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The local dimension of the circular economy: progress toward an ecosystem approach

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Extended summary in Italian

L’attuale modello economico, lineare, ha un impatto negativo sull'ambiente, sulle persone e sull'economia ed è quindi insostenibile e inadatto alla realtà attuale, dove i problemi ambientali e quelli relativi alla scarsità delle risorse sono più urgenti che mai. Per soddisfare la sola domanda annuale di materie prime dell'Europa, infatti, sono necessarie 2,9 Terre, mentre ce n'è solo una. Utilizziamo più di quanto la Terra possa fornire a spese delle generazioni future e delle popolazioni di altri Paesi. La necessità di un cambio di paradigma è quindi indiscutibile.

L'economia circolare, che può ridurre il consumo di risorse naturali, la perdita di biodiversità e gli impatti ambientali e promuovere lo sviluppo sostenibile, si pone come modello economico alternativo a quello lineare. Possiamo definire l'economia circolare come un modello di produzione e consumo che riduce al minimo l’uso delle risorse estendendo il ciclo di vita dei prodotti.
Negli ultimi anni, l'economia circolare ha acquisito sempre più importanza tra i politici come approccio innovativo allo sviluppo sostenibile, anche le imprese stanno cercando di attuare la transizione dal modello lineare a quello circolare, i cittadini dal canto loro sono sempre più sensibili al tema della sostenibilità. Tuttavia, l’economia circolare non sembra riuscire ad affermarsi, i risultati sono insoddisfacenti, tra il 2018 e il 2020, infatti, il tasso di circolarità globale è sceso dal 9,1% all'8,6%.

L’obiettivo di questa ricerca è quello di capire perché, nonostante l'impegno dei governi e la crescente sensibilità e lo sforzo di aziende e consumatori, l'economia circolare stia fallendo.
L'ipotesi sostenuta in questa tesi è che l'attuale modello di implementazione dell'economia circolare incentrato sulle singole imprese sia inadatto e che sia quindi necessario implementare un nuovo modello, quello dell'ecosistema circolare, in cui diversi attori, non solo le imprese, interagiscono dinamicamente per attuare strategie circolari.

Per sostenere questa ipotesi, la tesi presenta un’analisi critica del concetto di economia circolare sia da un punto di vista teorico sia da un punto di vista applicativo, in modo da analizzarne i limiti. L’analisi si sposta poi sull’implementazione dell’economia circolare a livello locale, in questo contesto viene presentata in maniera critica la simbiosi industriale. Da questa analisi viene sviluppata una riflessione sugli ecosistemi circolari, che in questa tesi vengono presentati come il modello più

appropriato per implementare l’economia circolare a livello locale.
Sempre a sostegno dell’ipotesi di ricerca è stato sviluppato e somministrato un questionario alle aziende manifatturiere di tre settori (tessile, carta, gomma e plastica) con sede nei 19 comuni che fanno parte del "Consorzio Chierese per i Servizi", in provincia di Torino. Il questionario si concentra sulle difficoltà che le aziende devono affrontare per trasformare il loro modello di business da lineare a circolare, sulle numerose interazioni e sull'alto livello di coordinamento necessari per implementare la circolarità, e sull'impatto limitato che una singola azienda può generare. Inoltre, il questionario mira a verificare la possibilità di implementare un ecosistema circolare nell'area scelta per condurre la ricerca.

I dati emersi da entrambe le ricerche sono a supporto dell’ipotesi. La circolarità, infatti, deve essere intesa come una proprietà di un sistema, piuttosto che di un singolo prodotto o servizio. Per garantire la circolarità, l'aumento dell'efficienza nell'uso delle risorse e lo sviluppo sostenibile dell'economia e della società, i flussi di risorse e materiali dovrebbero essere trasformati a livello di sistema. Gli ecosistemi circolari sono quindi un concetto più appropriato per descrivere l'elevato livello di coordinamento tra le diverse parti interessate necessario per implementare i sistemi circolari.

PREFACE

This thesis aims to investigate the implementation models of the circular economy at the local level, as opposed to the current business-centred implementation model. In particular, the circular ecosystem model, in which different actors at the local level, from public authorities, businesses, citizens, etc., work together to implement circularity strategies, is analysed.

This thesis research stems from my interest in environmental sustainability, which led me to do my curricular internship at Reland, an association based in Turin that deals with the circular economy and intends to develop a circular ecosystem in the territory over the next few years. Working on this project during my internship, I became increasingly interested in the ecosystem approach to the circular economy, which has only begun to spread in recent years and is still little known, but which has a great potential given the greater impact it can generate compared to a business-centered model. For these reasons, I decided to dedicate my thesis research to this topic.

I thank Reland and Marco Mangione for giving me the opportunity to participate in this important project. I thank my supervisor Francesca Gambarotto for having supported and guided me in writing my thesis. Finally, I thank my parents for having given me the opportunity to study and for having always believed in me, and my whole family for having accompanied me along this path.

INTRODUCTION

This paper develops from the observation that the circular economy is not achieving the expected results. It therefore proposes a critical analysis of the circular economy and its current implementation model, which focuses on individual enterprises. In opposition to this model, the circular ecosystem, an alternative approach where different actors, not just firms, interact dynamically to implement circular strategies, is analysed.

In our current economic system, which is linear, we take materials from the Earth, make products from them, and eventually throw them as waste. This model has a negative impact on the environment, people, and the economy and is therefore unsustainable. According to the “No time to waste” report published by the Bank of America Merrill Lynch, the total production of waste in the world amounts to approximately eleven billion tons each year, of which 75% is destined for landfills or incinerators, while only 25% is reused or recycled. Calculations relating to the need for industrial raw materials between now and 2030, estimate that the gap between demand and supply of commodities would amount to about eight billion tons at the end of the next decade, and then gain further share, reaching the peak of twenty-nine billion tons in 2050. (Sfridoo, 2022) To meet Europe’s annual demand for raw materials alone, in fact, 2.9 Earths are needed, while there is only one. We use more than the earth can provide at the expense of future generations and people in other countries. The trend, in line with the growth of the global economy and population, does not bode well. Since the seventies it has been clear that the linear economic model, inefficient and expensive, is a major cause of the environmental crisis, but today, after the Covid-19 pandemic, the Ukraine crisis which highlighted the problem of material scarcity, and climate change that is causing temperatures to be well above the seasonal average and has left the entire globe in the grip of drought, the problem is more urgent than ever.

It is in this context, characterized also by a growing awareness and attention towards environmental and social issues by the society and companies, that in the seventies a new paradigm based on the circular economy emerged.

The circular economy can reduce the consumption of natural resources, biodiversity loss and environmental impacts and can promote sustainable development, one of the main challenges of our time. We can define the circular economy as a production and consumption model which minimizes waste by extending the life cycle of products.

The strategies put in place to achieve this goal are sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products for as long as possible. In the circular economy, the key issues shift from economic efficiency to energy efficiency, as the goal is to have resources available in the future and not in the short term.

The linear economy, in contrast, predicts that once a product reaches the end of its life, the cycle of that product simply becomes waste, forcing the economic cycle to continually repeat the same pattern: extraction, production, consumption, and disposal. The transition to a circular economy would bring not only environmental benefits, but also social and economic benefits.

In recent years, the circular economy has gained increasing importance among policymakers as an innovative approach to sustainable development. Many countries have included circular economy commitments in their national development plans and climate programs. In Europe, for example, the new Circular Economy Action Plan has been promoted as a key pillar of the EU's European Green Deal.

Businesses are also adapting. According to a study by the "Politecnico di Milano" conducted in 2021 in Italy, the 44% of the sample of companies interviewed stated that they had adopted at least one circular economy practice. For the companies that have not adopted circular economy strategies (the 56%), the 40% intend to implement them in the future, while 60% have no intention of doing so.

For what concern the Italian society, according to a study by Lifegate, sustainability in 2020 has been a felt issue, sceptics and undecided appear as an increasingly small minority. Everyone else is looking for information, clarifications, advice. (Neri, 2021)

Despite these positive trends, we are turning back in the circular economy path. According to the Circularity Gap Report between 2018 and 2020 the global circularity rate fell from 9.1% to 8.6%. This trend is due to the increase in consumption, which in the last five years has grown by more than 8% (from 92.8 to 100.6 billion tons), against an increase in reuse of only 3%. We recover less than 9% of the resources we use, and the use of materials is growing at a rate that exceeds population growth. We are moving in the opposite direction to that indicated by Green Deal. In Europe, about 13 tons of materials were consumed on average per capita during the year. Data range from 7.4 tons per inhabitant in Italy to 17.5 in Poland. As regards the productivity of resources, the European average increase is 17%, the Italian one 42%. In 2020, the last available year of data, the European Union's circular use of matter was 12.8%. In

Italy the value has reached 21.6%. Regarding the share of renewable energy consumption, Europe has recorded an increasing trend of about 5% between 2010 and 2019, reaching 19.7% in the last year of analysis. Italy has known in the years a practically continuous growth trend in the circular utilization rate of matter, starting from 11.6% in 2011 to reach 21.6% in 2020.
However, the result of Italy appears overall good only if compared to the competition. In Italy the biggest problem is that in the last five years the decoupling between GDP and consumption of materials, which would indicate good circularity performance in the economy, has not occurred. (Circular Economy Network, 2022)

Why despite governments' commitment, and companies and consumers' increasing sensibility and effort, circular economy is not working as it should? What are the reasons under this failure?
The hypothesis supported in this thesis research is that the current circular economy implementation model focused on single enterprises does not work. It is therefore necessary to implement a new model, that of the circular ecosystem.

Currently the transition to a circular economy is primarily business driven. This leads to some critical issues that do not allow the circular economy to take hold and achieve sustainability. Circularity, in fact, should be understood as a property of a system, rather than a property of a single product or service. To ensure circularity, increase in the efficiency of resources use and sustainable development of the economy and society, the flows of materials resources should be significantly transformed at the system level. Circular ecosystems are therefore a more appropriate concept to describe the high level of coordination between different stakeholders required to implement circular systems. This model is implemented at the local level, as this is the dimension where ecosystems can most easily develop and where they can have the greatest impact

To support my hypothesis, I administered a questionnaire to manufacturing companies in three sectors: textile, paper, rubber, and plastic. The area I have chosen to conduct my research is the set of 19 municipalities that are part of the "Consorzio Chierese per i Servizi", in the Province of Turin. The questionnaire focuses on the difficulties that companies must face in transforming their business model into a circular business model, the many interactions and the high level of coordination needed to implement circularity, and the limited impact that a single company can achieve. In addition, the

questionnaire aims to test the possibility of implementing a circular ecosystem in the area chosen to conduct the research.

In the first chapter, a critical analysis of the concept of circular economy is presented. In particular, the limitations of the circular economy from a theoretical point of view and from a practical point of view, i.e., its implementation, are highlighted. In addition, the state of the art of circularity and the consequent reasons demonstrating the importance of addressing this topic are presented.

The second chapter focuses on the local dimension of the circular economy. The importance of the circular economy in achieving environmental, social, and economic sustainability and the important role that place and proximity play in this context are presented. The analysis then shifts to the current model of implementation of the circular economy at the local level, namely industrial symbiosis, which is critically analysed. From this critical analysis comes a reflection on circular ecosystems.

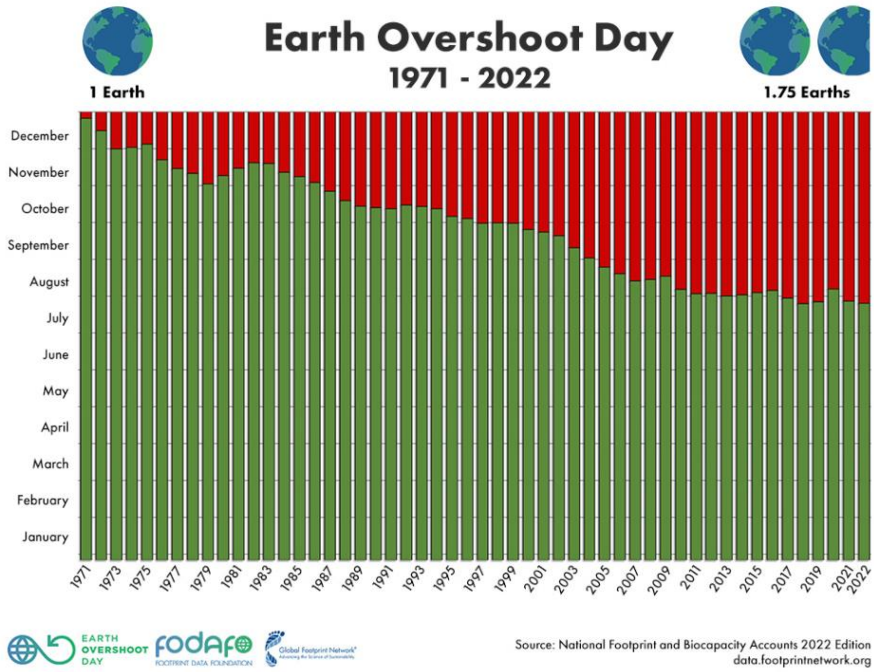
In the third chapter, the case study is presented. In particular, the experience from which the research originated, namely the Reland ecosystem, and the area on which it was conducted are described. Then the research methodology is presented, and the data collected through it are analysed to draw conclusions supporting the starting hypothesis.

CHAPTER 1: IS THE CIRCULAR ECONOMY THE NEW PARADIGM OF SUSTAINABILITY?

1.1 From linear to circular economy, differences and limits

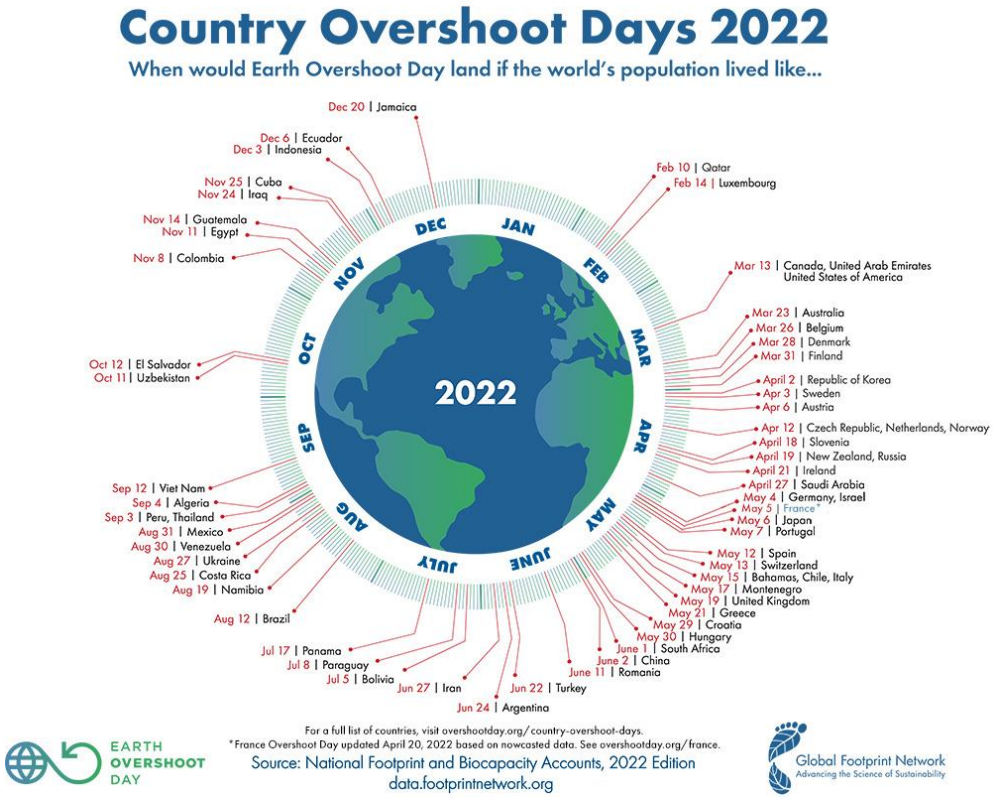
Between 1950 and 2015, the world's population tripled from 2.5 billion people to 7.7 billion people. (United Nations, 2015) Although the global rate of population growth has slowed significantly in recent years, projections by the world Organization of the United Nations indicate that there will be 9.8 billion people in 2050 and 11.2 billion in 2100. (United Nations, 2019) There is therefore considerable and justified concern about continued population growth, which focuses no longer on the volume of food production as in the past, but more broadly on the pressure of population growth on the natural environment (land, forests, biodiversity, ground water, oceans, air quality and climate) through unsustainable production and consumption patterns. (United Nations, 2015) It is necessary to emphasize that the problem is not population growth per se, this factor in fact simply aggravates the consequences of a globalized development context characterized by an increasing demand for materials that are, however, available in small quantities on our planet.

