Architecture and Design of the Politecnico di Torino and OffGrid Italia APs and is spread over an area of 9,600 square meters located south-west of the Municipality of Cambiano. about 20 km from Turin.

Reland is a developing project idea. They have started the selection of Italian excellences (artisans, professionals and companies) who want to make a change towards the circular economy[39].

Advantages of the projects are:

• created a network of partners who embrace the philosophy of the project (suppliers of material that is still reusable, artisans able to shape it, institutions, companies and associations that act as a megaphone for initiatives and to get in touch with new realities, professionals linked to world of construction and design, ordinary

citizens and enthusiasts);
• sensitizing the people involved in this experimentation in the search for potentially reusable materials, spreading the culture of reuse and waste prevention to businesses and citizens;
• activated donations from businesses and citizens;
• recovered materials from operators in the sector;
• experimented with the actual conversion of materials and transformed into furnishings, decorations and finishes according to the needs of the Cooperative;
• created a new format with 3 criteria for choosing materials:
- reuse and conversion of existing materials;
- use of natural and renewable materials;
- disassembly at the end of its life;
• generated collaboration with 2 other shipyards interested in experimenting with the EC model;
• generated associated turnover;

Disadvantages of the project are:
• the commercial activities showed their willingness to donate unused materials while few were the citizens of the neighborhood who participated in the workshops and donations;
• In the search for materials, the most immediate tool was certainly the use of word of mouth and instant messaging, while the Sublimart platform was unused. Despite this, the platform was evaluated by the Waste Management and Reclamation Service of the Metropolitan City as a valid tool for managing the exchange and sale of reusable materials;
• the involvement of artisans, despite the collaboration with Confartigianato, did not generate participation.

Extended realization times:
• availability of the cooperative's artisans;
• authorization times of the superintendent[39].

"Green Building Council Italia" Circular economy in construction

GBC Italia, as a national association devoted to the transformation of the market towards buildings that optimize the use of resources throughout the life cycle, to promote the dissemination of the principles of the circular economy in the construction sector in Italy, proposes:
• a presentation of the state of the art
• key messages
• priority actions.

The document defines the key actions that GBC Italia proposes, as a national association dedicated to the transformation of the market towards buildings that optimize the use of resources throughout the life cycle, to encourage the spread of the circular economy in the construction sector in Italy[40].

1. The principle of the circular economy in construction is applied at different scales: the concept of urban mining sees the city as a mine of materials that can be reused; the building understood as a material bank attributes value to the construction materials and products stored in the buildings; products and materials can be recycled, with both pre-consumer and post-consumer recycled content, and recyclable at the end of their life cycle.

2. The circular economy in construction provides for different application methods: the reuse / reuse of materials: ie the use of reused materials and their reusability at the end of their life; recycling: the use of recycled materials and their recyclability at the end of their life; the practice of sharing: for example the sharing of spaces (adaptability) and the concept of product / service (extension of the responsibility of the producer, who maintains ownership of the product and takes care of management and end of life).

3. The material flows associated with reuse / recycling practices can be intersectoral (currently they are mainly from other sectors towards the construction sector) or internal to the construction sector.

4. There are currently various strategies for the application of the principles of the circular economy in construction:
• End-of-life approach: selective demolition and end-of-life management of demolition waste
• End-of-life approach: Redevelopment versus demolition
• Design approach: Design for disassembling in the design of the new
• Design approach: Design for durability / flexibility in the design of the new
Key messages of the council:
• Many of the initiatives related to the circular economy in construction start from individual initiatives and, due to their fragmentation, fail to be solid and credible. A strong public push in this sense is therefore needed to define common rules, at European level but above all at national level (with an effective implementation of European lines of action), and to support the implementation of a shared action plan.
• The built environment represents a mine of materials that can be reused and recycled, but there is a lack of tools to analyze the material flows and the quality

of end-of-life products. Clear rules on disassembly are needed, structured and continuously updated databases and platforms to manage information and organize services to support circularity in construction.
• To improve the management of the end of life of buildings, from a circular perspective, it is necessary to introduce tools to support decisions and quantify flows, such as design for disassembling and pre-demolition audit. Product traceability tools, such as the material passport, and qualification procedures for recycled / reused materials are also needed for the management of the end of life of CD waste.
• In Italy there are various certifications that allow you to know the recycled content of the products. In particular, the self-declarations according to ISO 14021, the EDP, Remade in Italy. Different certifications, with different criteria and methods of verification and communication create confusion among operators.
• The CAMs are not very detailed compared to the transition from off-site production to subsequent phases, in particular those at the end of the building's life. They could therefore be characterized by complementary indicators to those currently in use, to support an approach to the evaluation of eco-compatibility that estimates the duration of the building's life cycle, in relation to the context, construction techniques and materials used[40].

Key actions are:
1. Definition of a harmonized framework of rules and actions
2. Transition from a bottom up approach to a top down approach
3. Monitoring of macroscale flows
4. Creation of platforms for the exchange of materials, products and information
5. Identification of strategies to reduce waste related to temporary uses
6. Definition of criteria for disassembly
7. Adoption of tools for selective demolition and pre-demolition audits
8. Adoption of tools for managing the end of life of demolition waste, product traceability and material passports
9. Introduction of procedures to verify the quality of the recycled / reused and qualification procedures
10. Development of political actions for the removal of regulatory obstacles to recycling and the use of incentives
11. Collection and characterization of waste and stabilization of flows for supply chain continuity
12. Implementation of criteria and specifications in the GPP CAM
13. Dissemination of research and development incentives for SMEs
14. Definition of common criteria in environmental product certifications
15. Introduction in the normal practice of tools for verifying the effectiveness and sustainability of circularity actions with the support of LCA and LCC methods.[40]

4.3.2 Circular food system in Turin

"REPOPP Project"

Piedmont Food Bank recovers and distributes 7,650 tons (2018) per year, meaning 15.3 million meals a year reaching more than 106,000 people.

RePopp Project, which has been operating in Turin Central Market for 3 years, aims to reach a "circular market" model in line with the city's zero waste vision. Repopp aims to reduce food waste and increase the appropriate classification of waste, including organic food waste. RePopp employs voluntary asylum seekers to raise awareness among vendors and customers on proper waste separation among vendors in Turin's central market and on how to avoid food waste through communication campaigns. In addition, at the end of the Sunday, volunteers collect unsold food from vendors and proudly present it to anyone who may need it, in a designated area of the market. Unsold food collected and distributed ranges from 400 to 800 kilograms per day, some of which is delivered to nearby shelters. Volunteers extended the event to take back unsold books at the nearby used goods market on Saturdays and awareness raising events in collaboration with the Municipality and non-profit organization Eco dalle Città. Through their volunteer activities, volunteers can contribute to civic life and gain experience in volunteering, which is useful in strengthening asylum applications[10].

The Project won different awards:
- Cresco Award 2018;
- 2018 Milan Urban Food Policy Pact;
- The World Health Organization Healthy Cities Network gave the project a mention in their Oscar of Health in 2018.

Thanks to this project, the average amount of unsorted waste produced in the second semester of 2018 dropped from 47.5% to 31.9% and the amount of organic waste collected increased from approximately 8% to peaks of approximately 33%.

'Il Banco Circolare - RePoPP' host awareness-raising activities against waste and the promotion of innovative experiences of recovery and cultivation, of valorisation of organic matter and soil promoted by the City of Turin, with debates cultural centers focused on the issues of sustainability of urban food systems and, through Food Metrics, the indicators of the Turin food system.

It housed RePoPP, the City project supported by Amiat Gruppo Iren, Novamont, Eco dalla Città and now also by the Turin Central Market, with the aim of expanding the possibilities of conserving food surpluses. In the shop, equipped

Figure 4.9: REPOPP Project [10]

with cold storage rooms, equipment for the processing and transformation of food and exhibition spaces, the desire to go beyond redistribution to enhance all that is

Quantities collected in Porta Palazzo in 2017 and 2018							
	Boxes		Organic waste		Unsorted waste		Total
Period	Weight	% out of tot.	Weight	% out of tot.	Weight	% out of tot.	Weight
1st semester 2017	685270	33.83	386420	19.08	953970	47.09	2025660
2nd semester 2017	811400	43.57	425120	22.83	625960	33.61	1862480
1st semester 2018	984220	44.99	480010	21.94	723490	33.07	2187720
2nd semester 2018	949360	45.73	465230	22.41	661420	31.86	2076010

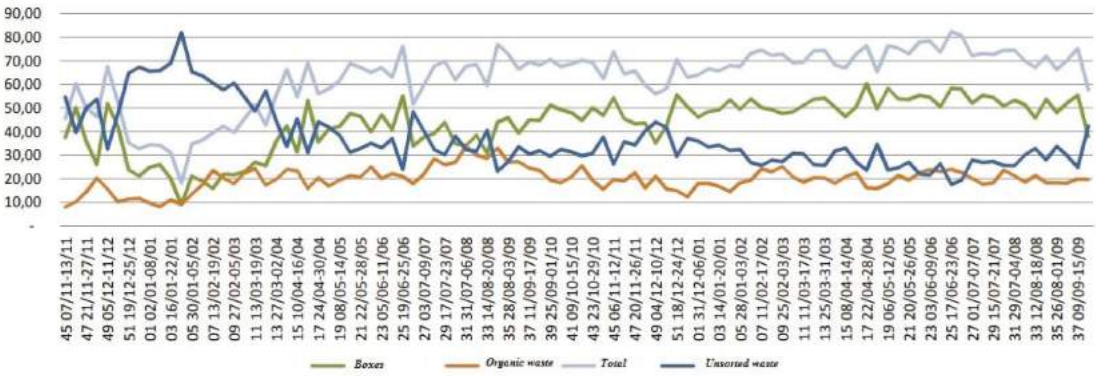

Figure 4.10: Results of the Repopp project in 2017/2018 and trend of the Repopp project in 2016/2019 [10]

recovered is realized.

The 'Banco Circolare' has no commercial purpose and will allow, in addition to an efficient system for the collection of organic food surpluses from the stalls of the Porta Palazzo food market, to anyone who needs them to collect them for free from Monday to Friday from 15 to 17, until exhaustion. But the space should not be seen not only as a social project but as a center of cultural exchange between the souls that make the neighborhood alive, capable of favoring the integration project between the different ethnic groups of Porta Palazzo. "The market was not born as a passing business" explains its founder Umberto Montano "but it is a reality that 'creates value' by relating to the city in a constructive and lasting way.

Figure 4.11: The Repopp plans [41]

Our projects - he underlines - are always born according to very specific objectives and integration and solidarity are very important to us. In Turin there is a need to facilitate exchange, seek dialogue and also make oneself available to those citizens of varied ethnic groups who brilliantly color the Porta Palazzo area.[41]"

On the occasion of the opening of the 'Circular Bank', as already done last February when the starred chef Davide Scabin prepared a hot soup with the food leftovers recovered from the stalls of the street vendors of the market by the Ecomori and the Sentinelle dei Rifiuti, the Central Market Turin has returned to propose the appointment "Goodness against waste" - in which various guests, including cooks and artisans, alternate each month preparing tasty dishes to be distributed free of charge. The intention is to celebrate the diversity of the communities of Porta Palazzo by demonstrating that all cultures and cuisines can enhance food surpluses and that, by contributing to the dissemination of good practices for the recovery and reuse of assets, citizens are encouraged to be in solidarity, also encouraging conscious consumption and the adoption of healthy and sustainable lifestyles[41].