According to the data published in 2022 by the Ecological Footprint Method promoted by the Global Footprint Network, in 1970 our consumption of natural resources was equal to the sustainable production of resources on the planet, but the situation has been eroding ever since. This year, Earth overshot day, which is the date on which humanity has used all the biological resources the Earth regenerates throughout the year, lands on July 28. As the graph below, representing Earth overshot days from 1971 to 2022, shows, the data continues to worsen. There was a slight improvement in 2020 due to the Covid-19 Pandemic, but subsequent years have not belied the previous trend.



(Earth Overshoot Day, 2022)

May 15 was Overshot Day 2022 for Italy, which means that the country consumes more natural resources than the world average. (Earth Overshoot Day, 2022)



(Earth Overshoot Day, 2022)

Waste is proportional to the consumption of resources. According to the UN, total waste production in the world amounts to about 11 billion tons per year, of which only 25 percent is reused or recycled, while the remaining 75 percent ends up in landfills or incinerators. Estimates of the need for industrial raw materials between now and 2030 indicate that the gap between demand and supply for raw materials will stand at about 8 billion tons by the end of the next decade, and then pick up further. In 2050, according to some studies, it would be set to peak at 29 billion tons. (Sfridoo, 2022)

As for Europe, what emerges from the “Municipal Waste Generation” Eurostat’s data, is that each European citizen produced an average of 505 kg of waste in 2020, 4kg more than in 2019 and 28 Kg more than in 1995. A total of 225.7 million tons of municipal waste was generated in 2020 in the EU, +1% compared to 2019 and +27.7% compared to 2005. Municipal waste generation varied considerably among the EU Member States, in Italy, waste per capita in 2020 was 505 kilograms, therefore equal to EU average. (Eurostat, 2022)

These calculations are not meant to be predictions of a grim future. On the contrary, they lead to the recognition of the need for a transition from the linear to the circular economic model, which during all stages, from design, to production, consumption, and end-of-life destination, can seize every opportunity to limit material and energy waste and minimize loss, paying attention to the prevention of negative environmental externalities and realizing new social and territorial value. (Frosch and Gallopoulos, 1989)

The linear economy, which developed in the late 19th and early 20th centuries, is an economic model in which natural resources are used without concern for their actual availability in the future, and waste and end-of-life products are considered useless material. At no stage of the process, from production to consumption of the product to waste disposal, are the environmental and social impacts assessed, with important repercussions for the quality of life of future generations. The result is a model based on purely economic interests which prioritizes profit over sustainability, with products made to be thrown away once used.
The linear economy found full affirmation with mass production, however, since the 1970s it has been clear that the incessant flow of extraction and disposal, inefficient

and expensive, was and still is a major cause of such phenomena as marine and terrestrial pollution, the emission of greenhouse gases and the resulting climate change, while also generating intense competition for control of raw materials. (Università di Padova, Legambiente, 2017)

Circular economy, on the contrary, is a sustainable economic model. The concept of circular economy is derived from the general term “Ecology”, introduced by the German biologist Ernst Haeckel in 1866. The earliest trace of the idea of the circular economy date back to the dawn of the modern environmental movement in the 1960s and 1970s. One of the earliest and most important texts related to circular economy is undoubtedly “The Economics of the Coming Spaceship Earth” written by Kenneth Boulding in 1966, which set out most of the insights on which current circular economy thinking is based. Boulding’s text opens with a discussion of the difference between open and closed systems, especially with regard to the three essential elements of economy: materials, energy, and information/knowledge. Boulding also discusses the concept of entropy, describing the thermodynamics of a circular economy and emphasizing the importance of energy and information. (University College London, 2019) In his paper Boulding introduces the idea of Earth as a spaceship, which represents a closed system, with no exchange of matters with the outside environment. The spaceship has therefore a limited number of resources and waste disposal options. He declares that the survival of the human species is closely tied to the ability to use an asset and carefully guard what we have available, regenerating the materials we use daily. Humankind must rethink its relationship with nature and revise the relationships among its components too, a circular economic system is in fact a prerequisite for the maintenance of the sustainability of human life on Earth.

The circular economy, however, was not fully defined and described as such in economic terms until 1990, with Pearce and Turner’s Environmental and resource Economic text. In 1971 it was Barry Commoner, environmentalism expert, who described the "circle to be closed". While in 1976 Walter R. Stahel, together with Geneviève Reday-Mulvey, drew a link between scientific and economic aspects in the report sent to the European Commission "Potential for Substitution Manpower for Energy." In 1982, again Stahel and Orio Giarini, founded the Product-Life Institute where, by retaining ownership of the goods produced, companies, according to the Institute, would increase their earnings by selling services instead of goods. By

adopting this business model, companies would maintain an ongoing relationship with consumers, maximizing the intrinsic value of their products. In 2002, with the book "Cradle to Cradle", William McDonough and Michael Braungart compared the natural processes of trees to industrial processes, laying one of the most important theoretical foundations of the circular economy. (University College London, 2019)

In 2010 Ellen MacArthur created the Ellen MacArthur Foundation (EMF), which today plays a key role in the discourse related to the circular economy. For this reason, it is appropriate to quote her definition of circular economy:

“An economy which is regenerative by design. In a circular economy there are two types of material flow: biological kind which can be put back into the biosphere and technical waste which has to be repurposed without ever entering the biosphere. We can therefore define the circular economy as a system in which all activities, from extraction and production, are organized in such a way that someone’s waste becomes the materials for someone else’s creation. On the other hand, the linear economy means that, once a product reaches the end of its life, the cycle of said product simply becomes waste, forcing the economic cycle to continually repeat the same pattern: extraction, production, consumption, disposal.”

According to the Ellen MacArthur foundation, in a circular economy, economic activities build and rebuild the overall health of the system. For the circular economy to work, it needs to be effective at all scales: for large and small businesses, for organizations and individuals, globally and locally.

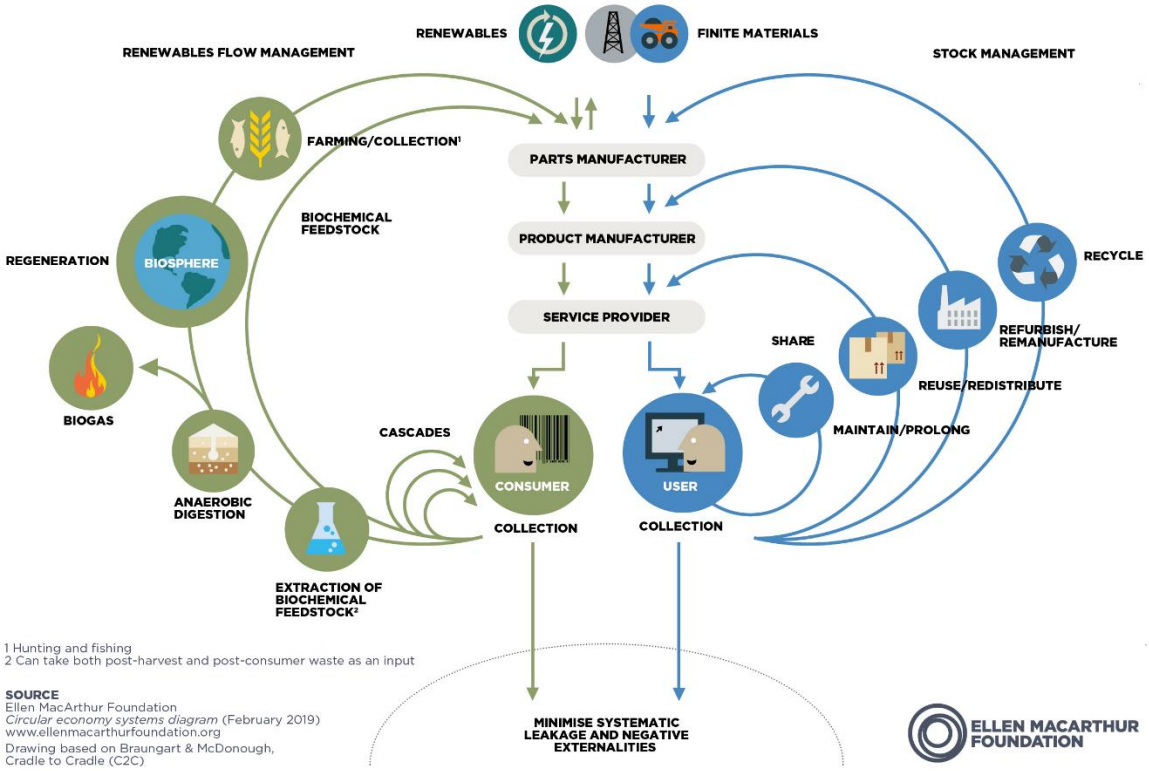
The circular economy is based on three principles:

1. Design out waste and pollution: the purpose of the circular economy is to remove the negative impacts of economic activity that cause harm to human health and natural systems. This includes the release of greenhouse gases and hazardous substances, air, land and water pollution, and structural waste.
2. Keep products and materials in use: a circular economy designs for durability, reuse, remanufacturing, and recycling to extend the life of products, components, and materials as long as possible while maintaining value in the

form of energy. Circular systems involve the effective use of biological materials, which circulate between the economy and natural systems.

3. Regenerate natural systems: a circular economy avoids the use of non-renewable resources and preserves or enhances renewable ones, e.g., by returning nutrients to the earth to support regeneration, or by using renewable energy instead of fossil fuels.

The essence of the circular economy is depicted in the diagram below, understandably called the “butterfly diagram”. (Ellen MacArthur Foundation, 2019)



(Ellen MacArthur Foundation, 2019)

The diagram shows the two types of cycles that characterize the circular economy: in the technical cycle products and materials are kept in circulation in the economy for as long as possible; in the biological cycle the strategy is to restore nutrients into the biosphere while rebuilding natural capital.

Technical cycles are usually for products made from non-biodegradable materials, the most effective technical cycle is to maintain and reuse products to preserve their value and increase their service life. Once a product cannot be reused, its value can be maintained by refurbishing or remanufacturing it. If the previous alternatives are not available, the material can be recycled, losing the value of the product itself but

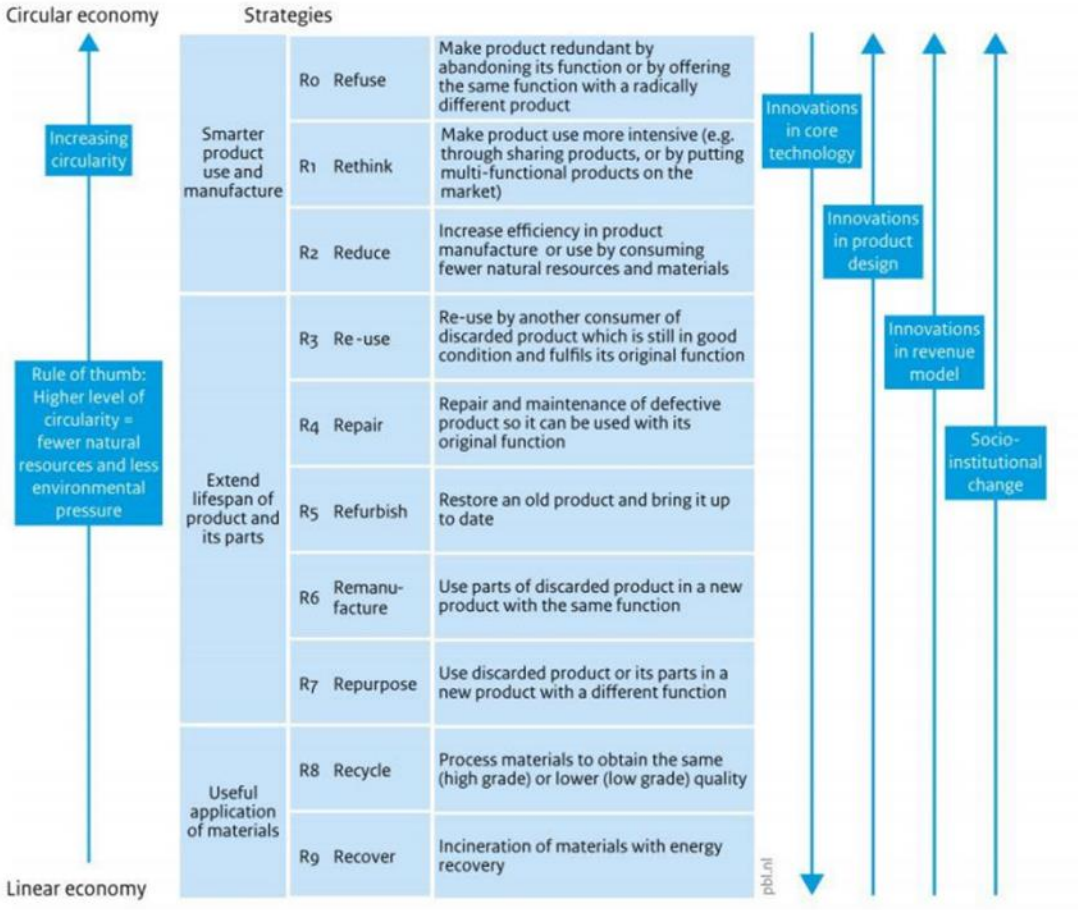
preserving the value of the materials.

In the biological cycle, biodegradable materials, which are renewable by nature but whose value can be cascaded through different applications, can be recycled. In this way, negative externalities can be minimised.

CE is about making the most from the resources that we have, while keeping their utility and value at the maximum.

The circular economy makes use of several strategies, recycling has been a key element of the circular economy from the beginning, but as time has gone on, the number of strategies has multiplied. In 2004 the Japanese Government's "3R Initiative" (reduce, reuse, recycle) was launched. In contrast, the European Union's waste hierarchy in its 2008 Waste Framework Directive developed four Rs (reduce, reuse, recycle, recover). In 2017, nine distinct Rs contributing to circularity were identified. (University College London, 2019) These strategies are illustrated in the diagram below.

Circularity strategies within the production chain, in order of priority



Source: Potting et al. (2017), Figure 1 : 5

(Potting et al., 2017)

Consumers play an increasingly important role in the economy. Their involvement increases when their demand is aligned with companies' sustainability goals, and they are invited to actively participate in product innovation. In recent years, consumers have become more and more sensitive and attentive to social and environmental issues. At the same time, however, there is still a strong scepticism about recycled and/or remanufactured materials. Therefore, the challenge of the Circular Economy is not only to improve the efficiency of production, but also to influence and change consumption patterns by creating greater awareness of the effects that a given purchase choice or behaviour cause on the environment, society, and the economy.