4.3.3 Adaptive reuse of spaces/infrastructure in Turin

The master plan for the liveable city

The General Town Plan (PRG), as the main tool for regulating the urban morphology and the distribution of the intended uses in the city, plays the role of defining the territorial elements that facilitate high livability and promote the quality of life. These elements are multiple and interrelated, including public spaces, green, recreational and landscape heritage, cultural heritage, well-served neighborhoods, lively, full of commercial establishments, well connected and accessible. The revision of the PRG pays close attention to these elements, focusing on the quality of life of citizens[9].

Turin has an extraordinary heritage of green infrastructure, consisting of rivers, parks, hills and vegetable gardens that shape the identity of the city and the quality of life in the city. Over 90% of towns and citizens manage to reach a recreational green space within 5 minutes on foot from their home, an enviable standard compared to many European cities. At the same time, the quality of the green heritage must be maximized. The revision of the PRG protects green infrastructure as an environmental resource and quality of life, promoting zero land consumption, the increase of permeable surfaces, the protection of green areas, agricultural uses and urban gardens.

Planning urban transformations and land uses also means dealing with culture and beauty. Turin has an important and stratified urban history, with a strong identity that the revision of the Plan intends to preserve, develop and innovate. This means avoiding the creation of alienating neighborhoods, improving urban quality,in particular in our suburbs, creating new public spaces for culture, for socializing and for leisure, taking care of and protecting the common and cultural assets. It also means paying attention to morphology and density, factors that strongly impact the livability of an area[9].

Well-being and quality of life are closely linked to the availability and accessibility of adequate services: home, school, assistance. The city still needs services, especially in some neighborhoods, especially peripheral ones. On these issues, the revision of the PRG is an opportunity to rethink a city that is a source of peaceful life. This means arriving at solutions capable of giving a new balance to the different areas of the city, pushing beyond the municipal boundaries, taking into account the citizens who go to the city every day for work, culture, research, leisure.

Last but not least, the revision of the PRG, through the definition of simpler

and more flexible rules and procedures, aims to guarantee capillary accessibility throughout the territory so as to favor the development of served, vital districts and the development of a polycentric and communicating city in all its parts, even the most peripheral ones[9].

Green resilient

The City of Turin enjoys an extensive, widespread and very diversified urban green system, which includes historical, natural, ecological, recreational and landscape elements. In addition, the city is known for its high professionalism in the care and protection of its green heritage.

Torino Vivibile capitalizes on this important heritage to make it increasingly capable of meeting the needs of citizens and the demands presented by the new climatic scenarios, which are in constant evolution.

On the one hand, citizenship expresses new needs, both for the demographic transition towards a more mature population and for new lifestyles, which require new responses from the urban green system. It means rethinking urban greenery and therefore structural interventions with a view to new uses and new opportunities for citizens.

On the other hand, the green urban infrastructure is the engine of ecosystem services that produce tangible benefits for the community, in many cases irreplaceable. This system of ecosystem services will be strengthened in Livable Turin, both to increase the benefits for citizens in terms of hygiene and health and in terms of environmental safety, and to cope with future climatic scenarios that could undermine the green system or otherwise make the management and maintenance of the system is more onerous and complex.

For these reasons, the Administration is implementing two important planning processes aimed at developing a green infrastructure capable of making Turin more liveable, even in the near future.

The first involves the development of the Green Infrastructure Strategic Plan, a tool for focusing on the current state of the green system, identifying critical issues and opportunities, developing strategies and priorities to guide future investments and system management.

The second, on the other hand, involves the elaboration of an adaptation plan to climate change, which will have important repercussions on the urban green system

as it is subject to future scenarios, but also the protagonist of adaptation actions aimed at mitigating the risks of the same climate changes.

In addition to the inter-departmental working groups, the two planning paths already see a series of concrete actions launched and being implemented in line with the objectives of a resilient green. Specifically, these actions concern the certified management of the wooded areas of the municipal territory, the planning of the renaturalization of critical and highly compromised areas, a series of activities in collaboration with the Committee for the development of public green areas of the Ministry of the Environment, climate actions -proofing of recreational green areas and a plurality of participatory planning initiatives together with citizens[9].

ITS and mobility as a service

Mobility As A Service (MAAS) is the concept of mobility of the Liveable City of the future. It is a set of actions that lead to such technological and operational integration as to allow the user to take advantage of a broad spectrum of modes of transport in order to reach each destination in the most effective way. Each journey is made more efficient, thus lightening the overall load of the road system and allowing for further improvements. The individual user is freed from the paradigm of having to own their own modes of transport being now able to take advantage of different modes, even similar to the private vehicle, without sacrificing convenience and comfort. The main elements of the project are:

* the creation of new communication systems at the service of mobility: an increasingly infrastructured road network with sensors, intelligent traffic lights and reserved lanes to ensure greater and effective priority for local public transport in the traffic present on the city road network;
* infomobility services, therefore information on the arrival of public transport at the stop and electronic ticketing for citizens, to be able to buy tickets quickly and easily using your mobile phone, with the aim of accessing and using in any place and mobility services at any time.
* Intermodality of forms of mobility through the implementation of MAAS services, Mobility as a Service, to provide citizens in a unified and integrated way with public mobility and that of shared vehicles (cars, taxis and bicycles);
* synergistic actions to make public transport competitive and attractive, to be able to move in an ecological and efficient way in the city;
* extension of the network of intelligent traffic lights, capable of making traffic flows more efficient and reducing unnecessary waiting;
* new widespread infomobility to make local public transport increasingly accessible and integrated with new forms of collective mobility, with soft and private mobility,

in a coordinated way with metropolitan, regional and interregional rail vehicles;
* new lanes reserved for local surface public transport, in order to make local public transport more efficient and make it more attractive to use, thus reducing private motorized vehicles and creating space for soft mobility and multifunctional roads;
* computerized ticketing to facilitate the ticketing process, streamlining waiting times and increasing accessibility electronically, making the use of public transport ever easier and more attractive[9].

Turin Open Center

The goal of the Torino Centro Aperto project is to create a lively and dynamic city center for residents, productive, commercial and service activities and open to everyone, Turin and tourists. It is about improving the quality of life of those who live, work, study or visit the central area of the city by reducing accidents, irregular parking and noise and air pollution and, at the same time, guaranteeing the right to individual mobility.

The project provides for the revision of the access rules to the city center through the adoption of new traffic regulation measures. At the same time, the public transport network will be strengthened and made more efficient and the clean mobility, an alternative to the car, will be increased. In support of sustainable mobility, more resources will be allocated to road maintenance and to the removal of architectural barriers and redevelopment of urban spaces, also encouraging the renewal of the last mile logistics fleet[9].

The new rules aim to decrease private vehicle traffic in the center by discouraging simple crossings and enhancing the commercial, cultural and service offer of this area of the city.

With the Torino Centro Aperto project, the entrance to the city center will be free: the new rules will not activate any specific prohibition within the central area, but the entrance will involve the payment of at least two hours of parking (where it is already foreseen today the payment of the parking), thus guaranteeing its full usability[9].

Safe roads

Torino Vivibile looks to the future by redesigning the urban space for its citizens, working for a greater heterogeneity of the road system so that it knows how to include forms of active mobility in a European key.

The urban road and the square are no longer considered exclusively as parking spaces or roads for motor vehicles alone, but as a driving force for urban regeneration. The model of European cities, strengthened by an efficient and functional welfare system where active mobility constitutes almost 50% of all journeys, is the direction in which to move. The international competition between urban areas is also played out on the field of liveability and on the health of public space.

In particular, the road is redesigned for its ability to become multi-functional and attractive for a plurality of use and users, of course always in its function as a road infrastructure, but also a meeting place, sociality, quality and lifestyles. healthy and sustainable A stimulus towards the integration of means of transport with particular attention to forms of gentle and active mobility, cycling and walking. In short, a more complete infrastructure of coexistence and conviviality[9].

The concrete elements of this strategy are:
* update of the Urban Sustainable Mobility Plan to facilitate accessibility to the city to all forms of mobility, with objectives and actions aimed at encouraging public, shared and active, pedestrian and bicycle mobility;
* reduction of road accidents with traffic and speed moderation interventions throughout the urban area, coordinated by the Zero Vision Plan;
* updating and implementation of the Bici-plan from a metropolitan perspective, planning corridors with priority cycling to encourage two-wheeled mobility in and out of the center, from the traffic attracting poles, universities and business centers to the entire metropolitan area. The cycle network will have to be built on the basis of inter-modal exchange with metropolitan and regional rail transport to encourage and encourage, to the fullest of its potential, inter-modality between rail transport and cycling[9].

Renovated public transportation

The transformations that have affected the urban fabric in recent decades have radically changed the urban layout and created new residential centers for aggregation and economic development, to which the local public transport network must respond. The Turin of 2030 will be livable if new urban places, university centers, service centers, business centers, places of cultural production and commercial structures are reachable in order to make relations between the different districts of the city ever more dense.[9]

The Torino Vivibile will enjoy an increasingly efficient local public transport network (TPL), updated and rethought in the logic of a polycentric city.

The evolution strategy of the surface public transport system includes several strongly interrelated elements. Inter-modality, therefore the interchange between different modes, represents the backbone of the public transport system of the Torino Vivibile. The key elements of the strategy are:
* the revision of the routes of the vehicles on the surface in order to obtain a robust network consisting of power lines and supply lines that respond to the needs of the new urban morphology;
* the development and making available to citizens of a multitude of collective mobility services, for example innovative cycle mobility, scooters and electric cars, and recharging infrastructures available to the public;
* stronger collaboration at various institutional levels for complete, accessible and innovative info-mobility;
* the expansion of the local railway network which includes the strengthening of the tram network and the replacement with the latest generation vehicles;
* the completion of the Metropolitan Railway Service and the commissioning of the Dora and Zappata stations;
* the completion of Metro Line 1 and the approval of the preliminary design of Line 2;
* the renewal of the circulating bus fleet, paying close attention to the reduction of pollutants with the latest generation of methane and electric buses;
* the efficiency of the interchange poles facing the city to ensure greater accessibility from the metropolitan area, favoring the interchange between private motorized vehicles and public transport vehicles to reduce pollution and urban congestion[9].

Social inclusion plan

The various socio-economic and demographic phenomena that have affected the Turin area, starting from the industrial crisis and going through the financial crisis of 2008, have led to increase in poverty such as to undermine the social services system of the city: the changed economic and social context therefore made an overall rethinking of the system indispensable.

The City of Turin had a large and articulated set of economic aid measures for people in difficulty, built over the years, which was affected, for better or for worse, from the historical time in which it was designed.

The complex characteristics of the multiple needs that the city currently faces have led to considerations both in terms of the organization of social services and about the need to rethink economic aid measures taking into account the national framework, which in recent years has acquired awareness of the need for a universal

income support measure. Income support measures will increasingly be coordinated with the methods of active inclusion of people, either in terms of emancipation through work, or in terms of better social inclusion in the reference communities, also by coordinating public and private welfare interventions to avoid overlaps and diseconomies.

Starting from these considerations, the reorganization of the social services system developed in the first two years of the mandate, envisaged a systemic approach in dealing with welfare policies, considering which paradigms: the centrality of the person, the value of community resources, transversality and inter-disciplinarity in the fight against inequalities[9].

Also thanks to a participatory approach from which the reorganization started, an important step started was to structure an innovative and experimental three-year path with the Third Sector, aimed at systematizing resources and the different sources of support for inclusion paths. , the contrast of poverty and serious marginalization, as well as the sharing with the private social sector of an overall strategy aimed at favoring the structuring of territorial support networks, of opportunities and widespread inclusive and employment opportunities, in support of autonomy paths, both with district and supra-territorial value.

Given the lack of national funds for incisive public housing policies, the Administration, with this methodology, intends to increase the ability of the City to cope with the problem of housing poverty by building territorial networks for housing, solidarity housing and hospitality. solidarity, bringing together the demand and supply of low-cost social housing, not only confirming and increasing traditional measures, but also promoting social and financial innovations to be designed together with the local actors, such as the promotion of "widespread living" .

The theme of living is only one of the areas envisaged by the Social Inclusion Plan, which intends to build district and / or supra-territorial infrastructures in coherence and consultation with the WE.CA.RE. regional program, to promote community support networks and accompanying social inclusion, as well as solidarity purchase networks for people and households in conditions of severe housing disadvantage.

The ambition is therefore to build a community welfare infrastructure that is both generative and participated by all the actors of the territory, each with their own individuality and peculiarity, but with the willingness to co-design to activate synergies and collaborations. useful for the growth of our city[9].

4.3.4 Water recycling in Turin

“SMAT" Water Points

Turin’s Water Authority operates multiple water distribution points to deliver both still and sparkling drinking water at ambient or cooling temperatures. Residents can fill reusable bottles for a nominal fee, thus reducing single-use plastic bottles and their associated carbon footprint. There are 12 Water Points in Turin, 10 in public spaces and 1 each in the “A come Ambiente” Environmental Museum and the Polytechnic University of Turin. The water points provide a total of 4,492 cubic meters of water per year, which corresponds to avoiding around 114 tonnes of plastic bottles and releasing 360 kg of CO2 into the atmosphere[10].

The integrated water cycle of the Turin metropolitan area is managed by SMAT SpA, a publicly owned plc, wholly owned by the Municipality of Turin, of which 293 Municipalities in the Turin Metropolitan Region are the largest shareholder.

1. Total drinking water consumption: 79.12% domestic use, 13.61% craft, commercial and industrial use, 5.83% public sector, 1.35% agriculture, other 0.09%’ It is 1772 million m3, including u. 2. In the city of Turin, the measurement coverage is 100%.
3. The water source for the City of Turin is as follows: wells 58.8%, springs 10.2%, river 31.0%.
4. For the Municipality of Turin, there are NO days of non-compliance with the Drinking Water Directive (DWD). For the entire Metropolitan Area, non-compliance days are approximately 1 hour/year/citizen. Total compliance with DWD is 99.98. There are 13 water supply points in the city of Turin.
5. The actual index of losses in distribution is 24.97% in the City of Turin.
6. The creation of urban drainage areas to manage stormwater, especially during heavy rainfall events, is a strategic action in the City of Turin’s climate change adaptation strategy. In the past, areas with a green surface arrangement were experimentally constructed to slow the flow of sewage water.
7. Annual energy consumption for drinking water is 0.530 kWh/mc.
8. Electricity consumption data relates to drinking water: water distributed to households and industries.
9. DWD compatibility City of Turin 100%. No derogation stands.
10. All transformation interventions are in line with the Flood Directive implemented by the Master Plan, which also serves as a reference for the Municipal Emergency Plan. Another important reference is represented by the Flood Risk Management Plans prepared by the Regional Basin Authorities.
11. The wastewater treatment plant in Castiglione allows three types of waste to be turned into sources. Biogas is fueled by 4 cogeneration engines to generate

heat and electricity. While electricity generation reaches 50% of the need, thermal energy meets all plant needs. The sands are washed and turned into a secondary raw material for reuse; clean sands are used as filling material or abutment for laying pipes.
12. With the "Turin city of waters" project, the Dora River was unveiled in order to return the flow of water to its natural flow and increase its hydraulic capacity.
13. Through the "Torino water city" project, the banks of 4 rivers were saved to create a continuous system of river parks (70 km in total) connected by pedestrian, bicycle, nature, educational paths, conservation and conservation. development of its own environmental and architectural features for each waterway[10].

Over the years, SMAT has devoted considerable efforts to launching and conducting an ambitious research program in the field of integrated water services, until the foundation in 2008 of its own Research Center[42].

Through the consolidation of a network of collaborations with prestigious universities, national and international research centers, trade associations and industrial partners recognized at European level, the company has integrated various skills, expanded research areas and potential and contributed to technological innovation. and industrial development in the water sector.

An important boost to Research and Innovation took place in 2014, the year in which a new path began with the entry of five young researchers with different skills in hydraulic and environmental engineering, physics and biotechnology.

The attention dedicated to Research and Innovation led SMAT to obtain an important recognition in 2018: the TOP UTILITY RESEARCH INNOVATION award, which was collected on the occasion of the presentation of the study "The performance of Italian utilities. Analysis of the 100 largest energy, water, gas and waste companies ", carried out by RSE Ricerca and Althesys Strategic Consultants[42].

Research and technological innovation have led the company to develop projects also in the space sector. In particular, the SMAT Research Center has been working on the production of water for the International Space Station (ISS) since 2008 and develops projects to produce water suitable for so-called 'long-range and long-term' missions, including those to Mars.

Strategies of the Turin Water Movement (2011- 2017)
Despite the fact that they own SMAT SpA, the municipalities tolerate the company's irresponsible attitude in protecting the environment and water users. For

Figure 4.12: SMAT water points in the city [10]

this reason, the Turin Water Movement launched a new campaign supporting a proposal to the town council to implement referendum results by remunicipalisation SMAT. The Democratic Party (PD) majority in office at the time beat around the bush for a year and a half, trying to discourage the water movement from insisting that the referendum be implemented. Eventually, the PD rejected the text of the popular proposal on the remunicipalisation of SMAT SpA. Instead, in 2014 they introduced a higher threshold for the admission of private shareholders.
Furthermore, a new provision was introduced stating that SMAT can distribute only 20% of its annual profits to shareholders, while the remaining 80% will be kept by the company in order to increase its capital for investments. To put this in context, 72% of the company's profits were distributed to municipal shareholders between 2008 and 2011. While the fact that profits were no longer completely distributed to

municipal shareholders and a large part had to remain in the company to finance investment was a positive development, the Turin Water Movement was still not satisfied[43].

The Turin City Council
Change came with the 2016 local elections in Turin. The PD coalition was defeated, and the 5Stars Movement obtained an absolute majority in the City Council. Despite some unpleasant incidents, misunderstandings and political frictions at the start of the new administration, the 5Stars Movement and the Turin Water Committee are trying to forge a good relationship. At the beginning of 2017, several of the council members of 5Stars Movement produced a draft resolution for the remunicipalisation of Turin's water system, which was signed and endorsed by two other councillors (Torino In Comune and Direzione Italia). It was finally approved by the absolute majority of the Turin City Council on 9 October 2017.

The new phase of water remunicipalisation now starting in Turin requires the attention and commitment of the entire Metropolitan Area. Up to now, only 40 municipalities (out of a total of 306) have taken the decision to restore water management under public law. The next step is to persuade all of the other municipalities to adopt a resolution so that the rule of public law over the ownership and management of our water can be restored[43].

4.3.5 Waste management in Turin

The City of Turin has adopted an ambitious multi-year Action Plan with the goal of increasing the percentage of waste separated to comply with the 1386/2013/UE Waste Directive (and relevant Regional legislation) mandating a 65% material separation and recovery rate by 2022. From about 44% in 2016 to 65% in 2021. The primary action in achieving this goal is to increase door-to-door collection from 48% in 2016 to 100% of the city in 4 years (2017-2021)[10].

Plastic-Free School Canteens

The Municipality of Turin has banned plastic tableware in purchase agreements for school canteens, replacing them with reusable ones. As a result, the Municipality received the MENSAVERDE award in 2013. Triciclo, a social enterprise, operates a repair cafe in one of the city's waste collection centers, where residents can bring items for repairs or shop for repaired items. The City of Turin has supported private centers for the repair and sale of electrical appliances and electronic devices such as Astelav.

Indicator	Type of Data (City/Regional/National)		Unit	Year of Data
Amount of municipal waste generated per capita	509.7 Kg/cap (City)		kg/capita/year	2018
Percentage of municipal waste that is recycled (including through composting and digestion of biowaste)	45.7% (City) All the waste collected separately per type of product will be sent to the recovery plant.		%	2018
Percentage of municipal biowaste that is recycled (through composting and digestion)	100% (City)		%	2018
Percentage of municipal waste sent for energy recovery (R1 code)	54.3% (City)		%	2018
Percentage of municipal waste sent to landfill (or other forms of disposal (D codes)	0% (City)		%	2018
Percentage of municipal waste that is collected separately	45.7% (City)		%	2018
Percentage of recycled packaging waste	45.7 % (The whole share of packaging waste present in the waste collected separately will be sent to recycling plants according to the type of goods fraction they belong to)		%	2018
Percentage of packaging waste that is collected separately	45.7% (In Turin, packaging waste is collected with the other types. We have no data for this type of waste which are different from those concerning general separate waste collection)		%	2018
Established collection systems for hazardous waste:	**Type of Data (City/ Regional/National)**	**Yes/No**	**Unit**	**Year of Data**
i) WEEE	3.5 Kg/cap (City)	Yes	kg/capita/year	2018
ii) Batteries	0.097 Kg/cap (City)	Yes	kg/capita/year	2018
iii) Waste oils	0.07 Kg/cap (City)	Yes	kg/capita/year	2018
iv) Household chemicals	0.20 Kg/cap (City)	Yes	kg/capita/year	2018
v) Asbestos	0.003 Kg/cap (City)	Yes	kg/capita/year	2018
vi) Construction & demolition waste	4.14 Kg/cap (City)	Yes	kg/capita/year	2018
vii) Unused pharmaceuticals	0.067 Kg/cap (City)	Yes	kg/capita/year	2018

Figure 4.13: Benchmarking data-waste information [10]

Currently, City's public waste management agency operates two types of waste collection services: streetside bins (inner city areas) and door-to-door collection (outside city areas). Door-to-door collection is now rolling out to central districts to achieve higher waste separation rates (from 28-33% for the street-side method to 58-65% for the door-to-door method). The average of the two systems is currently 47.5%. Waste is classified according to the following categories: non-recyclable, biological waste, paper/cardboard, glass/aluminum and plastic. To help residents sort correctly, the City of Turin has subscribed to the Junker application service, an application that allows users to scan the barcode of products to determine how to properly sort the item according to the local system[10].