Digital technologies, particularly new technologies related to industry 4.0, can play a key role in the circular economy. Indeed, they can transform the relationship between production and consumption, as well as the organization and control of production processes within companies and supply chains. Thanks to their ability to interconnect and make production resources cooperate, digital technologies can not only increase competitiveness and efficiency, but also stimulate the introduction of new business models, going so far as to overcome the traditional distinction between product, production process and service, thanks to the Internet of Things.
At the enterprise level, digitization makes it possible to optimize resource consumption, reduce energy waste and waste generated in the production process, even warehouse management is made more efficient by linking requests from production and purchasing. The impact of Industry 4.0 thus affects both the company dimension and the entire production system, enabling the design and management of integrated production and de-production supply chains. It also makes possible industrial symbiosis as well as a new geography of production activities potentially closer to end markets. (Università di Padova, Legambiente, 2017)

The circular economy is considered and can potentially be one of the main instruments to reach sustainability, however the concept has also received some critics from practitioners and researchers.
First able, the circular economy concept is very broad, building on a heterogeneous collection of scientific and semi-scientific concepts. There are over a hundred definitions of circularity, which include everything from recycling systems, to renting, to replacing products with services, to developing apps for the sharing economy, etc., therefore the concept means different things for different people. Moreover, there are

distinctions between researchers' communities, therefore the concept is fragmented, and measuring its real impact can be difficult.
However, according to the chairman of the International Solid Waste Association (ISWA) "[t]here is no single commonly accepted definition of the term "circular economy", but different definitions share the basic concept of decoupling of natural resource extraction and use from economic output, having increased resource efficiency as a major outcome".

Another critique is that the circular economy ignores established knowledge, in particular the thermodynamic teaching that one can neither create nor destroy matter: resources can only be converted and dissipated, but cannot be destroyed, therefore they must end up in the environmental system somewhere. A circular economy future where waste no longer exist is therefore impossible.

Material properties and production and reprocessing technologies also pose limitations to closing the loop, as do dissipation in the environment, cand contamination and material wear.
Moreover, the circular economy fails in recognizing and addressing the complexity of waste. Recycling markets are unpredictable and have high degrees of volatility, toxic waste cannot be recycled, and a large share of waste is managed by the informal sector, energy waste dominates both the economic and biological spheres, but is often not included in recycling practices.
According to others, the circular economy underestimates the difficulties related to linking waste streams to production and substituting secondary goods for primary ones.
Viewing waste as a resource can also, paradoxically, increase the demand for waste rather than reduce its quantity.

Positions in favour of the circular economy ignore the considerable number of materials and products that people have already accumulated, thus focusing on manufactured flows rather than inventories.
In addition, the potential rebound effect, whereby improvements in individual products, are offset by growth in materials consumption, is another unresolved issue.

The circular economy is often presented as the solution to the sustainability challenge, but it underestimates it. For example, it focuses on a relatively small portion of materials.

Short- and long-term environmental impacts remain vague when it comes to reuse, remanufacturing, and recycling projects, and it is not known to what level circular products can truly replace linear products. This is problematic as the circular economy is based on this very premise.

Moreover, in today's global market, products that are manufactured, purchased, disposed of, and recycled in the same geographic location are only a small fraction, resulting in material transfers around the world. Therefore, the circular economy would require a global reorganization of consumption and production, so it is unclear how a circular economy can globally meet human needs within planetary boundaries. Consequently, according to some, the only difference between a linear economy and a circular economy lies in the fact that negative environmental impacts will take longer to manifest themselves in a circular economy.

Although proponents of the circular economy claim that it leads to positive social impacts, the concept tends to boil down to a debate about resource consumption, with no connection to how the concept would lead to greater social equity. Some critics also claim that the circular economy depoliticizes industrial and environmental policies, favouring market and corporate power by promising that everyone will benefit from its implementation.

Critics of the circular economy do not question the concept of circularity per se, but highlight the need to really understand how the circular economy can be good for the economy, environment and people. (Corvellec, Stowell, Johansson, 2021)

1.2 Policies and legislation, driver or barrier of the circular economy?

The topic of the circular economy has been addressed several times in national and international contexts and to date is one of the European Union's top priorities. In December 2015, the European Commission published the Communication COM (2015) 614 final, "The Missing Link-European Union Action Plan for the Circular Economy", a plan financially supported by the European Structural and Investment Funds, Horizon 2020, the European Fund for Strategic Investments (EIFS), the LIFE

program, and followed by additional policies. The goal of the plan is to facilitate the transition to a circular economy through more sustainable use of resources, promoting EU competitiveness, stimulating sustainable economic growth, and creating new jobs. In addition, a number of actions have been implemented, such as: a push toward eco-design, which is a way of designing consumer goods that makes them sustainable and recyclable from conception; the introduction of the concept of "extended producer responsibility," which makes the producer accountable for the disposal and recycling of the goods produced; the introduction of best practices and of labelling systems that certify the sustainability of products, such as Ecolabel; the setting of recycling targets and disincentives to landfill of waste, as well as improved legislation on organic fertilizers, water reuse, traceability and safety in the use of chemicals.

Subsequently, in 2018, the Circular Economy Package came into force, consisting of four directives on waste, packaging, landfills, electrical and electronic waste, end-of-life vehicles, and batteries. The aim is environmental protection, with the goal of an average annual reduction in emissions of 617 million tons of Co2 equivalent, with a positive impact on employment-through the creation of 500,000 jobs-and on the eurozone economy and fostering GDP growth of up to 7 percent more by 2035, according to European Parliament estimates. The long-term strategy is to engage companies in making products from new materials that are entirely reusable and therefore do not generate waste, while the short- and medium-term strategy is to manage the waste produced more responsibly through reuse and recycling.

On December 11, 2019, the Commission presented its communication on the European Green Deal, which is a new growth strategy "aimed at transforming the EU into a climate-neutral, just and prosperous society with a modern, resource-efficient and competitive economy". The Green Deal includes an action plan aimed at promoting the circular economy, restoring biodiversity, and reducing pollution, outlining the necessary investments and available financing instruments, ensuring an equitable and inclusive transition. The EU, through the "Just Transition Mechanism", which will help mobilize at least €100 billion for the period 2021-2027 in the most affected regions, will provide financial support and technical assistance to help those affected by the transition to the circular economy. (Turco, 2022)

In line with the EU's goal of achieving climate neutrality by 2050 as part of the Green Deal, in March 2020, as announced in the Circular Economy Action Plan, the European Commission proposed the first package of measures to accelerate the transition to a circular economy. Proposals include improving sustainable products, empowering consumers toward the green transition, revising the Building Materials Regulation, and a strategy on sustainable textiles.
In addition, in its vote on February 9, 2021, the European Parliament called for stricter recycling, material use, and consumption standards with binding targets to be met by 2030. The Commission plans to extend the Eco-design Directive to non-energy related products and to create digital product passports. The goal is to share all relevant information throughout the product life cycle to achieve a European market for sustainable, climate-neutral, and resource-efficient products. Moreover, members approved initiatives to combat planned obsolescence, improve the durability and reparability of products, and strengthen consumer rights with the "right to repair". The importance of consumers' right to be properly informed about the environmental impact of the products and services they purchase was also stressed, and the Commission was asked to prepare proposals to combat the unfair practice of "greenwashing" (a term used to refer to a company's false sustainability policy).

The European Commission's action plan has established seven key areas that are essential for achieving a circular economy: plastics, textiles, e-waste, food and water, packaging, batteries and vehicles, buildings and construction.

- Plastics: MEPs promoted the European strategy for plastics in the circular economy, which among other things phase out the use of microplastics.
- Textiles: the textile industry uses many raw materials including a large amount of water, compared to less than 1 percent recycled material. In March 2020 the Commission presented the EU Strategy for Sustainable and Circular Textiles, which aims to ensure that textiles on the EU market are durable and recyclable, made as much as possible from recycled fibres and free of harmful substances by 2030. MEPs also encouraged new measures to counter microfiber loss and introduce stricter standards on water use.
- Electronics and Information and Communication Technology (ICT): electronic and electrical waste is the fastest growing waste stream in the EU, of which less than 40 percent is recycled. MEPs called for the EU to promote longer product life through reuse and repairability.

- Food and water: in the European Union, 20 percent of the food produced is lost or wasted. Therefore, MEPs have promoted halving food waste by 2030, as set out in the Strategy for Food Sustainability.
- Packaging: packaging industry waste in Europe reached a record in 2017. The new rules aim to ensure that all packaging in the EU market is economically reusable or recyclable by 2030.
- Batteries & vehicles: MEPs approved new rules on the production and type of materials used for all batteries on the EU market. They require that batteries have a low carbon footprint and that their production is carried out with respect for human rights, as well as social and ecological standards.
- Buildings and construction: The construction industry is responsible for more than 35 percent of the EU's total waste. The Commission has announced a revision of the Construction Products Regulation to update the rules in place since 2011. MEPs called for extending the lifespan of buildings, setting targets for reducing the carbon footprint of materials, as well as minimum requirements on energy and resource efficiency.

The EU produces more than 2.5 billion tons of waste per year. With this plan members aim to push EU countries to increase high-quality recycling, move away from landfilling and minimize the use of incinerators. (Parlamento europeo, 2022)

Regarding the Italian context, Italy has adapted to the commitments adopted under the Paris Agreement on Climate Change, the United Nations 2030 Agenda on Sustainable Development, the G7 and the European Union. In 2017, the document "Towards a Circular Economy Model for Italy. Framing and Strategic Positioning Document," aimed to provide a general framing of the circular economy and to define the country's strategic positioning on the topic, was published. However, since 2017, the reference context has changed, and it was therefore necessary to update the strategic lines, making them consistent with the new global challenges.
The concept of circular economy was incorporated into Italian legislation in 2020 with the transposition of European directives contained in the package of measures approved in June 2018 (Directives 849/2018, 850/2018, 851/2018 and 852/2018) and in particular through:

- the decree 116/2020 - circular economy package
- the decree 118/2020 - WEEE

- the decree 119/2020 - end-of-life vehicles
- the decree 121/2020 – landfills

With the circular economy package, targets are set for recycling of municipal waste: at least 55 percent by 2025, at least 60 percent by 2030, at least 65 percent by 2035; a limitation was also introduced on their disposal in landfills, which must not exceed 10 percent by 2035. The new legislation includes reform of the extended producer responsibility system, the establishment of a special national register of producers, and some changes to the waste identification form to facilitate its transport. There are also simplifications for the reuse of end-of-life vehicle parts that can be used as spare parts, maintenance activities, and minor construction work.

In November 2021 the National Recovery and Resilience Plan (PNRR) was launched. The theme of circular economy is addressed in Mission 2: Green Revolution and Ecological Transition, which provides funding and new regulations for the major themes of agriculture, mobility, energy efficiency of buildings, pollution, circular economy, and energy transition. This Mission aims to foster the ecological transition to management systems that consume as few resources as possible and produce as little waste as possible. The funds (€59.33 billion) and regulatory reforms will be used to address structural gaps that hinder the achievement of a new and improved balance between nature, food systems, biodiversity, and resource circularity, in line with the goals of the Circular Economy Action Plan launched by the EU. The PNRR also provides funding for circular economy "flagship" projects that promote the use of highly innovative technologies and processes in the following sectors: electronics and ICT, paper and cardboard, textiles, plastics.

Mission two is divided into four components to achieve its objectives, distributed as follows:
Component 1 - Circular Economy and Sustainable Agriculture: 5.27 billion;
Component 2 - Renewable energy, hydrogen grid and energy transition and sustainable mobility: 23, 78 billion;
Component 3 - Energy efficiency and building upgrading: 15.22 billion;
Component 4 - Land and water resource protection: 15, 06 billion. (Ecomondo, 2022)

In 2022, with the new "National Strategy for the Circular Economy", new tools have been defined to improve the market for secondary raw materials, extend producer and consumer responsibility, spread sharing and "product as a service" practices, support the achievement of climate neutrality goals, and define a time schedule of measurable actions and targets from now until 2040. The strategy has been included among the investment-supporting reforms of Mission 2, Component 1 of the National Recovery and Resilience Plan, dedicated to "Circular Economy and Sustainable Agriculture." Specifically, the new strategy will cover the following focus areas: eco-design and product innovation, bioeconomy, blue economy, and critical raw materials. The new strategy will include the following measures:

- A new digital waste traceability system that can enable, on the one hand, the development of a secondary raw material market and, on the other hand, the control and prevention of illegal waste management;
- The development of tax incentive systems able to support the use of materials from recycling supply chains;
- A review of the taxation system to make recycling more cost-effective than landfilling;
- The promotion of the right to reuse and repair;
- The reform of the Extended Producer Responsibility systems and of the Consortia to support the achievement of EU targets;
- The strengthening of existing regulatory tools (End of Waste legislation, Minimum Environmental Criteria) and the application of these tools to strategic sectors: construction, textiles, plastics, WEEE (waste from Electrical and Electronic Equipment);
- The support for the development of industrial symbiosis projects, through regulatory and financial instruments.

The Ministry of Ecological Transition has promoted a consultation on the programmatic content of the strategy, which was developed with the support of the Istituto Superiore per la Ricerca Ambientale (ISPRA) and the contribution of the “Agenzia nazionale per le nuove tecnologie, l’energia e lo sviluppo economico sostenibile” (ENEA). This ensured broad participation in the definition of the new "National Strategy for the Circular Economy". (Governo Italiano, 2021)

The measures described above are an important step towards the ecological transition, however they also have limitations. Policies related to the circular economy have important material ambitions, but these remain more uncertain for social justice and environmental protection. In fact, the policies focus on growth and competitiveness rather than on the social-ecological challenges of the 21st century, promoting circulation but not hindering the legacy of the linear economy.

Criticisms of policies associated with the circular economy emphasize the disadvantages of actions based on markets and businesses as driving forces when public authorities are the scene builders. The circular economy narrative is in fact often based on the efficiency of markets and ignores concerns raised by industrial ecologists and environmentalists that an exclusive focus on recycling will not be sufficient to solve the challenges posed by production and consumption.

Another critique concerns measures related to the waste sector which follow a top-down approach that incentivizes a single centralized waste treatment technology and does not take into account the lack of predictability that characterizes the sector, thus limiting the ability to adapt to circumstances.

In general, it can be said that European policies for the implementation of the circular economy have not taken into account the different stakeholders involved and have been characterized by a fragmented vision and governance that has prevented systematic implementation. Moreover, the policy uncertainty that characterise Italy, as well as other countries in Europe and elsewhere, contributes to the difficulty of measuring, evaluating, and improving circularity in the economy, increases the risk of developing suboptimal practices, and makes it difficult to understand what to expect from circularity in the future.

If the goal of the circular economy is to radically transform the system, then it has so far failed to do so and has not yet "disrupted the status quo in terms of power, norms, and policies." (Corvellec, Stowell, Johansson, 2021)

1.3 Characteristics and limitations of circular business models

When it comes to circular economy the importance of companies and the world of production is evident, indeed, the current circular economy implementation model focuses on them. The prevalent unit of analysis on the firm level is currently the circular business model.

A business model identifies the set of aspects that characterize a specific company

and build its originality such as the strategy and the organizational structure, the operational processes, and the specifics of relationships with suppliers, customers, and employees. It thus describes the ways in which a company identifies, develops, and obtains an advantage over competitors and creates value for itself and its customers. Its purpose is to provide an overview of the enterprise, emphasizing the factors that drive its choices. (Oghazi and Mostaghel, 2017)

Circular business models are sustainable models that can reduce the negative side effects on the environment from the extraction, use and eventual disposal of natural resources and materials. They in fact change the pattern of product and material flows through the economy, combining economic value creation with the reduction, slowing, or closing of resource cycles.

Not only these models improve materials productivity at the plant level, but they also generate more fundamental changes in production and consumption patterns. (OECD, 2018)

There are four regulatory requirements for sustainable business models:

1. Innovation based on a broader concept such as sustainable development, that reflects the balance of economic, ecological, and social needs.
2. Supply chain that involves suppliers in a sustainable supply chain management
3. Relationship with consumers that motivates them to take responsibility for their consumption
4. Financial model which reflects an adequate distribution of costs and economic benefits between the actors involved in the business model

There are different business models for circular economy: some are based on technology, others on the social dimension, and some on the organisational dimension. We can identify five main business models of the circular economy, and they in turn can be declined into additional business activities.

- Circular supplies/purchases: This category includes companies that can supply products from entirely renewable sources, from reuse, recycled, recyclable or biodegradable materials; and that rely on circular production and consumption chains;
- Resource recovery, reuse, and recycling: This model refers to companies that offer the possibility to take back their product once they have reached the end of the life cycle;

- Extending product life: It is a business model based on selling products designed to last a long time. In this case, the design phase of the product is critical to provide for and facilitate maintenance and replacement of components, upgrading of functions and in some cases restyling aesthetics;
- Sharing platforms: Thanks to increasingly advanced digitalization, recent years have seen a proliferation of platforms for users to collaborate on product groups, specific products, or idea proposals;
- Product becomes a service: It is a business model that in recent years has been adopted for cars, IT equipment, streaming music and movies, sports equipment, but is gaining popularity also in other sectors such as apparel, furniture, gifts, toys, and packaging. (Università di Padova, Legambiente, 2017)

The circular economy offers many opportunities for businesses. First, it offers the means to increase resilience and hedge risks related to uncertain future supply of raw materials and price volatility. Moreover, designing for reuse, disassembly, and recycling, with the goal of facilitating the remanufacturing and reintroduction of products, is often less expensive than producing new parts from virgin materials. With scrap, companies can also produce a second new product that can enter the market. The ability to increase the life and revenue of a given asset through repair and refurbishment schemes enables also new service-based business models and stronger customer relationship. The first firms that became sustainable may also have some advantages assuming a brand dominant position: by demonstrating that the company has a sustainable mission or that sustainability is relevant to its industry sector, it can become a leader and a role model.

The concept and implementation of circular business models, however, has also several limitations. First able, the literature on circular business models mainly focuses on the single enterprise and on the idea that the boundaries of the business model coincide with the boundaries of the enterprise. (Teece, 2010) However, according to the innovation literature, when companies face uncertainties and opportunities such as those concerning the ecological transition, they need the support of a system of partnerships and collaborations. Innovation and collaboration between actors are therefore key concepts that need to be explored further. (Chesbrough, 2006) This is important also because often the transition to a circular business model is not easy: according to Evans, “The lack of case studies makes it challenging for firms to

understand how to innovate their business models, identify and design alternatives, then assess and select the most adequate one". (Evans et al, 2017)

In addition, a portion of the companies that approach the circular economy transform only part of their operations, while the core activities continue as usual. The motivation may be the difficulty of scaling up pilot projects. Indeed, there are several barriers to implementing circular business models, such as technical barriers, inadequate technology, lack of training, high costs, uncertainty of returns and profits, institutional and regulatory barriers, and social and cultural barriers. Companies often lack the capabilities to implement circular economy business model innovation, so they fail to translate the concept into concrete operations. They also lack the means to measure the true circularity of a business model.

Another problem is that proponents of circular business models have a simplified conception of consumption, which boils down to buying and recycling, while citizens are seen as consumers and consumers as users. In this view, the role of citizens is to accept the practices established by designers, engineers, economists, and politicians. Companies also take advantage of circular initiatives to anticipate materials and environmental policies and make them more suitable for business interests. Several examples include the circular economy as a zero-waste economy, the adoption of green technologies and digital infrastructure, take-back systems in the fashion industry, and "infrastructure investments...made by air transport service providers, airports, waste and water companies, industry consortia in chemistry, freight carriers, storage facility providers, and network providers." These examples show that circular businesses can help hide the challenges of waste accumulation and resource scarcity. (Corvellec, Stowell, Johansson, 2021)

1.4 State of the art of the circular economy and problem definition

To measure the state of circularity in our society is very important, the Circularity GAP can be described as the unit of measurement for understanding what the state of the art of the circular economy is at the global or individual country level. The first measurement was proposed and developed by Circle Economy, which also pointed out the lack of global measurements of circularity or data to understand how to move and which sectors to invest in to achieve a full circular transition and monitor progress.

What emerges from the report released in 2019 is that our world is only 9 percent circular, and the trend is worsening. An upward trend in resource extraction is identified with a consequent increase in greenhouse gas emissions, going against the directions of the Paris Agreement. Problems related to the linear economy are destroying our planet and the engine of our global economy is going the opposite of how it should. Data show that in the past four decades global material use has nearly tripled, from 26.7 billion tons in 1970, to 92.1 billion tons in 2017, and is expected to grow between 170 and 184 billion tons by 2050. (Circle economy, 2022)
Moreover, according to the Circularity Gap Report, between 2018 and 2020 the global circularity rate fell from 9.1% to 8.6%. This trend is due to the increase in consumption, which in the last five years has grown by more than 8% (from 92.8 to 100.6 billion tons), against an increase in reuse of only 3%. We recover less than 9% of the resources we use, and the consumption of materials is growing at a rate that exceeds population growth.

The data of the "4th report on circular economy in Italy 2022" shows that in Europe, about 13 tons of materials are consumed on average per capita during one year. Data range from 7.4 tons per inhabitant in Italy to 17.5 tons in Poland. For what concerns the productivity of resources, the European average increase is 17%, the Italian one 42%. In 2020, the European Union's circular use of matter was 12.8%, while in Italy the value has reached 21.6%. Regarding the share of renewable energy consumption, Europe has recorded an increasing trend of about 5% between 2010 and 2019, reaching 19.7% in the last year of analysis. Italy has known in the years a practically continuous growth trend in the circular utilization rate of matter, starting from 11.6% in 2011 and reaching 21.6% in 2020. Total waste generation in the European Union in 2018 was 2.3 billion tons. Italy produced 173 million tons of waste in the same year. Germany produced 406 Mt, France 343, Poland 175, and Spain 138. The recycling rate of all waste was 35.2 percent (or 822 Mt), the remaining was sent to energy recovery (130 Mt) or landfilling (970 Mt). In Italy, the percentage of recycling of all waste was the highest in the European Union, reaching almost 68 percent and thus increasing by 9 percentage points between 2010 and 2018 compared to an almost unchanged European average. The data on asset repair, on the other hand, are negative for Italy. In 2019, more than 23,000 firms were involved in the repair of electronic and other personal goods (clothing, footwear, watches, jewellery, furniture,

etc.), losing almost 5,000 firms (about 20 percent) compared to 2010. The figure is also negative if compared to other European countries such as France (more than 33,700 firms) and Spain (just over 28,300). (Circular Economy Network, 2022)

The circular economy is captivating for business and government leaders. Their attention is captured by the opportunity to gradually decouple economic growth from the use of virgin resources, encourage innovation, increase growth, and create stronger employment.

The transition to the circular economy would have an impact on all of society. Eliminating waste and pollution by keeping products and materials in use and regenerating rather than degrading natural systems is a contribution to achieving global environmental goals. However, the potential benefits of the transition to a circular economy include not only the economic and environmental sphere, but also the social one.

Businesses, by adapting their operations to the principles of the circular economy, can reap significant benefits that include creating new profit opportunities, reducing costs by decreasing virgin material requirements, and strengthening customer relationships. Individuals can have significant benefits ranging from increased disposable income, improved living conditions, and positive health impacts. (Ellen MacArthur Foundation, 2017)

Regardless of these opportunities and benefits, but also of commitments of governments and companies, data are clear: we are far from reaching a circular society. Current circular models have many problems, the European situation, as well as the global, is not positive. Italy's figures appear overall good, but this is only true if we compare them to those of other European economies. In 2021, the rebound of the economy was much more positive than expected, with Italian GDP growth of 6.6 percent over 2020. But, embedded in the old linear economy model, this growth ran into the wall of commodity shortages. (Circular Economy Network, 2022)

Criticisms of the circular economy highlight the need for civil society and consumers, the private sector, and the policy framework to align their goals. If this does not happen, the risk is that the circular economy will be implemented only partially or in ways that do not mitigate environmental and social impacts. Without this transition, the circular economy will only maintain the current status quo. We need to question the way the circular economy is currently conceived and implemented in favour of a renewed,

expanded, and transdisciplinary agenda. (Corvellec, Stowell, Johansson, 2021) The solution is a circular economy capable of bringing real answers to real problems, in this perspective the local dimension can play a fundamental role.

Chapter 2: THE LOCAL DIMENSION OF THE CIRCULAR ECONOMY

2.1 Circular economy, sustainable development, and places: how are they intertwined?

Sustainable development can be defined as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. (Brundtland Report, 1987) It is a core principle of the Treaty on European Union, and an important objective for the internal and external policies of the Union. Circular economy is an important tool to achieve sustainable development, according to the UN Economic and Social Council, in fact, the circular economy is “a tool which presents solutions to some of the world’s most pressing crosscutting sustainable development challenges”. (Anderson, 2021) The circular economy is in fact one of the proposed means to address the ecological crisis by reducing the consumption of raw materials and energy, and limiting global warming to 1.5 degrees. (International Institute for Sustainable Development, 2022)
In recent years, moreover, experts in the field have been exploring how a circular economy can also address social and ethical issues and, in this way, create new jobs, ensure more equitable management of resources, promote health and safety, and combat inequality and discriminations.

The circular economy, in line with what we have just mentioned, contributes to the implementation of the Agenda 2030. The 2030 Agenda and the Paris Agreements on climate change constitute the roadmap for achieving sustainable development. The EU intends to play a key role in the implementation of the Agenda, both at the EU and global level. (Commissione europea, 2021)
The 2030 Agenda for Sustainable Development, signed in September 2015 by the governments of the 193 member countries of the United Nations, and approved by the Un General Assembly, is an action program for people, the planet and prosperity. It consists of 17 Sustainable Development Goals (SDGs) which are part of a larger action program for a total of 169 “targets”. Targets are “common”, which means that they concern all countries and all individuals: no one is excluded, nor should anyone be left behind. The goals are based on a number of important development issues and take into account the three dimensions of sustainable development (economic, social and environmental). Countries are committed to reach the goals by 2030.

The Agenda 2030 follows the Millennium Development Goals, the two documents present common goals on a number of important development themes such as the fight against poverty and hunger and the fight against climate change. (Nazioni Unite, 2022)

The 2030 Agenda has positive aspects, such as ambition, collectivity, universal goal setting, a strong and specific commitment to end poverty, and an overarching commitment to reduce inequality. But it has also been criticized for some aspects, such as the fact that the goals do not go far enough and ignore the underlying inequalities in the international system, or the top-down approach that ignores local context and peculiarities, the lack of data, and the fact that the SDGs represent hopes rather than real goals as they are not binding. (Trinity College Dublin, 2017)
Although it is necessary to be aware of these aspects, it is not what this thesis aims to focus on. The SDGs are only used in this paper to identify the most pressing sustainable development challenges in order to show the correlation between these and the circular economy.

The link between circular economy and some SDGs is evident, here are the most important: SDG 7 on affordable and clean energy, SDG 8 on decent work and economic growth, SDG 11 on sustainable cities and communities, SDG 12 on responsible consumption and production, SDG 13 on climate action, SDG 14 on life below oceans, and SDG 15 on life on land. The circular economy focuses mainly on materials, economy, and environment, however from the following image we can see how the circular economy strategies can contribute to a large number of SDGs, including those of a more social nature. (Anderson, 2021)

(Circle economy, 2022)

Indeed, circular economy-related initiatives developed around the world can improve livelihoods, stimulate economic benefits, fight inequalities, and create decent jobs. Some targets are not directly linked to circular economy, but they still benefit from it. The first two SDGs: no poverty and zero hunger, for example, target an area that circular economy is less known for. An example of how circular economy can tackle these two challenges is the non-profit organization XSProject in Jakarta, which works with communities of waste pickers to create better job opportunities. The organisation buy waste from the communities and community members are hired by the for-profit organization XSProjek to produce a range of recycled products, from bags to laptop cases. In this way individuals in communities are empowered, potentially reducing world hunger.

Goal 3.9 is about reducing the number of deaths and illnesses caused by hazardous chemicals and pollution and contamination of air, water, and soil. The circular economy plays an important role in this area, one of its core principles is in fact the use of regenerative materials and the adoption of systems that mimic the natural cycles of ecosystems. This means choosing natural and nontoxic materials and processes that respect and strengthen ecosystems while protecting the health of water, air, and soil. The food industry is crucial in this context. In the United States, for example, there are more than 16,000 deaths from agriculture-related air pollution, 80 percent of which are due to meat, dairy, and egg production. Furthermore, animal farming is not only a

health and environmental issue but is also linked to issues of social justice and environmental racism. In the state of North Carolina, 10 percent of the state's population, mostly African American and low-income, lives within five miles of an industrial pig farm, which stores pig waste in open-air cesspools and then sprays it on fields in massive quantities.
In a circular economy, animals in agriculture would be used in smaller quantities. In fact, a circular food system would use only the livestock needed to bring value to barren land where farming would not be possible and where effluent would be manageable. In the circular system, manure becomes a resource, a sustainable alternative to synthetic fertilizers, leading to a balanced agricultural system that benefits air, water, and soil, as well as human health.

Greater equality between genders, as outlined in SDG 5, or between social groups and communities, as in SDG 10, is not an automatic outcome of circular projects. However, circular economy initiatives provide for the systemic inclusion of minorities, the transition to circularity, in fact, should not repeat the inequality practices that characterize the linear economic model.

Beyond the use of materials, the circular economy can thus improve practices that emit greenhouse gases and pollute air, water, and soil. If implemented in the right way, it can also help create a more just world by ensuring more equitable access to resources, greater equality among minorities, and creating safe and decent jobs. The circular economy has a clear link to the SDGs in the environmental or economic spheres, but its link to the others hints at enormous potential: if applied holistically, a global circular economy can further the achievement of the SDGs. The social dimensions regarding the circular economy are less well known but no less worthy of attention. It is therefore necessary to promote greater awareness and knowledge in this area. (International Institute for Sustainable Development, 2022)

An aspect that asks for attention when it comes to sustainable development, is the territorial level (regions, provinces, cities and inland areas), which plays a fundamental role. If this aspect is not considered, the path towards sustainable development risks remaining abstract, uninvolving, and failing to influence the concrete behaviour of society and the business world. This is why, at international level, great importance is given to the 'territorialisation' of the Sustainable Development Goals, which is encouraged by the United Nations, the OSCE, and the European Commission. One example is the promotion of the Voluntary Local Review (VLR) by the UN, similar to

those carried out at the national level, and the European Commission's Handbook to involve economic and social forces at the local level in the implementation of the 2030 Agenda. Also the Ministry of the Environment and Protection of Land and Sea in the past years has stimulated the Regions, Autonomous Provinces and Metropolitan Cities to implement Sustainable Development Strategies in line with the national one approved in December 2017 by CIPE (Comitato interministeriale per la programmazione economica e lo sviluppo sostenibile).