All unsorted/non-recyclable waste is processed at the local waste-to-energy incineration plant, generating 367,656 MW/h of energy per year. Once door-to-door is operational in 100% of the city in 2021, the Administration will begin testing Pay-As-You-Go plans to further encourage good sequencing practices. Currently, segregated waste is processed at specific facilities recommended by the Italian National Packaging Waste Consortium as follows:

- Plastic: AMIAT
- Paper/cardboard: CMT, CARTAMACERO, ITALMACERI, BENASSI, ECOPIEMONTE
- Glass/can: ECOGLASS, EUROVETRO
- Organic: ACEA, AMIAT
- Unsorted: TRM [10]

Turin towards zero waste

The Livable City is a clean and healthy city, but also circular and innovative. Turin Towards zero waste is an overall strategy to achieve these goals, consisting of a series of actions aimed at reducing the waste of raw materials and material resources and aimed at improving the efficiency of urban metabolism.

From waste, these resources become raw material again, thus creating new economic chains. This strategy contributes to building a cleaner city, where waste is managed more effectively and without affecting public space, alleviating related problems. The first and fundamental pillar of the strategy is to complete the extension of the door-to-door waste collection service: from about 50% of the population served today to the whole city[9].

This transition, which has already started and is expected to be completed by 2023, will bring a significant increase, both quantitatively and in terms of quality, to achieve the European targets set at 65% of material destined for recovery.

To accompany citizens to the correct management and differentiation of waste, the Administration implements a series of awareness campaigns and provides tools, such as the Junker application, launched throughout the city to allow citizens to be protagonists. of this transition.

The second pillar of the strategy is to translate this transition into an opportunity for economic development, i.e. the creation of new supply chains and jobs generated by the recovery, reconditioning, conversion and reuse of recovered materials, closing the circle of urban metabolism. To achieve these objectives, the creation of a circular economy pole is being planned, a sort of reuse factory, where

various local players can carry out multiple activities, a pole that also wants to become a national innovation hub[9].

At the same time we intend to develop a local economic chain based on the ecological treatment of the organic fraction of waste and the consequent energy production, thus activating a virtuous circle of valorisation of compostable material and energy recovery. This supply chain also includes initiatives aimed at reducing food waste through projects in the markets and tools to access surplus food.

Finally, the strategy includes a series of actions aimed at making the municipal machine itself more virtuous, through the revision of public contracts with increasingly sustainable criteria and the reduction of single-use plastics in the municipal structure[9].

Sustainability laboratory

The Livable City is a city open to innovation, which favors the experimentation of new ideas and projects, to find solutions capable of improving and making the urban environment more liveable. In this direction, the Administration sets up experiments and initiatives aimed at introducing new tools, methods and raising awareness citizenship towards more sustainable lifestyles. Among the initiatives:

-ISO 20121 certification for sustainable events: the Administration launches an ISO certification process to encourage the organization of events by reducing environmental impacts, including the production of waste and food waste, and promoting good practices to maximize collective mobility and sustainable, energy efficiency and support for local supply chains.

-Big Belly: in 2019 an experiment will be launched, in the context of waste cycle management, with the Big Belly smart bins. The Big Bellys have an internal capacity up to five times that of a typical street bin thanks to the internal compaction with solar energy which, consequently, reduces the frequency of intervention. Animal welfare: initiatives aimed at raising public awareness of animal welfare, virtuous behavior towards them, giving visibility to municipal kennels, opportunities for adoption and the carrying out of awareness raising events.

-Clean air: a series of initiatives aimed at increasing awareness of air pollution, knowledge of the impacts on health and virtuous behaviors to be adopted to reduce exposure, such as the publication of information materials, the launch of pilot research on exposure, the production of recommendations to reduce their effects

on health, information and public debate events, capillary analysis using innovative tools. These are complementary actions to emergency measures to combat pollution[9].

4.3.6 Ecological Restoration in Turin

1. The Administration's Turin 2030 Action Plan outlines 32 structural projects that the City will implement to realize the Sustainable and Resilient Turin vision. The plan includes numerous projects based directly on eco-innovation principles, as well as public partnerships and innovation clusters. In particular, the City of Research and Innovation project proposes the development of five hi-tech clusters, which are also defined in the ongoing revision of the City's General Master Plan: The Thyssen District, the site of a former industrial plant, has identified the innovation cluster for the automotive sector where electric and autonomous vehicle technology will be developed and tested.

The Alenia Site will be a newly developed high-tech campus dedicated to the aviation industry. The Turin New Economic Zone in the Mirafiori industrial zone will host the Industry 4.0 Manufacturing Competence Center, a partnership between the University of Turin, the Polytechnic University of Turin and 24 private firms. 10.5 million euro investment already committed by the Ministry of Economic Development. The eco-innovation center and incubator Environmental Park will be expanded and further specialize in green and circular economy innovation. Turin's Energy Center, a clean energy and energy technology innovation center, is a partnership between the Polytechnic University of Turin, the City of Turin, the Piedmont Region, and two local philanthropic foundations that will combine research with innovative initiatives and public services. The center recently cost 20 million euros. Turin's Innovation Center will focus specifically on the evaluation of big data from artificial intelligence, blockchain development and public services.

2. The Administration has recently completed a public call for proposals for the installation of curbside electric charging stations throughout the city. Each operator will determine the location of 80% of the stations according to customer demands, while the remaining 20% of the locations established by each operator will be determined by the Municipality. As a result of this RFP process, over 400 universally accessible charging stations will be installed throughout the city.

In addition, the revised Building Code (art.39 c.9 reg.302) requires all new larger developments to provide electrical charging. Currently, more than 50% of daily journeys made by public transport are made by electric vehicles (metro, bus, tram). This rate will increase further with the expansion of the metro 1 line until 2023

and the 5.3 km line of 464 million euros already allocated will be added. 30 latest generation electric trams will be delivered until 2023 at a cost of 75 million euros. The development of the metro 2 line is expected to cost 3.7 billion by 2028, and a major eco-innovation will include the use of geothermal energy to power the underground line and stations and other buildings along the line. The revision of the Green Public Procurement Law will also enable the gradual conversion of public vehicle fleets to hybrid and electric vehicles.

3. The Turin 2030 Action Plan also includes the University City initiative, which aims to create synergies between the strengths of local universities and the Administration's development priorities. The Healthcare Park project is one such synergy where the city has developed a regional health center of applied medicine and research with universities and the Piedmont Region. The public tender process for the development of the new health center at a cost of 400m euros is currently underway and is expected to be completed by mid-2020.

4. The city subscribed to the Junker app in 2018, making it the largest city in Italy. In addition to the various standard services provided by the application, the City is gradually increasing the number of special services offered in the city of Turin, including the location of bike sharing stations, drinking fountains, and water distribution points etc.

5. The Turin 2030 Action Plan also includes the Turin Zero Waste project, which includes the creation of a "Reuse Factory", a circular economy hub where private firms, artisans and non-profit organizations can settle to build a critical mass around the circular and green economy. and promoting innovation in this field.

6. Following the commitments made in the Climate and Energy Mayors Convention, the City of Turin is taking bold steps to achieve a true energy transition. To that end, the City assembled a task force of local experts and private firms to develop Italy's first full hydrogen power operation: the project envisions the production of hydrogen-powered cars and passenger trains, as well as a hydrogen production, storage and distribution facility. . The city is currently in talks with OEM manufacturers, electricity distribution companies and the Ministries of Environment and Economic Development to become Italy's flagship hydrogen energy innovation hub[10].

There are also some other studies to improve ecological restoration.
-The KM0 farm: first experimentation of participatory hydroponic production near the Falchera lakes aimed at spreading new agricultural practices for healthy food production, accessible to all and ecologically virtuous. Furthermore, the project

becomes a place of aggregation and social inclusion.

-New oils: a public-private partnership is born to recover a heavy waste rich in energy properties wasted today. Used domestic oils will have the opportunity to find a second life through the enhancement of the production of oils for commercial use. Tree generation: implementation of an environmental and food education project involving students and families in schools and homes for the cultivation of trees and food, thus creating awareness of the value of the tree as a generator of ecosystem services and food in proper nutrition[10].

4.3.7 Reuse of goods in Turin

"TriCircolo" Reuse Center

Figure 4.14: TriCircolo [44]

"TriCircolo" seems to refer on the one hand to the tripled "recycling / recycling" and on the other to the "tricycle", a three-wheeled vehicle used both by children

and for transporting goods. Tricircolo Reuse Center is a place of production, trade and sociality equipped to host meetings, training, solidarity exchanges, production and sale of goods and services related to reuse and the theme of eco-sustainability.

The TriCircolo Project, of the Tricycle Social Cooperative, has in recent months addressed citizens and artisans of the Barriera district of Milan to create an aggregative capacity on the issues of reuse and the circular economy[45].

The TriCircolo Reuse Center in via Regaldi 7/11 has been, and continues to be, a place of production, trade and sociality equipped to host meetings, training, solidarity exchanges, production and sale of goods and services related to reuse and the theme of eco-sustainability.

In particular, the TriCircolo spaces are aimed at artisans, professionals or simple hobbyists, who can use them to create and exhibit their products every day starting at 9.00 in the morning.

TriCircolo has chosen Barriera di Milano as a place to implement its project, relying on the long artisan tradition of the neighborhood, which was born as a working-class village in the mid-nineteenth century. TriCircolo operators aim to develop the great manual and artisan potential of the residents of these streets[45].

As a result, the project has managed to bring on board for some initiatives important partners such as the Polytechnic of Turin and Compagnia di San Paolo, as well as hosting another social reality specialized in textiles (Glocal Factory) together with 7 artisans who have settled in these spaces and that deal with the reuse of cycling materials.

It is important to underline that despite the various historical markets that are organized in the TriCircolo Reuse Center and the numerous collateral initiatives, the aim of the project is not the sale of final products, but to provide services and facilities to the artisans who make them trying to put the producers in contact. with potential customers and with any investors interested in developing their projects.

TriCircolo Reuse Center project is part of the 15 generative welfare projects of the Turin Social Factory program of the City of Turin, co-financed by the National Operational Program for Metropolitan Cities and by the European Union, European Social Fund, carried out within the framework of Turin Social Impact.

Despite a setback due to Covid-19 and the recent end of citizen and European

funding, the TriCircolo project continues to wait for the artisans who want and all interested citizens at the headquarters in via Regaldi 7/11[45].

4.4 The final table for Turin

CIRCULAR SYSTEMS IN TURIN	Practices in Turin	Scale	Circular Action		
			Loop	Adapt	Regenerate
Circular Construction	"Edilizia circolare"	Nbh. Lingotto	✓	✓	
	"Green Building Council Italia"	City-Region			
Circular Food System	"REPOPP Project"	Nbh. Centro	✓	✓	✓
Adaptice Reuse of Spaces/Infrastructure	General Town Plan (PRG)	City-Region	✓	✓	✓
	Green Infrastructure Strategic Plan	City-Region			
	Local Public Transport (TPL)	City-Region			
	Mobility As A Service (MAAS)	City-Region			
Water Recycling	"SMAT" Water Points	City-Region	✓	✓	✓
Waste Management	Plastic-Free School Canteens	City-Region	✓		
	"Big Belly"	City-Region			
Ecological Restoration	"32 structural projects for 2030"	City-Region	✓	✓	✓
Reuse of Goods	"TriCircolo"	Nbh. Barriera di Milano	✓		

Figure 4.15: Circular Systems in Turin

The table is created in order to show circular systems in Turin. There are some relevant circular systems in order to analyze the city as in the research paper of Jo Williams[8]. Circular construction, circular food system, adaptive reuse of spaces infrastructure, water recycling, waste management, ecological restoration, and reuse of goods are examined in order to make out the situation in Turin.