Territories play a fundamental role in the implementation of the 2030 Agenda, representing the overall demands of citizens. A sustainable development that, while following nationally and internationally shared lines, is implemented with a bottom-up approach, can provide an infrastructure of cooperation that can foster shared decision-making processes, pool economic resources and expertise, and stimulate forms of collaboration. (ASVIS, 2020)

Moreover, although sustainable development goals set global targets, their achievement depends on their implementation at the local level. All sustainable development goals are in fact directly linked to the responsibilities of local and regional governments. A local view of development goals allows a pragmatic approach to the objectives, can adapt them to the particular and unique local context, and helps citizens understand the impact and importance of their actions and of the local context. (Global Taskforce of Local and Regional Governments, 2016)

The localisation of the Sustainable Development Goals requires the definition, implementation, and monitoring of strategies at the local level. It is therefore crucial to integrate all levels of government and all stakeholders in the development of strategies, the use of transformative implementation tools and appropriate methods for monitoring and reporting. (European Commission, 2021) According to the Sustainable Development Report 2021, 105 of the 169 Targets of the SDGs (62%) will not be achieved without the involvement of subnational governments. The stakeholders present in the area must therefore be involved and the administrative bodies must collaborate with each other, adopting a multilevel governance. (Asvis, 2022)

Since the circular economy is an important part of achieving sustainable development, its territorialisation is crucial. This, as far as the circular economy is concerned, is not only true for the reasons just expressed, but circularity benefits from spatial proximity for other reasons as well:

- Consumption: circularity is mainly about changing the way we consume products and materials. Changing the way we consume is easier when we focus on the local level, as it is possible to introduce regulations and changes that positively adapt behaviour, taking into account local governments, cultures and habits.
- Reduction of emission, inflow dependency, costs: when distances are short, energy use and associated emissions can be reduced and avoided. We can think for example to the emissions related to transport. Thanks to this factor we can also avoid the dependence on external resources
- Availability of resources: it is easier to organize and close material flows, products and resources are in fact used and collected locally. Materials are kept within the local community rather than having to trade and import materials. This is important especially in areas where resources are scarce
- Use of resources: resources are available locally, plus they can also be used more efficiently to add further value. Analysing the structure of urban metabolism and identifying circular flows of materials and energy provides opportunities for endogenous development
- Make use of new opportunities: In a specific territory, resources can be more easily identified, potential stakeholders can be approached quickly, opportunities for new business and co-creation are identified more easily, political actions and changes of initiatives can be promoted directly. For example, local businesses that do not reuse waste can be more easily encouraged locally. (Waltring and Harmes-Liedtke, 2020)

Cities are a great example of how circular economy can thrive at the local level. Cities are responsible for 85 per cent of global GDP generation and 75 per cent of natural resource consumption, produce 50 per cent of global waste and 60-80 per cent of greenhouse gas emissions; they are also huge collectors of materials and nutrients. Cities have a high concentration of resources, capital, data, and talent concentrated in a relatively small geographic area. Because of these, cities favor innovation and can support certain circular business models, such as sharing models, reuse systems or product-as-a-service models. (Ellen Macarthur Foundation)

Not only the implementation of the circular economy at the local level is more practical and has a greater impact, but members of local communities are also more likely to

change their behavior when they can see an immediate impact of their actions. This is especially true for vulnerable communities, where locals are most affected by changes generated by an action or project implemented in their area. Visualizing problems at the global level is not easy, but when you can see immediate change through local circular economy systems, you become more open to supporting and participating in circular strategies that ultimately benefit the whole world. (TonToTon, 2020)

2.2 The main circular strategy implemented at the local level: industrial symbiosis

If we consider the importance of the meso level for the implementation of the circular economy, and therefore the importance of territories, the concept of industrial symbiosis, which is one of the main circular strategies implemented locally, becomes fundamental. (Wallner, Narodoslawsky, 1995) Industrial symbiosis is a part of industrial ecology which refers to the interaction between different entities in a collective approach to maximize the reuse of resources like materials, energy, water, and by-products. The keys to industrial symbiosis are the possibilities offered by geographic proximity. (Chertow, 2000) Location in a specific place and proximity can give companies a competitive advantage that is not only monetary. Moreover, geographical proximity is a condition for building a community of economic and social actors based on local values, as well as for the stability of relationships of trust and knowledge.

The origins of the concept of industrial symbiosis date back to 1989, when Frosch and Gallopoulos wrote about “an industrial ecosystem”, in which “the consumption of energy and materials is optimized and the effluents of one process ... serve as the raw material for another process”, setting in this way the basis of the industrial ecology literature. (Frosch and Gallopoulos, 1989)

In the same years Robert Ayres developed the metaphor of the biosphere/technosphere, according to whom, similarly to what happens in the biosphere where efficient use of material resources and energy is observed, the "technosphere", imaginable as the place where industrial activities reside and operate, should be directed toward redesigning its production processes to minimize the harmful releases of unused by-products into the environment.

Over the years, through the contribution of various studies and publications, the definition of industrial ecology has thus emerged. The concept provides a large-scale,

integrated vision that envisions the future design of industrial infrastructure as a series of ecosystems interconnected and interfaced to the global ecosystem. This idea subsequently led to the concept of industrial symbiosis. (Battaglia, 2019) The term “Symbiosis” refers to the notion of biological symbiotic relationships in nature, where two or more otherwise independent species exchange materials, energy, or information in a mutually beneficial manner. Industrial symbiosis consists of place-based exchanges among different entities. By working together, enterprises aim to achieve a collective benefit greater than the sum of the individual benefits achievable by acting individually. This approach can advance the social relationships among the different stakeholders, which can extend to surrounding areas as well.

The concept of industrial symbiosis is characterized by an approach that in Circular Economy concepts underlies the principles of economic model innovation: the win-win approach. This term is used to refer to the mutual benefit that arises in a given situation that does not displease or harm any of the parties involved, who have the perception of having achieved their initially set goals. According to the European Commission's 2015 report, the implementation of the Circular Economy package is expected to enable the achievement of a "win-win situation," with benefits from economic, environmental, and social perspectives. (Commissione Europea, 2015)
The new push toward sustainability includes important elements that lead companies to find such solutions between the parties, passing through a new way of weaving relationships between companies. (Symbola, 2017) This implementation strategy, involving not just one, but several companies, overcomes the criticism posed to the classic circular business models, where the boundaries of the business model coincide with those of the company.

We can identify two organizational models of industrial symbiosis that can be more or less related to the spatial dimension: the continuous model, which include Industrial Symbiosis Districts and Eco-industrial Parks; and the Batch model which includes the Industrial Symbiosis Networks. In the former model, the industrial symbiosis mechanisms implemented are susceptible to less variation, while the batch model is much less constrained and allows for time and space-varying Industrial Symbiosis interventions. On the latter model fit the SaaS sharing and common ERP management platforms where companies can share waste, energy, resources, and expertise. (Carlson, Hartman, Portmess, Sambataro, 2005)

To the category of industrial symbiosis districts belong experiences in more or less extended territorial areas, among several realities that over time carry out specific interventions for the closure and optimization of life cycles. In this case, we speak of a "bottom-up" approach in that the system of relationships arises from specific agreements between two or more actors who carry out exchanges of matter, energy, or services. (Battaglia, 2019)

To the Eco-Industrial Parks, on the other hand, belong U.S.-style initiatives, implemented initially and mostly in the United States, Canada, and Asia. In this case the approach is "top-down," the eco-industrial park, in fact, is planned, designed, and managed based on the principles of ecology and industrial symbiosis.

Chertow has proposed in 2000 a taxonomy of 5 different material exchange types according to a study of 18 potential eco-industrial parks examined at the Yale School of Forestry and Environmental Studies from 1997 to 1999. These types are presented below:

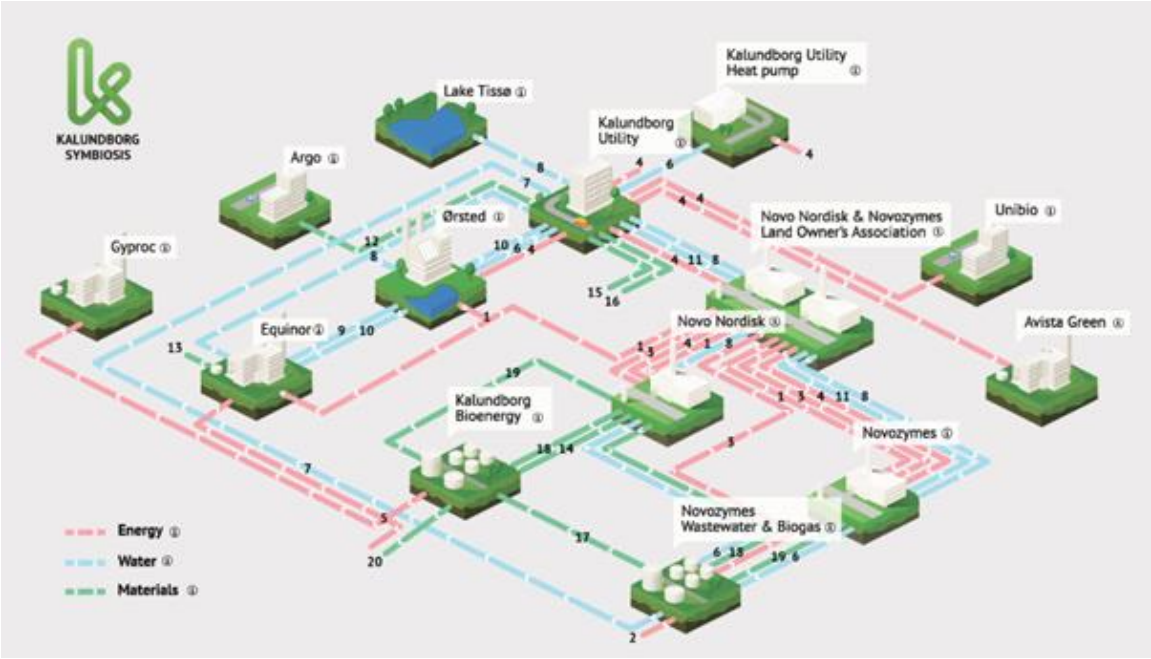
1. Through waste exchanges: businesses recycle and donate recovered materials through third party brokers to other organizations;
2. Within a facility, firm, or organization: material exchange occurs mainly inside one organization, especially when they are large;
3. Among firms collocated in a defined eco-industrial park: businesses and other actors located in the equivalent of an industrial park exchange water, energy, materials, and information;
4. Among local firms that are not co-located: takes as a starting point what is already existing in one area linking existing businesses;
5. Among firms organized “virtually” across a broader region: depends on virtual linkages rather than on colocation. The benefit of this approach is that it encompasses a regional economic community, and small businesses can be included.

We can also identify different tools and approaches that can help implementing industrial symbiosis. The main tools are input-output matching, stakeholder processes, and materials budgeting. The input-output matching tool helps match the inputs and outputs of different entities that could participate in industrial symbiosis. The stakeholder process consists in community involvement techniques, it is in fact

important to understand the advantages to each party. The materials budgeting tool is used to map material and energy flows through a chosen system.
For what concern approaches, they can be stream-based or business-based. Business-based projects begin with a developer seeking tenants in the hope that companies will adapt to industrial symbiosis, on the other hand stream-based projects present a more idealistic vision of planning an industrial symbiosis from the beginning, and the connections are made according to the specific flow of physical resources. The best model would combine the two approaches. Finally, another important difference in approach is whether the planned project relies on new or existing elements. (Chertow, 2000)

One of the most important examples of industrial symbiosis is the Kalundborg district, which has been the first eco-industrial park fully realized. The term industrial symbiosis was in fact coined by the director of the Kaloundborg power plant, meaning: “a cooperation between different industries by which the presence of each...increases the viability of the other(s), and by which the demands [of] society for resource savings and environmental protection are considered” (Engberg, 1993).
Kalundborg Symbiosis is today a partnership between thirteen public and private companies. The main stakeholders in Kalundborg are an oil refinery, a power plant, a plasterboard plant, a pharmaceutical plant, and the city of Kalundborg. The partners share groundwater, surface water and wastewater, steam and electricity, and exchange a variety of residues that become raw materials for other processes. Waste exchanges amount to about 2.9 million tons per year. Thanks to the district, water consumption is reduced by 25 percent and 5,000 homes receive district heating. In addition, environmental and economic efficiency has been increased. The district has also produced other less immediate benefits for industries involving personnel, equipment, and information sharing, creating growth for the local community and supporting the green transition.
The Kalundborg district began in 1961, but it was not until the late 1980s that participants in the Kalundborg project recognized the benefits, improvements and environmental advantages of the partnerships and exchanges that had evolved since the early 1970s, and was not recognized as an example of Industrial Symbiosis until 1989. Companies still participating to this day in symbiosis have from the beginning defined their operations as "working together is just a smart business". (Chertow, 2000)

The image below represents Kalundborg Industrial Symbiosis project.



(Tondo, 2022)

European policies promote industrial symbiosis as an integral part of industrial and environmental policy. Indeed, in 2015, in the EU Action Plan, the Commission affirmed the importance of implementing innovative industrial processes such as industrial symbiosis. Subsequently in 2020 this objective was reaffirmed with the new action plan stating the need to encourage an increase in the circularity of production processes by facilitating industrial symbiosis through a system of communication, company reporting, and certification. (Cutaia, La Monica, 2021)

The importance of industrial symbiosis is also emerging in Italy. Ecologically Equipped Industrial Areas (AEAs) were introduced into the national legal system by Article 26 of Legislative Decree 112/1998, which defines them as industrial areas "equipped with the necessary infrastructure and systems to guarantee the protection of health, safety and the environment". This solution constitutes a model comparable to the experience of international Eco-industrial Parks. In these areas, the norm requires the presence of unified management, stipulating that "production facilities located in ecologically equipped areas are exempt from the acquisition of authorizations concerning the use of services therein." In the case of AEAs, the objective is mainly to manage environmental services related to industrial activities in a unified and integrated manner, also to simplify administrative requirements for the management of environmental aspects. (Battaglia, 2019)

In 2017, the Ministries of the Environment and Economic Development drew up the document “Towards a circular economy model for Italy” where the importance of industrial symbiosis as a tool for eco-innovation is emphasised, as well as the need to support businesses along this path. Finally, Italy’s National Recovery and Resilience Plan envisages the inclusion of concrete measures aimed at supporting the industrial symbiosis project through appropriate regulatory and financial instruments. (Cutaia, La Monica, 2021)

Industrial symbiosis is usually implemented locally, in a distinct geographical area, however it brings global benefits. Everyone, for example, will benefit from the reduction in the use of materials or of emissions. Indeed, industrial symbiosis has a great potential for environmental improvement, bringing many benefits such as increased energy efficiency through cogeneration and reuse of by-products, recycling of grey water to reduce the overall amount of waste, recovery of solvents, and reuse of various residue streams that do not have to be discarded as waste.

Firms would also benefit from industrial symbiosis because of cost reduction, shared infrastructure (building, facilities, energy, water), increased profitability and competitiveness. Regardless of these benefits, companies that engage in these projects are still few. The reasons are different, first there are the commercial reasons, based on the barriers to implementing industrial symbiosis: risk, finance, capital mobility, availability of higher return options elsewhere. Companies may also lack time and resources. Also at the local level there may be a lack of industrial symbiosis expertise and low awareness about the opportunities involved. In general, this approach is not convincing when there are no large continuous streams of process waste. The role of regulation, which varies by location, is also very important, both in promoting and hindering progress, and must therefore be carefully considered in non-traditional development projects.

Industrial symbiosis has also high limitations. First, it raises the question of whether the desire to reuse waste streams comes at the expense of waste elimination upstream in the process. The same arguments apply to water or energy use. In addition, eco-industrial parks favour older, dying industries and keep them alive rather than promoting a new generation of clean industries. So industrial symbiosis could also potentially discourage companies from upgrading. It is reasonable to assume that companies will do what is in their economic interest. Whether, through incremental improvements or through large-scale process redesign, a company can cost-

effectively eliminate waste, then it will do so. It is plausible, however, that if it is more cost-effective, a company may favour symbiosis over pollution prevention. (Chertow, 2000) Implementing the circular economy locally through industrial symbiosis brings many benefits and overcomes some of the problems associated to circular business models. However, some critical issues remain to be solved.

2.3 Circular ecosystems: a new opportunity to drive the transition to sustainability

Circular business models and industrial symbiosis, the main strategies currently implemented to achieve circularity, are very beneficial for the economy, people, and the environment. However, it is also clear that they have several limitations, both from a theoretical and a practical point of view. Moreover, these strategies do not seem to be able to take hold, the data showing the circularity of our society confirm this.

The traditional literature on the circular economy is characterized by a single-firm view, which is useful for an analysis of a local firm engaged in circular activities but limiting for a comprehensive analysis of business activities based on circular economy principles, which often extend beyond organizational boundaries, covering entire value networks and crossing multiple sectors and markets. In line with the literature, the circular models presented so far focus on the enterprise level. However, circularity must be understood as a property of a system, rather than of a single product, service, or firm. (Konietzko, Bocken, Hultink, 2020)
Taking this aspect and the importance we have attached to territories and the local level into account, we can affirm that circular ecosystems are a more appropriate concept to describe the high level of coordination among different stakeholders, not just firms, needed to implement circular systems and strategies. Indeed, the adoption of the circular economy by companies requires a shift from a business-centric operational logic to intensive interaction with an ecosystem of actors. An ecosystem perspective for circularity, where different actors, networks, and institutions interact dynamically to create not only environmental but also socioeconomic value, is needed to advance, and spread the circular economy.