In the table, there is one column related to practises in Turin. This column investigates the name of the projects, associations, or plans according to the circular system type. Some circular systems have the practices more than one and we can see from the table. There is also another column in the table about the scale of the project or plan in the city of Turin. It shows if the project/plan involves the city region or only the neighborhood.

In the table, there is one column related to the circular actions which are looping, adapting, and regenerating. The circular actions are associated with circular systems and this binding between each other is the result of the author's literature research. We can see this one also one of her tables of benefits of circular systems identified by service and infrastructure providers[8].

According to the table, the first circular system in Turin is circular construction that is revealed in two practices in the thesis. One of the projects is "Edilizia

circulare" which is in the neighborhood of Lingotto. The second one is the "Green Building Council Italia" which Turin Municipality has followed the rules in the city region. Circular construction has looping and adapting as circular actions.

"REPOPP Project" is the practice of the circular food system in Turin. The project was created in Porta Palazzo in order to utilize dead stocks of foods and vegetables. Unfortunately, there is only one example in Turin about the circular food system in Porta Palazzo. Additionally, we can see all the circular actions in this system.

There are many studies on behalf of adaptive reuse of spaces/infrastructure in the city scale of Turin. This system includes all circular actions that are looping, adapting, and regenerating. First of all, the Municipality of Turin has a General Town Plan (PRG) that includes many general improvements made on behalf of the city's general infrastructure. Secondly, Green Infrastructure Strategic Plan focuses on the greenery areas of the city. Lastly, Local Public Transport (TPL) and Mobility As A Service (MAAS) projects are related to the improvement of the city transportation network.

There is an association is called "SMAT" Water Points is the water recycling circular system in the city of Turin. The work of SMAT shows its impact on the whole city scale. Not only it has drinkable water points in the city, but also it carries out research and development studies on the clean and gray waters of the city. Therefore, water recycling is a circular system that includes the entire circular action.

In Turin, many comprehensive investigations and sanctions are also implemented about the waste management circular system. It is expected that all of these studies will be carried out within the scope of the city scale and will yield serious results. "Big Belly" and Plastic-Free School Canteens are the most relevant practices related to this circular system. Furthermore, this system naturally only has looping circular action.

The municipality of Turin has made a comprehensive future plan, targeting the year 2030. All the 32 structural projects in this plan are perfect practices for the ecological restoration circular system in Turin. All these structural projects are planned to be made within the scope of the city scale and this circular system is contained within the entire circular actions which are looping, adapting, and regenerating.

The last circular system is the reuse of goods in the table. "Tricircolo" is an

association that ensures that used items reach people who need them again. Thus, the reuse of goods is brought back to use and comes to life again in the circular economy in the city of Turin. TriCircolo is located in the BR neighborhood of Turin and aims to increase its influence day by day throughout the city. Reuse of goods has the only looping as a circular action.

From this table, we can find out the information about the circular systems in Turin. Due to this table, we can easily find the activity of each circular system and look at what scale it takes place in the city of Turin. It shows also the relation between circular actions and circular systems.

4.5 Conclusion

This part of the thesis has a target of the examination of the city of Turin as a circular city.

Turin has a particular history from Roman times to the Italian state and to the present day. Turin also was the industrial capital of Italy with automotive and mechanical manufacturing firms. Before everything, in order to understand the city of Turin, by researching its history, keywords of the city can be discovered for circular improvements. For example, the dead spaces that exist today emerged from previous industrial areas.

Turin's urban development should be analyzed very well. There are two main factors and they are adapting the urban core for new infrastructure of the Baroque style of the old town. The second one is the centrality of the industry and the expansion of the population related to it. The urban development of Turin should be analyzed to find out the necessity of circular improvement.

Transformation of mobility is a unique issue related to Turin. There are some regulations to force the people from the private automobile to public transformation. Transformation of mobility has relevant reasons for the ecological, social, and economic benefits. Turin should consistently continue and improve the feedbacks from improvements made about mobility.

The city of Turin has a project is called "Evaluation of ecosystem services in public green areas of Turin". The project has a target to improve ecosystem services products in the public parks. The services are the storage of atmospheric carbon, the removal of atmospheric pollutants, temperature regulation, hydrogeological protection, the infiltration capacity of rainwater, biodiversity and habitat quality,

social benefits, agricultural production, and pollination. These services should be examined in order to understand what kind of benefits they are giving the city of Turin.

Building a sustainable and resilient city means paying attention to the urban environment, the green infrastructure of the city, meeting places, proximity trade, cultural sites, accessibility, and connections between neighborhoods. It means addressing inequalities, bringing out and enhancing new communities and identities. It means promoting new production activities with a low environmental impact, an ecological economy, also through business incubators and research centers, the designation of new technological innovation poles. It means enhancing the food and wine sector and opening up to the creation of new forms of sustainable tourism, investing in the urban green system, from the hills to large parks, to the ecological corridors that connect our territory with the Alpine one.

Turin follows the roles from The New Urban Agenda for Europe which started in 2017. This agenda was created in order to implement a circular economy on the urban scale. In addition, Turin participated International Urban Cooperation program. The program's target was the creation of sustainable urban development challenges by paring between European Union cities and the United States cities. Turin and Baltimore were the pair in 2017. All of these activities show that Turin started to have awareness of the circularity in the urban scale in 2017. Turin should continue to follow the challenges and EU policies for circular development all over the world.

The municipality of Turin has an important action plan for 2030. These future actions are divided into 4 main concepts which are participative, dynamic, liveable, and supportive. In order to increase the possibility for success, the Municipality of Turin should consider compactly future actions presented in this plan, evaluating also the mutual effect and combining performance between them. In addition, the overall social, economic and ecological benefits to the city should be evaluated according to these actions.

Turin participated in the European Green Capital competition and Turin was one of the finalists between four cities. The motivation why Turin was chosen as the finalist is that the studies about climate change mitigation and adaptation, sustainable urban mobility, sustainable land use, nature, and biodiversity, air quality, noise, waste, water. Turin should participate in more competition in order to find the motivation to improve the city.

There are the main urban systems in order to have circular improvement according to the research paper of Jo Williams. It should be examined these urban systems in the city of Turin which are construction system, food system, adaptive reuse of spaces or infrastructure, water systems, waste systems, ecological restoration, and reuse of goods.

"Edilizia Circulare" is a project which is a challenge in Turin in order to recover construction waste such as paints, insulators, tiles and avoid disposal in landfills. This project has been done for the Fabbrica del Chinino and has a lot of interesting results for the circularity. The project is a useful example in order to perceive the benefits of circularity in the construction system. But Turin still has not gone beyond this project on an urban scale. The municipality of Turin should make some regulations, financing, and smart data platform in order to have a circular construction system in the city.

"REPOPP Project" is created to reduce food waste and enhance the suitable classification of waste in Turin's central market is called Porta Palazzo. They recovered 7.650 tons of food and the food reached 106.000 people in 2018. Volunteers collect unsold food from the bazaar to anyone who needs it. The municipality of Turin also collaborates with the volunteers to increase the performance of the project. However, REPOPP is not a project that covers the whole city. Habitants should be informed and raise awareness of the food bank. The project can be extended all over the city.

Turin has the General Town Plan is aims to regulate the urban morphology and improve territorial elements such as public spaces, green, recreational, and landscape heritage, cultural heritage, well-served neighborhoods, lively, full of commercial establishments, well connected, and accessible. But when we check the practical works, the municipality mostly focuses on two main reformations which are green resilient and transformation. ITS, MAAS, safe roads, and public transformation are their actions to improve the city. Although there are unused industrial areas in Turin, a comprehensive circular park project like QEOP in London has not been realized until now.

"SMAT" is the company that manages the integrated water cycle of the Turin metropolitan area and the municipality's own. SMAT supplies water points in the city to avoid around 114 tonnes of plastic bottles and releasing 360 kg of CO2 into the atmosphere. There is also a wastewater treatment plant that allows three types of waste to become again sources. There is also some water treatment of the Dora river for water recycling. SMAT water points should expand in the city center of Turin and also municipalities.

The administration conducts a series of awareness campaigns and provides tools to accompany citizens on the correct management and segregation of waste, like the Junker application. On the other hand, there should be some projects after differentiation of waste should become a source again and produce something with.

"TriCircolo" is a reuse center which a place of production, trade, and social area to host meetings, solidarity exchanges, sale of goods and services related to reuse and eco-sustainability. However, awareness of the inhabitants should be raised and a city-wide activity should be planned in order for the goods to return to the economy and lifecycle.

Chapter 5

Interview with Prof. Giulio Mondini

5.1 Questions and Answers

In order to more focus our study on the city of Turin, I realized a technical interview with a local expert about this topic who is Prof. Giulio Mondini, which has already realized some studies about circular cities in Piedmont. The questions for interview distinguish the mainly two parts. First part is the related to characterising and sampling of the circular cities. The second part is about the lecture of him in Polytechnics University of Turin in 2020. The evolution of the paradigm of the future cities, chaos theory and fractals, systems diversification and growth of the resilience, participation, and multi-parametric evaluation were the main focuses in the second part of the interview.

5.1.1 About the circular city

1. What should be considered when analyzing a city as a circular?
(Cosa si deve considerare quando si analizza una città in quanto città circolare?)

ANSWER: The first question that we should clarify is that today on this planet there are not cities that work in a circular way, so this one about the circular city is a theory, is a paradigm that we use to imagine the future of the cities and that cities should try to adapt to it, and to reach this circularity. What should be proposed to the cities, so that they can start to think of circular cities? First of all, we should analyze the condition of the environment and try to understand from which environmental condition that city is starting, from the point of view of air quality, water quality, green quality, and all those elements that could help the

city to become a sustainable city. But this is not enough to be a circular city. For this all the actions that are developed (done) in this city should be actions that do not produce waste. Everyone produces waste, but it is necessary that it is taken to reuse all the waste of one city and to imagine that all the waste is resources. We should start from the concept that all the waste should become a resource. A new paradigm is an opposite of what we did until today. This is the way to consider a city as the beginning of an adventure so that it can become a circular city.

2. What kind of development should urban systems have in order to consider the city as circular?
(Quale tipo di sviluppo deve avere un sistema urbano per poter essere considerato città circolare?)