The term circular ecosystem is inspired by the biology, where the term ecosystem defines "a biotic community or assemblage and its physical environment in a particular place." The ecosystem can have several dimensions given the existence of living

organisms, physical environment, and interactions within them.
From this biological conceptualization, ecosystems have been adopted in numerous contexts such as business ecosystem, industrial ecology, and industrial symbiosis, yet the existing literature has only limited applicability in this context. For example, in the literature on industrial symbiosis (which is considered a type of circular ecosystem) the focus is on the use of the waste resources of one or a few ecosystem actors as inputs for another, covering only a small number of possible actors and interactions, whereas this thesis wants to emphasize the quantity and heterogeneity of relationships that characterize circular ecosystems. (Kanda, Geissdoerfer, Hjelm, 2021)

The cooperation that characterizes ecosystems is fundamental as circular economy transitions are socio-technical in that they involve multiple actors in different economic and noneconomic spheres. The ecological transition concern in fact several factors like society, flows of materials, energy, and value, that must change at the system level. This operation requires the interaction of multiple different actors such as organizations, cities and municipalities, and citizen-consumers, in a multi-actor context. The ecosystem approach allows precisely to recognize the existence of different actors, technologies and institutions linked together by interdependencies and co-evolutionary patterns.

The stakeholders involved in circular ecosystems form hierarchically independent yet interdependent communities of heterogeneous actors that collectively generate a sustainable outcome, that is, a system-level outcome characterized by circular processes of recycling, reuse, and reduction. The actors involved are interdependent and play complementary roles. Actors include for-profit companies, utilities, government agencies such as ministries, municipalities and cities, universities, non-profit organizations, and citizen-consumers.
Circular ecosystems arise or are created from a common, system-level goal related to resource circularity. Such emergence can result in the creation of CE knowledge, CE businesses, and economic as well as social value.

Ecosystems can have different characteristics and variables. The ecosystem structure can in fact vary from tightly coordinated models to loosely coupled affiliation structures oriented to circular economy goals.
Also agency can vary and be actor-driven or widely distributed. For what concern this last aspect, because of the coordination mechanisms that characterize circular ecosystems, the agency of actors is nuanced; in fact, an ecosystem actor's actions do

not depend solely on an individual actor's desired outcome but are instead defined by his or her role within the ecosystem. Indeed, an actor's agency is defined by its role, which, in turn, determines its actual material contribution, of knowledge or value, to the ecosystem. The interdependence that characterizes actors and roles is due to propinquity, physical interconnections, asset specificity, shared institutional logic, common value proposition, shared purpose, cognitive affiliation, or technological complementarity. Due to such physical, spatial, technological, economic, and cognitive interdependencies, the agency of a particular actor is limited. Agency in an ecosystem can also vary. In some circumstances, the interdependencies that shape an ecosystem confer significant agency to certain roles. These roles are often called "keystones" or "orchestrators," where a central actor acts as a "hub" to manage the ecosystem. In other circumstances, the nature of interdependencies means that agency is distributed among ecosystem actors.

As we have seen ecosystems have some differences, but they all have some commonalities. First, each ecosystem consists of a network that has a system-level outcome, which means that the ecosystem produces a higher outcome than any single actor can provide alone. Second, ecosystems consist of a set of heterogeneous and hierarchically independent actors, with different roles within the ecosystem. Third, actors within these ecosystems are linked by interdependencies, for example, physical interconnectedness, spatial proximity, technological complementarities, economic ties, and shared cognitive perspectives. Fourth, ecosystems are characterized by distinctive coordination mechanisms that are primarily based on role definition, complementarities, and technological, economic, and cognitive alignment structures that achieve a balance between change and stability in ecosystem outcomes. (Aarikka-Stenroos, Ritaia, Thomas, 2021)

We can also identify five factors through which we can identify circular ecosystems:

1. Value: this element includes: a circular value proposition, co-creation of value, collective value capture, and multiple circles of value. The circular value proposition is important because when it is actualized collectively, actors set the same goal and carry out the necessary activities to structure the ecosystem, only in this way sustainability can be achieved. To keep the ecosystem healthy, however, it is necessary to capture collective value on an ongoing basis, thereby ensuring that the different actors in the ecosystem remain engaged and involved. Actor engagement results in different circles of value that require

more structured collaborative configurations than a single-circle industrial system.

2. Actors: circular ecosystems are characterized by a set of actors linked together for the purpose of developing and commercializing an innovation. This cooperation is very important as a circular solution cannot be implemented unless there is a joint effort. We can identify six critical factors regarding this category. First are heterogeneity, which facilitates problem solving due to the presence of complementary characteristics, and interdependence, which contributes to conflict reduction. The second aspect is the alignment of interests. Both individual and collective interests must be aligned to achieve circular goals. Third, there is the definition of each actor's role and responsibilities, which helps the evaluation of ecosystem members. Fourth is the trustworthiness of trading partners, which is essential for the entry of new actors and the exchange of information, which would be difficult in the absence of trust. Fifth, an appropriate balance as, in addition to heterogeneity, the ecosystem must ensure enough actors to achieve resource circularity. Finally, circular ecosystems often require an orchestrator, which is often a private company or public institution responsible for coordinating and supporting the activities carried out by other actors.
3. Data, materials, and flows: there are four main aspects associated with data and material flows in the circular ecosystem. First, resource use patterns, including data, need to be redefined and examined for alternatives that maximize material circulation. The data generated are used as inputs for the development and implementation of more circular strategies. Second, data from different sources need to be integrated to get an overview of the ecosystem; this process needs to take place continuously. Third, ecosystem actors need to strengthen resource sharing. This sharing can involve tangible resources (e.g., products) or intangible resources (intellectual property). Finally, information and material flows need to be managed carefully to support decision-making as well as value co-creation. Data, materials, and flows are also associated with communication within the ecosystem, this can be facilitated by a platform that connects actors.
4. Circular activities and strategies: in addition to the circular value proposition, all activities carried out by actors must also be circularity oriented. There are three relevant aspects related to actors' activities. First, activities can be carried out

in different spheres. Second, it is essential to focus on strategies that have collective purposes. Third, these strategies must provide economic and environmental benefits. In addition, the ecosystem must have an economic return for it to remain healthy.

5. Governance: governance supports coordination and value sharing among actors, which is one of the key determinants of successful ecosystem initiatives. Members must follow a set of rules and standards that may be set by government agencies (e.g., legislation imposed on waste recycling) or by the ecosystem orchestrator negotiating individually with other actors. The government also plays a key role by setting environmental laws. (Hofmann Trevisan, Goncalves Castro, Gomes, Mascarenhas, 2022)

Although circular ecosystems are all characterised by the elements listed above, they can be grouped into three distinct categories based on certain variables such as interactions, flows, and system-level objectives. It is therefore possible to identify five distinct types of ecosystems.

The first category is made up of industrial and urban ecosystems, which are based on material flows. In this case circular economy actions are often developed within a given physical environment, enabling the flow of local resources through industrial or public-private collaboration. In both industrial and urban ecosystems, the role of actors is defined by the specificity of their assets and resources, which in turn determine the nature of ecosystem interdependencies. In this category, the agency of actors, being embedded in the local physical, economic, and institutional environment, is both enabled and constrained by it.

An example of an industrial ecosystem is the eco-industrial park, which we have already talked about. Another example are urban ecosystems, which refer to the built environment and infrastructure within which circular flows of energy and materials occur. They consist of non-hierarchically related actors, such as utilities, local and city governments, transportation authorities, service providers and resident citizen-consumers. Urban ecosystems focus on the inflow of energy, capital, information, and people, and are not only concerned with the sustainable production of goods and services but are also concerned with the support to urban services such as social activities, quality infrastructure, and the physical environment. The level of

sustainability of an urban ecosystem is determined by policies, governance, culture, and individual and collective behaviours.

Then there are entrepreneurial and knowledge ecosystems based on knowledge flow. Entrepreneurial ecosystems are regional business clusters in which actors implement a shared knowledge base related to advances in digital technologies and infrastructure to develop new sustainable business models by taking advantage of recycling, reuse, and resource reduction opportunities.
Knowledge ecosystems, on the other hand, are characterized by research and development of knowledge related to the circular economy, reflecting R&D and innovation processes in a pre-competitive and pre-commercialization context. These types of ecosystems are often distributed in terms of agency and develop through continuous and changing negotiation and sensemaking among actors in the collaborative process of new knowledge creation.

Finally, there are innovation ecosystems based on the economic value stream that include platform and business ecosystems. Innovation ecosystems are multi-stakeholder venues for the co-production of sustainable value propositions focused on reuse and recycling, or entirely new innovation ecosystems created to focus on reduction. Circular innovation ecosystems are characterized by a set of components and complements that support the focal enterprise to realize the sustainable value proposition, which depends on the availability of complementary products and services. Often this type of ecosystem has a platform or set of shared compatibility technology standards that enable actors to deliver the outcome. The dominant agency role is often assigned to the central actor, who coordinates the ecosystem to achieve a sustainable value proposition. The nature of interdependencies is shaped by the ecosystem governance, which guides the agency of individual actors.

Given this classification, circular ecosystems can, and should, have characteristics relating to different types of ecosystems, since, as we have already mentioned, the transition from linear to circular economy requires a socio-technical transition involving actors at many levels of analysis. (Aarikka-Stenroos, Ritala, Thomas, 20219) This is why industrial symbiosis, involving only a limited number and type of actors, is not sufficient. Indeed, it is important to note that in this thesis when we speak of a circular ecosystem, we are not referring to one of the typologies described above, but to an ecosystem capable of incorporating more than one, so as to achieve the cooperation

between different actors that is necessary for the implementation of circular strategies and projects.

Now that we have explored the characteristics of circular ecosystems and what we refer to by this term, it is necessary to deepen the reasons why they represent a better strategy for addressing the ecological transition. As we have already mentioned, the circular economy concept requires a shift from an enterprise-level perspective to an ecosystem-level perspective, as the collaboration of several different actors is needed to achieve circularity. Therefore, the current circular economy approach based on a single product or single business unit view needs new developments.

From a practical point of view, the complex nature of circular business models makes them cross-cutting across sectors, such as waste management, energy, transportation, and agriculture, all of which are influenced by local and institutional conditions. Ignoring this complexity by adopting a single corporate view limits the understanding of the sources of value creation, delivery and capture for companies implementing the circular economy. It is therefore necessary for companies to bring their business model closer to the network in which they are involved.

The transition from a linear to a circular business model brings not only opportunities but also challenges. Indeed, companies often lack the capabilities to transform their business model and have also to face external obstacles. The ecosystem view helps such companies and new entities that wish to develop circular propositions, such as start-ups and venture firms, by providing support. Other problems that businesses face are interdependence, transaction costs, power relationships and the need for intermediation in the system to create, deliver and capture value. Circular ecosystems can minimise such problems of complexity and coordination. Within an ecosystem, therefore, enterprises are supported and sustained by a network of virtuous actors that enable them to make the ecological transition in a safer and less risky manner.

Moreover, business models based on circular economy principles often do not explicitly consider circular economy principles and value creation is predominantly economic in nature and limited to a few business transition actors. Tthrough the ecosystem, enterprises can go beyond the creation of economic and environmental value to include social value and use it as a competitive advantage more easily. Indeed, in a localized view of the circular economy, social impacts are more highly valued; this is especially true for circular ecosystems, where the community and

citizens at different levels are involved in the design and implementation of circular models. In this way, the impact on all components of sustainable development, not only economic and environmental but also social ones, is valued.

The implementation of circular ecosystems necessarily requires the interaction and dialogue between the private and public sectors, in this way the political and governmental component takes on new importance and responsibility in the decision-making process and is no longer dependent on the logic of the market but enters a constructive dialogue with it.

The focus on the local level, and thus the valorisation of territories, facilitates adaptation to different, geographically dependent, and unpredictable circumstances, thus fostering resilience; it also facilitates the reorganization of consumption and production, thus generating a greater impact of circular economy activities. Consumers, represented by citizens, being an important part of the ecosystem, would have a greater opportunity to make their voices, needs and demands heard, becoming a key part of the change, which would be supported by attentive and aware citizens.

Finally, through an ecosystem perspective, it is also easier to estimate environmental, social, and economic impacts in the short and long term; in fact, designing and implementing an ecosystem requires the effort of different actors toward a common goal that must necessarily be clear and shared.

Business models need to be analysed using an ecosystem perspective, bringing into play a new set of suppliers, customers and institutions that can provide incentives and inputs for innovation potentially linking circular activities to sustainability.

Chapter 3: The implementation of the circular economy in the Province of Turin: what difficulties and what opportunities?

3.1 The Province of Turin between innovation and tradition

As we have seen in previous chapters, the circular economy has great potential, but struggles to establish itself and achieve satisfactory results. In my thesis, this is attributed to the limitations of current circular economy implementation models, resulting in the need to find new strategies. The research presented in this thesis has the task of supporting my hypothesis, which is the need to implement new circular economy models, by highlighting the barriers and difficulties that companies currently face in making the transition from the linear to the circular economy and the reasons why they end up not making the transition or only partially making it. This first part of the research therefore aims at investigating the inadequacy of current circular economy implementation models.
I will then try to verify the possibility of finding key actors for implementing a circular ecosystem project in the Province of Turin by checking the willingness of companies to participate in it.

Turin is the theatre of my research; I chose this city for different reasons. First able, it is the place where I did my curricular internship, so not only having already worked in the area and knowing the actors involved in it would have made my research easier, but my research will also serve the organisation where I did my internship to implement a circular economy project. Second, Turin has favourable characteristics and conditions for the implementation of a circular economy project.