ANSWER: The first answer that I have in my mind is: the city should have a harmonic development. "Sustainable" is an abused word, that lost its original meaning, so we should try to understand which ones are the factors of urban development. Therefore, the system of traffic, the system of living, the models of living, the cultural systems, the multi-cultural and multi-ethnic cities. All these systems should be analyzed so that a city can be considered a circular city. The collection of the systems that compose the urban system. In order to understand where the risks of this action are, we must do a SWOT analysis so that we can understand the economy, society, and environment, which elements characterize that city. Also, the system of water is relevant. The cities are different, so there is not a paradigm for every city and we should consider each city and understand for that city which elements are relevant to have a circular system. One of the main problems is to convince society to operate in a virtuous system, and that they can have benefited from it. If benefits are not on the community, this is a problem from the point of view of the possibility. These actions of circularity are not in the big industrial systems but in each person. They will be careful with all the elements that compose the urban system.

3. According to you, which cities can be a good example of the circular city in Europe or other parts of the world? and which circular development do they have in their cities?
(Secondo lei, quali città possono essere un buon esempio di città circolare in Europa o in altre parti del mondo? E quale sviluppo circolare hanno riportato?)

ANSWER: We go back to the first question. There are not cities that work as circular cities but we can give an example of eco-sustainable neighborhoods, because there are several of them in the world, with different scales and targets. There are several in North Europe and Arabic countries, where cities were conceived

as sustainable from their project. They are not circular neighborhoods, because the circular economy gives rise to the circular city. In these eco-sustainable neighborhoods, most of the attention is given to the building envelope, to the quality of the green, to the energy saving, to avoid water waste. It is needed that a city, in order to be sustainable and circular, should have both conditions. In our work, in fact, we spoke about eco-dynamic cities. For example, green is an element that can change. Eco dynamics is a characteristic that cities should have to be circular.

4. What is your opinion about Turin as a circular city? Nowadays, what point has Turin reached in terms of circular developments?
(Qual è la sua opinione riguardo Torino come città circolare? Attualmente, quale punto ha raggiunto Torino in termini di sviluppo circolare?)

ANSWER: Turin is quite back about this. It is an extraordinary city from the point of view of the image that the city has. But if we analyze the systems, they have some critical points. A simple element related to all the citizens is the city care. As we take care of our home, also we should take care of the city as well. The second important element is recycling. All the elements should be collected at a high percentage (90% for example). This is the first element of the circular economy. At the same time, companies should behave in the same way. Moreover, the production cycle of companies should be circular. They should take care of where the waste goes, but generally the waste end in dumps, with a high level of danger and low level of purification. So, the cycle should be about all the systems, especially the production. Another element: if Turin wants to be a circular city, we should think about the collection of home appliances, mobile phones, televisions, computers. Practically, they ended their primary function, but they did not end their economic life. All the elements that compose them are very precious. The minerals used to produce them are rare and precious, so we should learn that all these components should be divided into several pieces, and the useful ones should be selected and taken because they are useful. An example from Japan: all the medals in Tokyo 2020 Olympic Games are produced by reusing the recycled parts of the goods that I mentioned before (mobiles, televisions, etc. . .). It is a symbol, we can not change the world like this. But this is a good example of a circular economy. That medal will never have a new life. It will stay there forever. If Turin wants to go in this direction, it should have a department dedicated to the green transition and, mostly, to the formation of a circular economy for the city.

5. What studies in Turin fall into circular development according to you?
(Quali studi a Torino riguardano lo sviluppo circolare, secondo lei?)

ANSWER: I already answered the previous question. As part of our group, we

worked on green and we gave some indications about the environmental system and the city.

5.1.2 About the lecture

1. In the lecture, you mentioned about process of the "Sustainable development –> Sustainable community –> Circular city". I would like to ask what is the explicit difference between sustainable cities and circular cities?
(Nella lezione ha parlato di processo di sviluppo sostenibile–> comunità sostenibile–> città circolare. Vorrei chiederle qual è la differenza esplicita tra città sostenibili e città circolari?)

ANSWER: It is an evolution, more than a difference. In the lesson, I demonstrated as the current moment that we characterize as a discussion about the circular economy, is the evolution of the first idea of sustainable development, in the '80s. It was discussed about the meaning of sustainable development. Mostly it was related to environmental ecology, and not extended at 360 degrees as we do today. Later it was said: if we want to discuss the sustainable development of the cities, cities are a collection of elements and they are characterized by communities. Therefore we spoke about cultural sustainability: multi-culture, multi-ethnicity. The city should accomplish cities from other cultures, but cities are not ready for this yet were not designed for this in the beginning. Cities should care for communities. Communities need several services. But cities have a lot of services, but the wrong ones. Services for future generations are not provided yet. An interesting experiment in Torino is "Portineria Culturale"(cultural lodge): there are some kiosks in the city where newspapers were sold and now they are abandoned. They are public properties, so they thought to reuse them as lodges ("Portineria"). "Portineria" in our western culture is the place where the person that took care of the building was living. So in this place, everyone meets the custodian, that gives help. In these cultural lodges, we can ask services for family, for home, for dogs, for sons and daughters. It is a place where services can be asked. Who stays there, as the custodian in the home lodges, is the custodian of this knowledge. This is a good system to consider new systems for the people. For example, the population is getting old and more caregivers and maids are needed. Today there are associations that are collecting some caregivers, preparing them culturally. Caregivers should have some preparation because they interact with old people and old people have some specific needs from medical and mood points of view, for instance. In the past, there was not a service like this. This "Portineria" is very interesting and the city needs these services. The following evolution is the

circular city: in order to close this circle, the economy should be present and the system should become economic. The only way to do this is through a circular economy.

2. In the lecture, you mentioned: "We should think that circular actions are related to the second law of thermodynamics. This makes us think of an eco-dynamic city." According to me, it is very interesting to find the relation between the second law of thermodynamics and an eco-dynamic city. Could you explain, and give an example of this comparison?
(Nella lezione ha detto che dovremmo pensare che le azioni circolari sono correlate al secondo principio della termodinamica e che questo ci fa pensare ad una città eco-dinamica. Secondo me è molto interessante questa relazione tra il secondo principio della termodinamica e una città ecodinamica. Potrebbe spiegarmi questo, e darmi un esempio su questa analogia?)

ANSWER: The concept of the first law of thermodynamics is: it is impossible to realize a transformation where it is possible to transfer heat from a colder body to a warmer body without external work. In order to do this, we consider the concept of entropy. It is defined as the measure of equilibrium degree reached from a system in an instant. For each transformation of the system that implies an energy transfer, the entropy increases since equilibrium can only grow. I will try to explain why this produces circularity. I will give a simple example. If I consider a cooking pan and I warm it, and I take an ice cube and I put it inside the pan, the ice cube melts, because heat is transferred from the pan to the ice cube. When perfect equilibrium is reached? When the temperature of the pan equals the temperature of the water (melted ice). The increase of the transfer of energy is an increase in entropy. Every time that pan melts an ice cube, entropy grows and I reach equilibrium. It is the same concept of waste. If I consider a product, when I buy it, it is at its maximum level because I can use it. I use it for a lot of time until I can not use it. If I throw it, it ends its economic life. But if I follow the second law of thermodynamics, I can separate its components and save them, so that they can start a new life cycle and go towards equilibrium. I will reach equilibrium when all the pieces will not be usable anymore.

3. In the lecture, you mentioned: "Systems are elements ruled by subsystems. The representation is fractal. The systemic approach comes from chaos theory. Fractal is one subsystem that reproduces itself until it becomes a big system." Circular systems and their subsystems were compared to fractals. What are the advantages of this approach to thinking of them as a fractal?
(Nella lezione ha detto "I sistemi sono elementi regolati da sottosistemi. La rappresentazione è frattale. L'approccio sistemico viene dalla teoria del caos. Il frattale è un sottosistema che riproduce se stesso fino a diventare un sistema grande." I

sistemi circolari e i loro sottosistemi sono paragonati a frattali. quali sono i vantaggi di questo approccio?)

ANSWER: It is exactly that example that I did now. Fractal is important because it reproduces itself, producing several shapes, in a random way. In the chaos, there are some laws. The circular economy is like a fractal because it keeps reproduces some relations because I thought by systems, but not in a systematic way. The division of an object (pencil) is systematic, but then I put them in a system. I should think by systems. Commerce, production, packaging, finally composing the general system. There is a big system with small subsystems that between them, they move randomly. So we have fractals.

4. Could you explain the relation between systems diversification and growth of the resilience?
(Potrebbe spiegare la relazione tra diversificazione dei sistemi e crescita della resilienza?)

ANSWER: If we do not diversify our activities and we only have one, this one, when it is stressed and can not react to this stress, that system ends. I will try to give you an example. If China, which is a big producer of rice, decides to use only one type of rice, and in that year there is an illness of that type, there is a decrease of the production that can imply a risk for several lives of Chinese people, because they eat a huge quantity of rice and world could not supply. If I have more types of rice, the system is resilient. In the economy, investors do not do only one investment, but several at different levels of risk. This system is resilient.

5.“Public, individual, and social participation are very important for the urban transformations.” According to you, what kind of projects or practices can be effective to adapt the circular approach to the community?
("La partecipazione sociale, pubblica, individuale sono molto importanti per le trasformazioni urbane".Secondo lei, quale tipo di progetti o azioni possono essere efficaci per adattare l’approccio circolare alla comunità?)

ANSWER:Participation is a fundamental element of social awareness-raising. With Prof. Bottero a lot of years ago we worked with an association that asked us for materials for middle schools so that they could start there an act of awareness-raising. We did it because we believed in what we were teaching. It is important to do some actions during the educational period. This is valid also for multi-culture, multi-ethnicity, sport, all the values that we consider values of the future. It is needed to start to work about it from kindergarten. Today we start to have a good level of environmental awareness-raising. But since the beginning of this process,

40 years passed. We hope that PNR (Piano Nazionale Resilienza) can be a strong element in this sense because, in order to approve a project, it needs some passages.

6. In the lecture, you mentioned mono-parametric evaluations such as cost-benefit analysis will not be able to through the transformation of the cities. Because they should also consider territorial and natural capitals. According to you, how will multi-parametric evaluations work in the future?
(Nella lezione ha detto che le valutazioni mono-parametriche come analisi costi benefici non saranno sufficienti ad analizzare le città durante le loro trasformazioni, perchè dovrebbero anche considerare capitali naturali e territoriali. Secondo lei, come funzioneranno le valutazioni multiparametriche in futuro?)

ANSWER:Firstly it needs benefit-cost analysis, that evaluates financial and economical benefits. This is important, and benefit-cost analysis should be oriented on this. The second element is that when there are some alternatives to choosing the projects, it will be mandatory to use multi-criteria analysis. In order to be a resilient plan, the project should be sustainable. The correct way to evaluate this is the life cycle assessment. This is the path that new projects should do. It is the same path from sustainable development to circular economy.

5.1.3 If there is

1. Have you ever had any projects or researches about circular cities in your academic career?
(Ha mai avuto progetti o ricerche riguardo le città circolari nella sua carriera accademica?)

ANSWER: They do not give us the circular economy project. We should create them. When we have a project, we should organize it so that it can become circular development. We did an experience about the development plan for Asti territory (Piano di Sviluppo del territorio astigiano). We tried to identify some actions (seven) that, if realized, can give a circular economy.

5.2 Exposition of the Interview

5.2.1 Characterising the Circular City

Circular cities are a theory, a paradigm for the future of cities. Cities should try to adapt to this paradigm and achieve circularity.