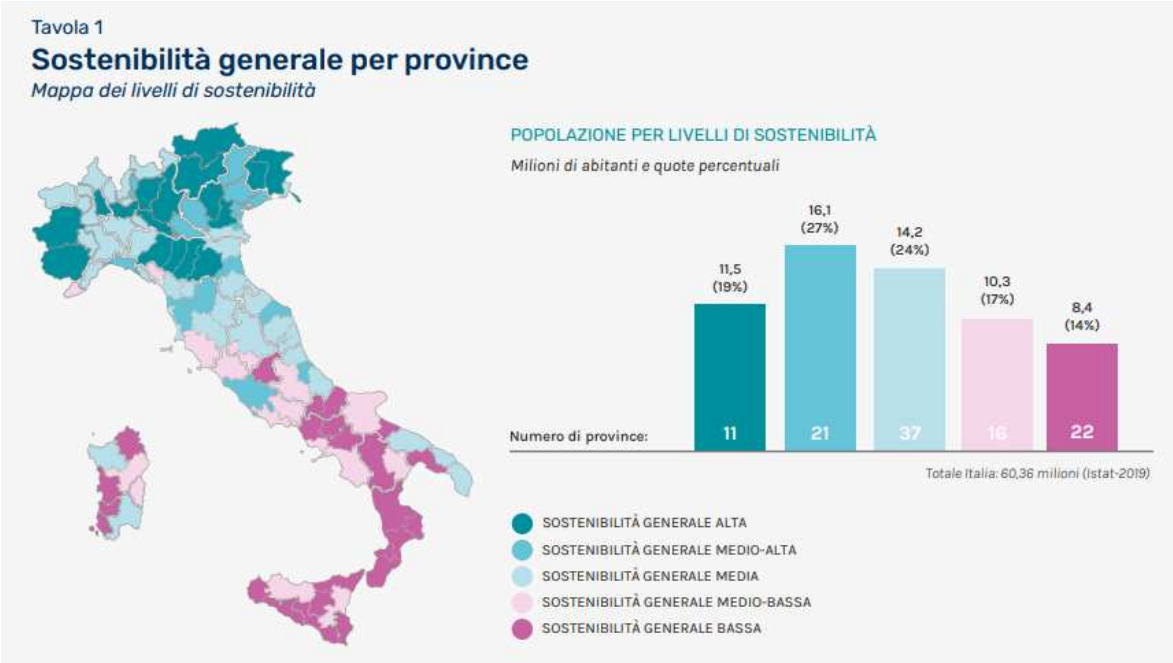
Turin, located in north-western Italy, is the regional capital of Piedmont. The city is located on the river Po, in a wide and fertile plain east of the Alps.
Turin is one of the most important industrial and communication centres in the country; it is a major road and rail junction and has an international airport. The capital is especially famous for its automobile industry and is often associated with Fiat, which has its headquarters in Turin. At the end of the 20th century, however, the automobile industry went through a severe crisis and the city had to diversify its economy. For this reason, tourism and the technology industry became increasingly important. The same happened to the aeroplane, ball bearing, rubber, paper, tanning and leather processing, textile, printing, and lithography industries. The metal, chemical, plastic,

and electrical engineering industries are also important. Chocolate and wines are prominent products. (Britannica, 2022)

Sustainability is an issue that requires attention throughout the peninsula however, for some geographic areas it is a more pressing issue than for others, thus the situation of the city compared to other areas of the country is presented below.
The “Sustainable Italy Report”, drawn up in 2021, and developed from the Cerved Group's information database and public sources, examines hundreds of variables to highlight the territorial differences related to the issue of sustainability in Italy. The data system measures the sustainability of territories from an economic, social, and environmental perspectives, through a total of 280 elementary indices aggregated into 20 measurement criteria listed below:

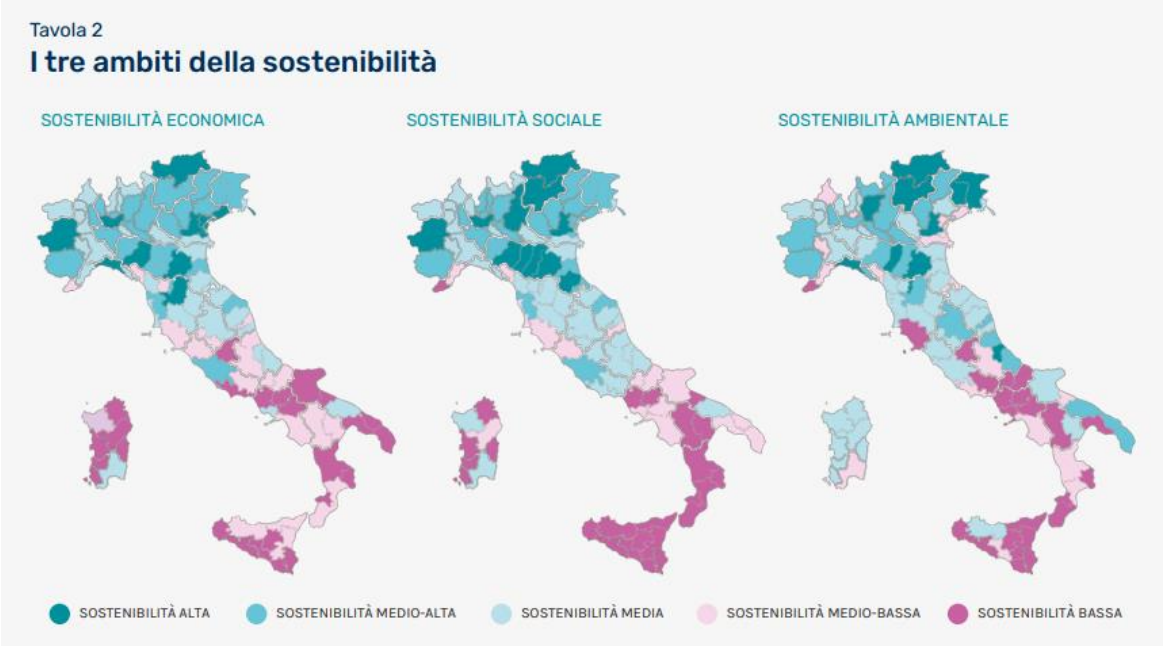
- Economic sustainability: productive capacity, investment and innovation, digital innovation, competitiveness, business strength, transportation networks, infrastructure, employment, and labour dynamics;
- Social sustainability: human capital and training, household care, household wealth, social fragility, condition of the elderly, health and health care system, security and justice;
- Environmental sustainability: Pollution and resource consumption, land and water protection, hydrogeological and seismic sustainability, energy consumption and conversion, waste and waste management.

The research highlights the country’s heterogeneity, with 11 provinces, including Turin, characterized by a high level of sustainability, 21 provinces characterised by medium-high sustainability, 37 provinces with a medium sustainability, 16 with a medium low sustainability, and 22 provinces characterised by a low level of sustainability. The map proposed below represents the sustainability profiles of the Italian provinces.



(Cerved, 2021)

If, however, we investigate the three areas of sustainability (social, environmental, and economical) in more detail, it turns out that the province of Turin, while showing an overall positive trend, is characterised by a lower level of environmental sustainability than social and economic sustainability, the figure below represents this situation.

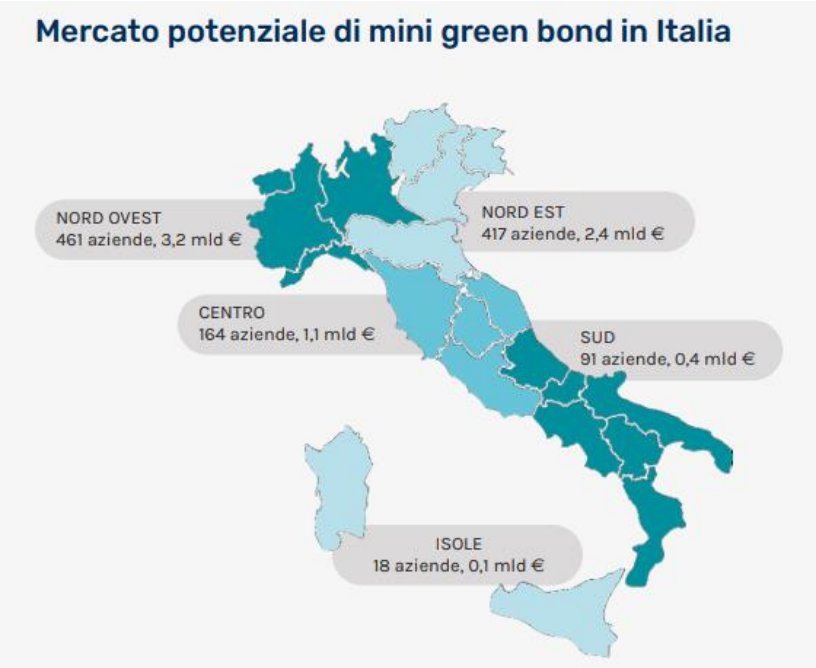


(Cerved, 2021)

The city has in fact placed itself in a prominent position in the economic area, particularly due to the competitiveness of its companies, investment capacity, and

digital transformation. One issue that still requires attention in this area is employment and labour dynamics, although the index remains above the Italian average.
As for the social area, which also registers positive data, Turin stands out in human capital and training and in family services, but critical issues were noted in wealth distribution.
Finally, with regard to environmental sustainability, the most critical area for the city, positive data are recorded in consumption management and energy conversion, while difficulties persist, despite registering indices not far from the Italian average, with regard to pollution, resource consumption and land and water protection.

An important aspect related to sustainability and the possibility of implementing projects related to it is the potential market for mini green bonds in Italy, which are bonds issued by listed or unlisted Italian nonfinancial companies whose issuance is related to climate or environment related projects. Cerved has estimated a potential market for mini green bonds at 7.2 billion euros, of which almost half, 3.2 billion euros, in the Northwest. The chart below shows this situation. (Cerved, 2021)



(Cerved, 2021)

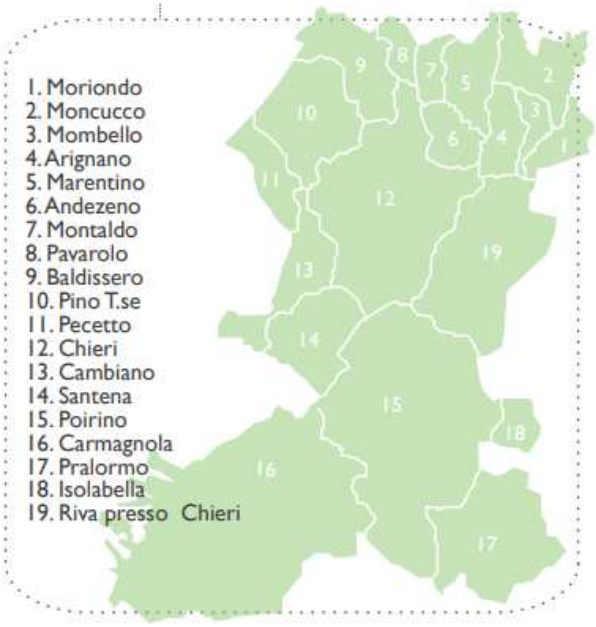
Another important aspect of a territory is the awareness of citizens on sustainability issues. According to a survey by Lifegate conducted in March 2022 among a sample of 603 people over the age of 18 and sponsored by the European Commission, the Ministry of Ecological Transition and the Piedmont Region, Turin residents who feel

involved in sustainability issues are the 71 percent, a stable percentage compared to 2021. The corresponding national figure records 75% of citizens who define Themselves as sustainability-conscious, therefore there is a slight discrepancy compared to the national average, but the figure is still positive, with seven out of ten citizens believing sustainability influences daily habits. (Bongioanni, 2022)

To cope with the situation, which is overall positive but has some critical issues particularly with regard to environmental sustainability, Turin has initiated a green turn. The most significant initiative the city is pursuing is the "Torino 2030 Action Plan," which is a blueprint for building an accessible, circular, healthy, and green Torino. This vision has been developed through citizen participation and has been consolidated in government acts. In 2020, Turin was also honoured, among the large European cities that are members of the Covenant of Mayors, for demonstrating a growing commitment to the energy transition and for its action on climate; the city was in fact able to reduce its emissions by 33 percent compared to 1990. (Città di Torino, 2022)

Environmental sustainability is the critical issue of the city of Turin, which is, however, characterized by a favourable climate to innovation. So, Turin is not only the city where I did my curricular internship, but also a city that requires the implementation of new projects to meet the challenges of sustainability, all in a conducive climate. Turin is a city that wants to evolve and improve, but struggles to do so.

However, the territory of Turin would have been too wide to be analysed, therefore 19 municipalities, listed below, were selected to conduct the research: Andezeno, Arignano, Baldissero T.se, Cambiano, Carmagnola, Chieri, Isolabella, Marentino, Mombello di Torino, Moncucco T.se, Montaldo T.se, Moriondo, Pavarolo, Pecetto T.se, Pino T.se, Poirino, Pralormo, Riva presso Chieri, Santena. Together these municipalities cover an area of 434.56 km2, for a total of about 125.647 inhabitants. The population density is thus 289 inhabitants per Km2. Compared with other areas of Turin, therefore, the population density of this area is low, which means that air pollution is also probably lower. Moreover, this is an important aspect to consider as it can influence economic activities as well as cooperative behaviours. (Yegorov, 2015)



(Reland, 2022)

These nineteen municipalities were not chosen or grouped together randomly but are part of the “Consorzio Chierese per i Servizi”, which is one of the eight mandatory basin consortiums of the optimal territorial scope of the Province of Turin. The task of the Consortium is to ensure the governance and coordination of the municipalities, prepare the consortium regulations, menage the TARI, the waste collection and transportation services, and implement fixed facilities.

There are mainly two reasons why this area was chosen to conduct this research: first, the association where I did my internship maintains good relations with the municipality of Cambiano, which is part of the Consortium; this aspect is not only advantageous for conducting the research, but the involvement of such an actor is also an important component of the ecosystem concept. Secondly, the municipalities that are part of the consortium participate in the ECO3R project, financed by AtoR (Turin Area Association for Waste Management) and promoted by the Chierese Consortium for Services, which is the project leader, and the Department of Architecture and Design of the Polytechnic University of Turin. The ECO3R project envisages the establishment of a "Reuse Laboratory" aimed at studying and testing the best way to promote the recycling of some important categories of goods currently destined for recovery or disposal. It also intends to develop a research program called "Observatory for the circular territorial economy" through which the territory's materials supply chains and the various responsible parties will be mapped in real time to determine the best circular economy

strategies. (Consorzio Chierese per I Servizi, 2022) It is therefore assumed that the area is conducive to the development of a potential circular economy project.

3.2. The Reland ecosystem

As mentioned earlier, this thesis research has two main purposes: the first is to support the thesis hypothesis, i.e., the inadequacy of the current business-focused method of implementation of the circular economy and the consequent need to implement new models, in this case the circular ecosystem; while the second is to verify the possibility of implementing a circular ecosystem in the territory of Turin. This is indeed the project that Reland, the institution where I did my curricular internship, in collaboration with the Polytechnic of Turin and the Municipality of Cambiano, which is part of the Chierese Consortium for Services, intends to implement. It is from this project and the consequent need to verify the presence of important nodes, the enterprises, in the area, that this thesis research was born.

The Reland ecosystem aims to connect and network different actors who can contribute to the development of a project which uses waste materials to apply a circular and sustainable economy model. The method consists of mapping the actors of the territory, identifiable locally by a limited radius of km, to create a virtuous network in the area of reference. Thus, an ecosystem will be created in which waste will change its destination (the landfill or industrial recycling processes), to be rethought in its possible use, undergoing an artisanal transformation, through minimal waste of energy and resources, and thus finding a new life as materials/components in architecture, construction, design and art. The entire process will be automated through a virtual platform where the stakeholders can relate to each other.

The aim of the Reland ecosystem is to simplify what is today complicated, enabling the exchange of materials at territorial or local level in a fast and regularised way, realising complex and high-quality architecture and design projects, and generating a positive social impact. In this way, objects are guaranteed more than one life cycle, through phases of creation, regeneration, use and reuse. The intention of the project is to include in the map not only waste materials, but also those professionals who are able to rethink (designers, architects, creatives,...) and remodel (craftsmen, artists) these materials to be reused in different product sectors.

The implementation process of the Reland platform will have to go through several stages:

1. Identification of stakeholders;
2. Creation of an involvement model and tools;
3. Scouting and selection;
4. Ways of reuse of materials and matching;
5. Process of conception and creation of the Reland Method;
6. Platform creation of the Reland ecosystem.

The purpose of programming the different phases is to create a system that is repeatable at any time and for any territory.

The actors involved are categorized, just as in a natural ecosystem into different nodes. In this case, the nodes we have identified are four:

- Connector nodes: these are the actors that group macro categories of individuals and lead to particular nodes. Connector nodes are therefore all the business associations, social promotion associations and local administrations, which manage and coordinate the various stakeholders on a large scale or local level;
- Producer nodes: these are the nodes that generate waste and resources; companies and enterprises are part of these nodes;
- Transforming nodes: these are the actors who generate ideas, solutions and those who are physically capable of realizing them.
- Consumer nodes: these are the users who benefit from the final product and can be private or public.

According to the Reland process, these nodes can be grouped into three categories, the 3Ms: material, minds, and hands (mani in Italian).

The materials that can be considered in the upcycling process are those that can convert their function while retaining the same form. In this way no new production processes are required. The nodes from which the materials can be sourced are companies, small craftsmen who produce waste during their manufacturing and

production processes, construction sites, and commercial and craft activities. The types of materials are many: metals, polymers, wood, glass ceramics, rubber, textiles, cardboard, paint/dye, clay, aggregates (earth, clay sand, gravel, ...), stone, etc. The materials will be catalogued, so that it is easier to understand the potential of each product and how to reuse it.