First of all, it is necessary to analyze the state of the environment and understand

from which environmental condition the city started. Air quality, water quality, green quality and all the factors that can help the development of the city are examples of this.

But these elements are not enough to be a circular city. For this, all actions developed in the city must be non-waste actions. It is very common to generate waste in the city, but reusing all the wastes of a city as a resource would be a solution. Contrary to what has been done so far, we must transform the city into a circular city, seeing it as the beginning of an adventure.

To address the city in a cyclical manner, urban systems must have harmonious development. First of all, it should be understood which urban development factors are. The traffic system, the living system, the life models, cultural systems, multicultural and multi-ethnic cities and such urban systems should all be analysed. By making a SWOT analysis, we can characterize the economic, social and environmental elements of that city.

Also, Cities are different from each other and each city should be considered separately. For each city, which elements have a circular system or not should be analyzed separately. One of the main problems is convincing society that they can work and benefit from a virtuous system. This is a probabilistic problem if the benefits are not on society. These circularity acts are for humanity, not for its large industrial systems.

5.2.2 Example of the Circular City

There are no working cities like circular cities, but there are several eco-sustainable neighborhoods in Northern European and Arab countries that are designed to be sustainable. They are not circular neighborhoods because the circular economy leads to the circular city. An example of cyclical activities in these eco-sustainable neighborhoods is to pay attention to the building envelope, quality of green, energy saving to prevent water wastage. For a city to be sustainable and cyclical, it must be an eco-dynamic city, and the green element is a necessary element for the city to be eco-dynamic.

5.2.3 Turin as a Circular City

Turin is quite backward in terms of cyclical developments. Although Turin is an extraordinary city, it has some critical points regarding its urban systems. Just as all citizens take care of their homes, they should protect and care for the city with the same care. Community awareness is very important. Another important

element for circular development in the city is recycling. All elements must be collected at a rate as high as 90%. This is the first element of the circular economy.

At the same time, companies should act in the same way and carry out their production in accordance with circular rules. They must be mindful of where waste goes, as waste often ends up in landfills with high levels of hazard and low levels of treatment. For this reason, all systems, especially production, have to deal with this problematic waste cycle.

Another necessary element for Turin to be a circular city is that it has to review its waste collection of household appliances, mobile phones, televisions, computers. Practically speaking, we should not terminate the economic life of these technological devices after they have ceased to function in their primary function and put them back in the loop. All the elements that make them up are very valuable, and the minerals used to produce them are rare and valuable, so all these components should be broken down into several parts and the useful ones should be selected and added to the cycle.

A similar example took place at the Tokyo 2020 Olympic Games in Japan. All medals are reused from recycled parts of products such as mobile phones and televisions. We must change the whole world with such an approach. However, when we look at this example, we should consider that those medals will not have a place again in the circular economy.

If Turin wants to embark on a circular development path, it must have a department dedicated to a green transition and the formation of a circular economy for the city.

5.2.4 The Relation between Sustainable Cities and Circular Cities

There is more of an evolution than a difference between sustainable cities and circular cities. While the discussions about the circular economy started today, the evolution of the first idea of the sustainable development emerged in the 80s. The meaning of sustainable development was discussed in the 80s and mostly it was about environmental ecology. As we do today, there was no mention of a development that was addressed in 360 degrees, both socially and economically.

If we want to discuss the sustainable development of cities, cities are a collection of elements and are characterized by communities. Therefore, cultural sustainability is very important for cities at this point. Cities were not originally designed

to accommodate this, as they were not multicultural or multi-ethnic. However, communities in cities have this feature today and the city must be created and adapted according to multiple cultures. Cities must take care of communities and respond to the diverse services of communities. Unfortunately, services for future generations have not yet been provided.

An interesting experiment in the name of cultural sustainability took place in Turin. Its name is “Portineria Culturale” cultural pavilion. Nowadays, These kiosks, which are abandoned and where newspapers are sold in the city and public property in the past. They were thought to be reused as “Portineria” lodges. In Western culture, "Portineria" is also called the place where the person who looks at the building lives. So everyone here has the opportunity to meet the carer who helps. In these cultural shelters, it is aimed to provide services for the community of the city, family, house, dog, boys and girls.

Those who stay there as guards in the house lodges are the professionals. Thus, it is a good system for people to consider new systems. For example, the population is aging and more caregivers and maids are needed. Today there are associations that gather some caregivers, prepare them culturally. Caregivers need to have some preparation because they interact with older people and for example the elderly have some special needs in terms of medical and mood. There was no such service before. The “Portineria” is very interesting and a nice solution to meet the city’s needs for these services.

After all, the following evolution is the circular city: To close this circle, the economy must exist and the system must become economical. The only way to do this is in a circular economy.

5.2.5 An Eco-dynamic city

The concept of the first law of thermodynamics is that it is impossible to achieve a transformation in which heat transfer is possible from a cooler body to a warmer body without external work. To do this, the concept of entropy emerges. It is defined as the measure of the degree of equilibrium reached from a system at once. For each transformation of the system, which implies a transfer of energy, the entropy increases as the equilibrium can only grow.

This concept produces circularity. As a simple example, when a baking pan is heated and I take an ice cube and put it in the pan, the ice cube melts because the heat is transferred from the pan to the ice. When is the perfect balance reached? When the temperature of the pan is equal to the temperature of the water (melted

ice). An increase in energy transfer is an increase in entropy. Every time that pan melts some ice, the entropy grows and reaches equilibrium.

It is the same concept of waste. When a product is purchased for the first time, it starts to be used at the maximum level. It should be used for a long time until it becomes unusable. If it is thrown, its economic life ends. But if the second law of thermodynamics is followed, it can separate its components and they can be recovered so that they can start a new life cycle and go into equilibrium. Equilibrium can be reached when all parts are no longer usable.

5.2.6 Chaos Theory and Fractals

The fractal is important because it reproduces itself by randomly generating several shapes. There are some laws in chaos. The circular economy is also like a fractal in that it is not systematic and continues to reproduce some relationships when considered in terms of systems.

The division of an object such as a pen is systematic, but then it has to be incorporated into a system. It should be considered in terms of systems. Trade, production, packaging, finally make up the overall system. There is a large system with small subsystems moving randomly between them. So it's like fractals.

5.2.7 Systems diversification and Growth of the resilience

Activities in city systems should be diversified. Because if the necessary diversifications are not made in the system, the city will be at risk. If there is only one activity, the system ends when that one activity gets stressed and cannot respond to that stress.

To illustrate with an example, we can take China, a large rice producer. If China decides to produce using only one type of rice and there is a disease in that type of rice that year, it will be taking a huge risk in production. However, if China uses different rices during production, that is, it diversifies the rice, the risk ratio also decreases. Thus, More rice provides flexibility of the system.

In economics, investors make not just one investment, but several investments at different risk levels. This increases the durability of the system.

5.2.8 Participation and Multi-parametric Evaluation

Participation is a fundamental element of creating social awareness. Many years ago, Prof. Bottero worked with an association that wanted materials for secondary schools so they could start an awareness raising action. It is very important to raise such awareness during the education period. Because it is also valid for all values that we see as the values of the multicultural and multi-ethnic future. Studies on this subject should start from kindergarten. Today, we started to create a good level of environmental awareness. But 40 years have passed since the beginning of this process. PNR (Piano Nazionale Resilienza) can be a powerful element in this sense because it needs some passages to approve a project.

It requires cost-benefit analysis that primarily evaluates financial and economic benefits. This is important and the cost-benefit analysis should be geared towards it. The second element is that the use of multi-criteria analysis will be mandatory when there are some alternatives in project selection. To be a flexible plan, the project must be sustainable. The correct way to evaluate this is with a life cycle assessment. This is the way new projects should do. It is the same path from sustainable development to circular economy.

5.3 Conclusion

Cities should try to adapt to the circular city paradigm and ensure circularity. First of all, it should start with the analysis of the city, because each city is unique and its urban systems are different. The solution would be to ensure that all actions developed in the city are non-waste actions and to reuse all waste as a resource.

Urban systems need to develop harmoniously. The traffic system, life system, life models, cultural systems, multicultural and multi-ethnic cities and similar urban systems should be analyzed. With the SWOT analysis, the economic, social and environmental elements of the city can be characterized. Society must be convinced that they can benefit from a virtuous and circular system. The benefits of circular action should be on society, not on industrial systems.

Although there are no cities that function like circular cities today, there are several eco-sustainable neighborhoods. They are not circular neighborhoods because the circular economy leads to the circular city. For a city to be sustainable and cyclical, it must be an eco-dynamic city.

Today, Turin lags behind in terms of circular developments. Just as the habitant of Turin take care of their homes, they must protect the city of Turin with the

same care. Recycling is the first element of the circular economy and all elements must be collected at a high rate.

At the same time, companies should act like the city community and carry out their production according to the circular rules, and they have to deal with the problematic waste cycle with the whole system, especially the production.

Turin should review the waste collection process such as household appliances, mobile phones, televisions, computers. All the elements that make up these technological devices are very valuable, so all these components must be separated and added to the cycle by selecting the useful ones. If Turin wants to embark on a circular development path, it must have a department dedicated to a green transition and the formation of a circular economy for the city.

There is an evolution between sustainable cities and circular cities. The evolution of the first idea of sustainable development appeared in the 80s and was more concerned with environmental ecology. However, the discussions about the circular economy started today and it is a development that is discussed in 360 degrees both socially and economically.

Cities are a collection of elements and are characterized by communities. Cities were not originally designed to accommodate this, as they were not previously multicultural or multi-ethnic. Today, however, the situation is the opposite and the city must be redesigned for multiple cultures. Cities must respond to the diverse services of communities. For example, an increase in the elderly population is observed in the community. For this elderly population, appropriate and special city systems should be designed.

The concept of the second law of thermodynamics is the same as the concept of circularity. For example, when a product is purchased for the first time, it is used at the maximum level and when it becomes unusable, it is divided into parts and participates in another cycle. This is the second law of thermodynamics, meaning it can disassemble and start a new life cycle.

The circular economy is very similar in that it is not systematic like a fractal and continues to reproduce some relationships. It should be evaluated in terms of trade, production, packaging, and final systems. There is a large system with small subsystems moving randomly between them, such as fractals.

The activities in urban systems should be diversified and the risk level should be reduced. Because when only one activity gets stressed, the whole system collapses.

Instead, different systems and different risks should be created in the city. This increases the durability of the city.

Cost-benefit analyzes should be conducted to evaluate the financial and economic benefits in the city. When there are some alternatives in the selection of the project, it should be selected by making multi-criteria analyzes. To be a circular plan, the project must also be flexible. Also, the path to sustainable development is the same as that to the circular economy.

Chapter 6

Conclusion

The purpose of this work was to characterise the circular city and its application to Turin. The circular cities which have the development of sustainable cities by implementing circular economy, is a critical paradigm for the future cities. It also addresses in 360 degrees both ecological, social, and economic. Analyzing all systems of each city separately is the most meticulous work that needs to be done in order to start circular developments in cities.

In order to reach this target, I did general review of the literature in order to find out already existent studies, existing analysis, and characterization of the circular cities. It is necessary to be clarified the give a context of the circular city terms. The description of the relationship between sustainable cities and circular cities is mostly about one evolution and expansion of the concept of future cities. In the case of circular cities, it focuses on eliminating all resource inputs and waste and emission leaks from the system, with all the city's systems operating in harmony and balance with the circular economy.

Sustainability is often actuated by the idea of staying within the boundaries of the planet in terms of environmental impact. In contrast, circularity mainly arises from the idea that resources can be used better by using circular systems rather than linear ones.

Transforming a city into a circular city and promoting a circular economy are necessary tools to achieve a sustainable city vision, but it is not be sufficient if cultural, social and ecological tools and approaches do not complement them.

World population growth and the city capacity are the reason why we need to have sustainable and circular cities. We should take to reduce our collective environmental impact is to empower the community. Empowering women and girls,

promoting quality education for all, and global justice can be the solution to the world population growth.

The transformation of cities is not only spatial but also ecological, social, cultural, and economic. The city should be designed and reintroduced by considering ecological, social, cultural, and economic transformation. For this reason, only a city planner is not enough to plan the cities. There should be one collaboration with economists, ecologists, socialists, historians, and psychologists. This group can explore new possibilities for cities and create multicultural and multi-ethnic.

Buildings and design, mobility and connections, and products are the main milestones of a city. Buildings should be designed for different types of buildings, such as the existing area of hospitality, residential areas. The city is a mobility network and we should have structures that allow sustainable mobility. by reducing the private car roads in the city center. Thinking about connections with integrated mobility may be a solution.

Furthermore, according to my literature review work, the most useful and complete study about this topic was presented in the paper of Jo Williams "What are the benefits of the circular development?". This paper gave me inspiration and conceptual background for the original chapter related to analysing the city of Turin as a circular city.

I examined the research paper of Jo Williams in order to establish the rigorous criteria for defining if one city can be classified as circular by exploiting some well-defined indicators. The author creates the methodology to analyze cities; research papers, and interviews from 4 cities, and then she compares these two studies in order to understand the benefit of circular development and identify indicators for the actual analysis of these 4 cities.

The circular actions that are looping, adapting, and ecologically regenerating should be located in city systems. After that, some relevant benefits for the city will come out. The ecological, social, and economic benefits should be estimated before then applying the circular development in the city. Circular development that can supply the ecological benefits such as reducing resource consumption, reduction of greenhouse gas emissions, and increasing urban capacity to adapt to climate change should be discovered by each city.

Local cycling such as local circular food systems, community energy; and regenerative actions like community gardening, conservation projects, urban agriculture can increase environmental awareness among the public. Circular actions should

increase access to resources in communities such as goods, accommodation, heat, clean air, green spaces. They also should result in economic benefits such as supplying and production costs to manufacturers, economic value creation, diversification of the economy, and creating employment.

Each city defines circularity differently. Focusing on the application of CE principles within the framework of RESOLVE, which consists of six actions, such as supporting circular business models like London, promoting industrial symbiosis like Rotterdam or managing municipal material waste like Lisbon. So, every city should find its way to define and apply circular development according to its urban character. The city must be studied in order to enter the path of becoming a circular city by using elements of Waste management in the city, construction, organic, food, material, water, reuse of public spaces, greenery, etc. In addition, applying circularity in one part of the city such as one park, examining that region, and starting applications can be a solution for the beginning.

Amsterdam and Paris realized some circular actions such as the connection between waste producers and users, looping the construction and organic waste by creating the smart data about wastes, encouraging the pop-up circular experiments, reusing the houseboats for different activities, gray water cycling, covering the city's roofs and walls with 100 hectares of vegetation. The cities should take as an example of these circular actions and they can apply them in their own cities by looking at their suitability.

London, instead of other cities, has a strong example of a circular park is called Queen Elizabeth Olympic Park (QEOP). It has an ecological restoration process and starting work on a part of the city should be a good start to have circularity in the city.

Stockholm has had cyclical principles for 25 years, called Ecocycles 1.0, and organic waste from seaports is used to feed the waste-to-energy system, the stored water used for watering vegetation in the port for circularity. Cities should find out some circular actions according to their local requirements related to their urban systems.

The comprehension of the analysis performed for the just mentioned European cities was necessary to develop useful methods and tools for the case study object of this work. In fact, taking inspiration from these studies, I worked on the characterization of Turin as a circular city. I have some results by using the methodology of the research paper of Jo Williams related to Turin.

The keywords of the city can be discovered for circular improvements by researching

the history of the city of Turin. For example, the dead spaces that exist today emerged from previous industrial areas. Turin's urban development has two main factors that are the new infrastructure of the Baroque style of the old town and the centrality of the industry and the expansion of the population related to it. Turin's urban development should be analyzed to find out the necessity of circular improvement. Turin has a transformation of mobility and this has vital results for the ecological, social, and economic benefits. Turin should consistently continue and improve the feedback from improvements made about mobility.

Urban systems and its subsystems of Turin are examined if there are circular development related to Turin Municipality and Turin community. I created the table in order to show circular systems with the activity of each circular system and look at which scale it takes place in the city of Turin. I found out some projects and associations which supply the circular development in the urban systems in the city of Turin. The urban systems in the city of Turin are construction systems, food systems, adaptive reuse of spaces or infrastructure, water systems, waste systems, ecological restoration, and reuse of goods.

Turin does not have a circular construction system like in Amsterdam or Paris. But there was a challenge is called "Edilizia Circulare" for the Fabbrica del Chinino and the target was to recover construction waste such as paints, insulators, tiles and avoid disposal in landfills. It was a successful challenge but it has a very small scale compared with the city. Turin should regulate some roles, and create smart data like the Amsterdam platform in order to have a circular construction system in the city.

Turin has a food bank is called the "REPOPP Project" (Re-design Project of Organic waste in Porta Palazzo market) which is created to reduce food waste and enhance the suitable classification of waste. The project realized in Turin's central market is called Porta Palazzo and 7.650 tons of food was saved and the food reached 106.000 people in 2018. However, REPOPP should be extended all over the city because inhabitants do not inform enough. The community should raise awareness of the food bank in Turin.

Turin does not have one circular park project such as QEOP in London even if there are some dead industrial areas in the city. Turin should take inspiration from the QEOP and can realize a circular park project. On the other hand, there will be some improvement with the General Town Plan that has aims to regulate the urban morphology and improve territorial elements such as public spaces, green, recreational, and landscape heritage, cultural heritage, well connected, and accessible. Particularly, the reformation of the transformation system is under

process with the municipality.

The municipality of Turin has a company to take care of the water cycling in the city is called “SMAT” (Società Metropolitana Acque Torino). It distributes water points in the city to avoid around 114 tonnes of plastic bottles and releasing 360 kg of CO2 into the atmosphere. They treat the water of the Dora river and also have a wastewater treatment plant that allows three types of waste to become again sources. There should be more SMAT water points in the city center of Turin and municipalities.

The administration provides tools to accompany citizens on the correct management and segregation of waste, like the Junker application. There are also a series of awareness campaigns for waste recycling in Turin. However, there are not some projects after differentiation of waste to gain the output back for the city. “TriCircolo” is a reuse center in Turin. It is a place of production, trade, and social area to host meetings, sale of goods and services related to reuse, and eco-sustainability. However, it is not a city-wide activity. For that, awareness of the inhabitants should be raised in order to return the goods to the economy and life cycle.

At this point, a large amount of data and findings collected about Turin as a circular city in our previous analysis needed a confrontation with more detailed and practical knowledge about the actual situation of the city. İn order to receive feedback in this sense, I completed my study with an interview with a renowned expert about the circular city who has worked with Turin and Piemonte area and has also collaborated with Turin municipality. He is Prof. Giulio Mondini who is professor in Politecnico di Torino.

During the interview, some important conclusions were made. The terms of the circular city is a paradigm that the cities should make an effort to reach for their future. The first thing that cities should analyze is their urban systems that need to develop harmoniously and they should recognize their unique features to find out their circular development. Non-waste actions and reusing all waste as a resource are the main issue of the circularity for the city. Not only the society but also the companies should have awareness of circularity and they must carry out their activities according to the circular rules.

There is an important evolution between sustainable cities and circular cities that the sustainable development was started to concern with environmental ecology in the 80s. But nowadays, circular development is discussed in 360 degrees both ecologically, socially, and economically. In contrast to the past, cities are

multicultural and multi-ethnic. The city must be redesigned according to the new character of the community for multiple cultures and elderly people.

The concept of the second law of thermodynamics has the same concept of circularity. Because a product should be used at the maximum level and when it becomes unusable, it should be divided into parts and participate in another cycle. A fractal is also a very similar concept to the circular economy. They both have a large system with small subsystems moving randomly between them.

A further effort can be done to realize a more detailed comparison between Turin and other cities with a relevant amount of available data. It can be done also a comparison of Turin with other Italian cities of the same size or Turin with other cities in the same region.

Briefly:

In conclusion to this study, since I started to review the literature about sustainable cities, circular economy, and circular cities, I found out how to qualify the circular cities by an implementation of the circular economy to cities. Furthermore, a relevant finding from the literature review was the discovery of the research paper of Jo Williams about the benefits of circular development in the cities and additionally, the examination of some European cities which are examples of circular cities: Amsterdam, Paris, London, Stockholm. Thus, I explored the way of analyzing the city as a circular by studying these European example cities that have circular development in their urban systems.

Moreover, after completing the literature review and the examination of the research paper, I studied the general situation of Turin in terms of circular applications to its urban systems. Primarily, I started to search the overview of Turin about history, urban development, and transformation. After that, I searched Turin's urban systems which mostly have circular developments in the example cities from the paper of Jo Williams. I created one table to demonstrate the urban systems with their reasonable circular development in Turin.

According to my point of view, even if there are some projects, challenges, practices for the improvement of the urban systems in Turin, there are not enough circular actions to call Turin is a way of becoming a circular city. However, the existing practices have the potential for the beginning of the circular developments for the urban systems if they will enlarge their range of action, reaching the scale of Turin city. In my opinion, the Municipality of Turin also should have one department that takes care of the circular development for regulations, financing, and information.

In the following step, I made an interview with Prof. Mondini in order to clarify and supplement my study. To the best of my belief for my study, the circular city is an actual model that considers not only ecology like sustainable city idea in the 80s, but also sociology including multi-cultural evolution of the community, and economy, which realizes a passage from linear to circular. For that, multi-disciplinary collaboration is very essential between architects, urban planners and economists, ecologists, sociologists in order to rethink and redesign the cities for circularity.

In order to practically reach this target, we should analyze the city and its urban systems and particularly find out the characteristic urban systems of the cities. There are some obvious circular actions like looping, adapting, and regenerating. But we should determine the characteristic circular development in the urban systems such as reusing houseboats in Amsterdam or feeding the waste-to-energy system from the seaports of organic waste in Stockholm. According to me, the municipality of Turin should identify the attributes of the city such as redeveloping the green spaces since the city is fortunate to inherit large parks and greenways from its baroque past, or water treatment from the Dora river.

We should redesign the social, economic, and ecological features of cities and make circular developments for the future.

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