The minds can be identified in the transforming nodes, in this case the architects, designers, project managers and marketing managers, who plan and design the type of material transformation. The interventions in which they can participate, which must benefit the community, are public or private. This meso category represents the point of connection between materials and hands. Minds will work closely with hands in order to experiment and convey their creative ideas in the transformation of materials. Minds may have different types of specialisations, but all must be oriented towards a circular and low environmental impact approach. They can therefore have specific skills towards a certain type of material or aptitude for reuse, monitoring and control of projects both at the conception and realisation stages, or towards strategies and activities to promote end products.

The hands comprise those nodes that are responsible for transforming the waste into the object of the project defined by the minds. These actors are therefore those who carry out a handcraft, artistic or otherwise creative activity. The hands have precise skills that depend on the type of material they will be working on, so for example those who will transform metal will be the blacksmith, those who will transform wood will be the carpenter, glass the glassmaker and so on. The area on which the hands will work will depend on the type of project devised by the minds.

Waste materials are selected according to universal criteria that make one donor of material more attractive than another, such as: the location of the business, quality, status of the material, quantity, type of material, aesthetic level, ease of processing, adaptability, price, and ease of transport.
Minds and hands are selected based on objective criteria such as: the level of experience of the professionals, professional qualifications, previous work past, experience in the field, location, and then subjective criteria such as originality, aptitude and enthusiasm.
Once the materials have been selected and the various roles assigned to the chosen subjects, communication relationships will be established with all types of subjects. It will be necessary to formulate a proposal for collaboration between the producer nodes

and the processor nodes, to draw up a contract that formalises their relationship and puts the waste donors in good standing. For administrations, on the other hand, it will be necessary to activate a sponsorship to communicate activities and grow the virtuous network, launching it in certain contexts where there are active nodes willing to collaborate.

The nodes must relate to each other effectively. Once the network is established, it will be necessary to understand what tools to provide to the various nodes to communicate and collaborate effectively with the entire ecosystem. Taking natural ecosystems as an example, circumstances can be created in urban areas to facilitate relations between actors and enable the efficient exchange of resources that would otherwise be lost.

As far as the design and creation of the final reuse is concerned, the design process is based on the available resources and the " Reland method ", in which all team members together with the stakeholders discuss the project goals and organise the timeframe. The material experts explain all the possibilities of transformation, the people involved in the design process (architects, designers and creative people) participate and are actively involved, with a shared vision of the previously defined goals and results. In this stage the project objectives are defines as well as the way in which the material will be reused and possibly with which other materials it will be assembled, hence the most appropriate scope of application.

Reland has already initiated such a project. In fact, it collaborates with the "Cartotecnica Cambianese", a paper mill located in the territory of the municipality of Cambiano and therefore part of the Chierese Consortium. The paper mill has made available its waste materials, mostly cardboard. The stakeholders have decided to implement a project aimed at educating citizens, and in particular the new generations, on the issues of environmental sustainability and circular economy. Learning moments are therefore organised in schools as well as in trade fairs and other events open to citizens where participants learn through creative reuse. During these events, cardboard finds new life by being reused to create lamps by the recipients of the project. The beneficiaries so far have been 4500 children, 400 young people and 200 adults. In line with Reland's vision, the project that has been implemented has not only an economic and environmental purpose, but also a social one, responding to the objectives of sustainable development and social responsibility.

(Reland, 2022)

The hope is to find other companies such as the “Cartotecnica Cambianese” that will make their waste materials available to pursue sustainable projects. My thesis research is therefore part of this project and tries to make a theoretical and practical contribution to the implementation of the Reland ecosystem.

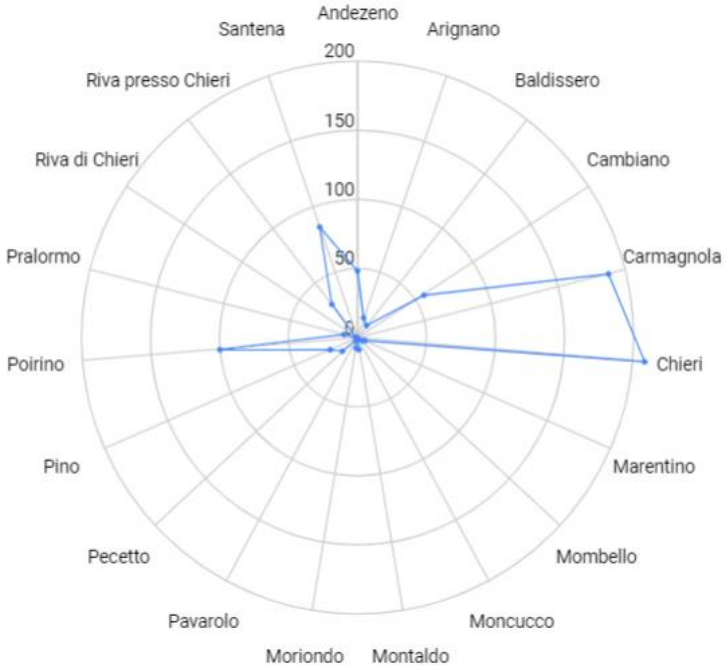
3.3. Research method and data

Once defined the territory on which to conduct the research, namely the “Consorzio Chierese per i Servizi”, the next step was to choose the economic activity on which to focus. To this end, Ateco codes, the classification of economic activities adopted by ISTAT, were used. First, I decided to focus on manufacturing activities, which correspond to category C of the Ateco codes. This is because Turin is historically home to an economic development mainly based on the manufacturing sector. Moreover, this sector is the one in which the role of materials and therefore of the circular economy is most evident. Each category is divided into subcategories, for the category in question there are twenty-four.

At this point it was essential to have access to the list of the manufacturing enterprises in the territory chosen to conduct the research, to understand the number and the type

of companies. However, the list of the enterprises related to a given ATECO code present in a territory is not public. To access it free of charge, it Is necessary to be a public administration and to provide valid and verifiable reasons why the list is needed. In this operation, therefore, the collaboration of the Municipality of Cambiano, which acted as a go-between to obtain the list of businesses, was essential. This is an example of the importance of the involving different types of actors in the implementation of circular economy projects. Thanks to the list I was then able to verify the number of manufacturing enterprises in the survey area. The following graph shows the number of enterprises per municipality.

Table 1 : Number of enterprises per municipality



The companies belonging to the manufacturing sector based in the Consorzio Chierese per i Servizi are nearly 1,000, a number too large to be analysed in this research. Therefore, I decided to further narrow down the sectors on which to focus and selected the textile industries, those involved in the manufacture of paper and paper products, and finally those involved in rubber and plastic goods, for a total of 115 firms. 60 of those industries belong to the textile sector, 27 to the paper sector, and 28 to the rubber and plastic sector.

The choice of these three sectors is due to several factors: first, the plastics, textile, and packaging sectors (closely related to the paper sector), are considered essential by the European Commission for achieving the circular economy. Moreover, the PNR

funds circular economy "flagship" projects in these three sectors in addition to that related to electronics and ICT. Finally, all three sectors chosen are among the most relevant in the Turin area. The following graphs show the distribution of enterprises divided by sector in different municipalities. As can be seen, the distribution is variable, and not all in all municipalities we can find enterprises belonging to certain categories.

Table 2 : Spatial distribution of textile industries

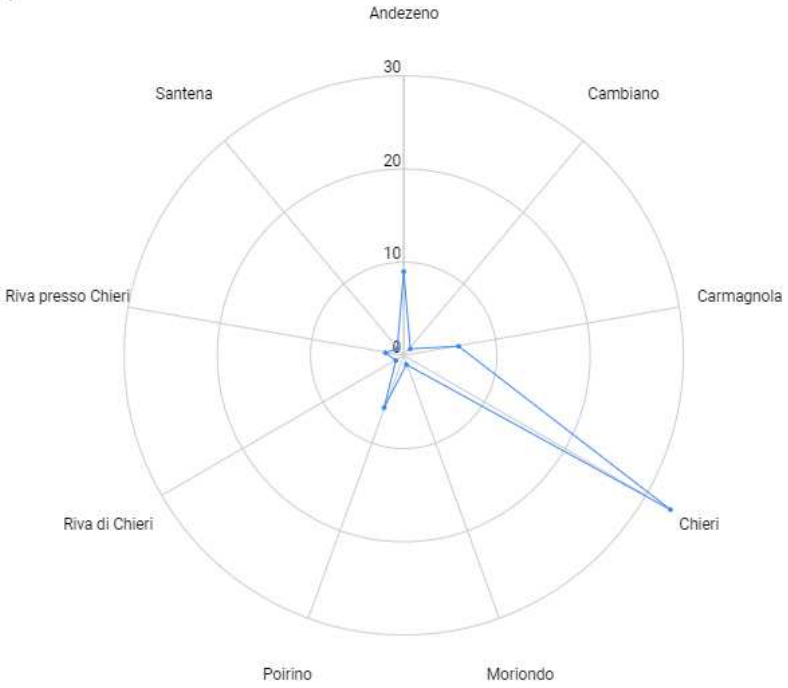


Table 3 : Spatial distribution of paper industries

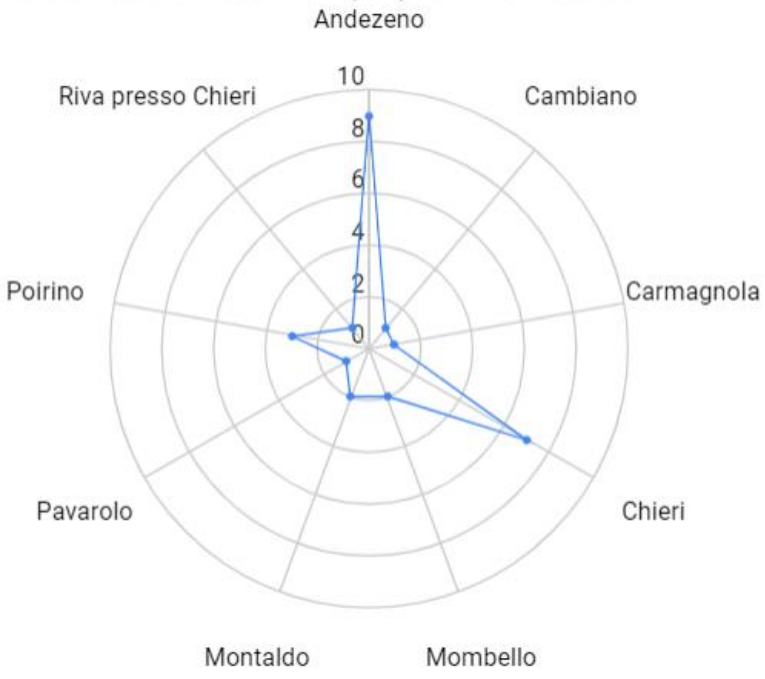
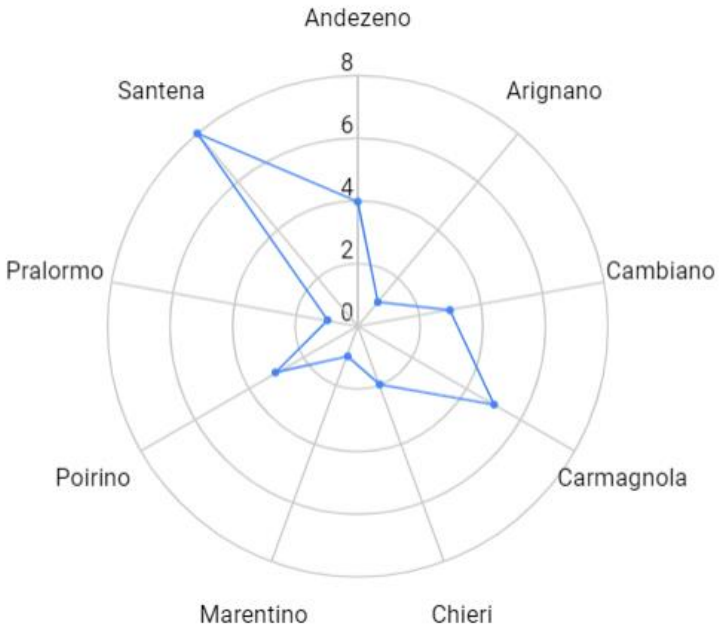


Table 4 : Spatial distribution of plastic and rubber industries



For what concerns the research, of an exploratory nature, it was carried out as a quantitative approach through a standardized questioning procedure. Exploratory research is used to better understand the nature of an existing problem and to gain more insight into a situation but does not provide conclusive results. This type of research can be conducted in two ways: primary, and secondary. In primary research, data is collected directly by the researcher, as in this case. The data collected can then be qualitative or quantitative. For this research, the quantitative method, which uses numerical data to find patterns, make predictions, test causal relationships, and generalise results, was used. Quantitative methods therefore emphasise objective measurements and statistical, mathematical, or numerical analysis of data collected through surveys, questionnaires, and polls, or by manipulating pre-existing statistical data with computational techniques.

In this study, quantitative data was collected using a questionnaire, one of the possible tools used for data collection. (Babbie, 2010) A questionnaire consists of a series of questions, in this case closed-ended, designed to gather information about the survey sample. This method was chosen because the questionnaire meets the need of this research to expand the target universe as much as possible; this would not have been possible with qualitative research because of time and resource limitations. This choice

was made in the awareness that structured questionnaire-based surveys have limitations, mainly caused by the bias that resides in the way questions are formulated, but also by the fact that this method fails to explain the underlying reasons for the outcome. (Sbalchiero, 2021) The questionnaire was administrated through telephone interviews, this is because this method makes it possible to minimize the limitations of the questionnaire we previously discussed, ensures that questions are properly understood, normally results in higher response rates, is often the best way to collect data from hard-to-reach respondents, is a cost-effective method, can speed up time, and avoid difficulties related to potential respondent's technological knowledge. In addition, conducting the questionnaire over the phone allowed me to gather more information, to capture the mood of the respondents, and to elaborate on some of the opinions. Therefore, the most interesting insights were noted down for later analysis. The chosen methodology thus increased the level of understanding of the answers and added important insights.

As for data collection, sample data collection was used. Indeed, because of statistical inference, we can acquire information about a population based on a sample, i.e. a subset of the population. A sample is defined as a set of n units selected from the N units that compose and represent the population. The sample and the population must be similar to each other. The reasons for using this method are often economic ad practical, testing the entire population is in fact often almost impossible.

There are different methods to select the sample, for this research, a non-probability sampling method, i.e. a sampling technique in which the researcher selects samples according to his or her subjective judgement, rather than by random selection, was used. In this method, not all individuals have the same chance of being included; some members of the population, compared to others, have a greater but unknown chance of selection. Non-probability methods are often criticized because they lack the statistical basis of probability methods. However, a statistical survey is not always the best choice either; random sampling may adopt methods such as mail delivery, which usually has extremely low response rates, so the risk is to obtain a sample that is still not representative of the entire population anyway. It is therefore up to the researcher to evaluate the best method according to the situation.

In this case, a convenience sample was selected. A convenience sample is a sample of units easily accessible and/or known to be cooperative. This method was chosen because out of 115 companies, the addresses and data of only 66 of them were accessible. This methodology is in fact used to avoid difficulties when there are no

criteria required to be part of the sample, so it is not necessary a random selection of the sample based on a set of criteria. A convenience sample has a significant degree of bias therefore it cannot be used to draw statistically significant conclusions from the results obtained. However, this method can be useful in situations where the goal is to obtain a range of information regarding attitudes and opinions and identify tentative hypotheses that can be tested more rigorously in further research, as in this case. (Galloway, 2005)

The research has some limitations to take into consideration. First, it focuses only on the manufacturing sphere and only on three sectors of it. Second, it is focused only on enterprises, even though they are only one of the actors involved in the ecosystem. It also focuses on a limited area of Turin which has probably different characteristics compared to other areas, especially considering the vastness of the area covered by the city.

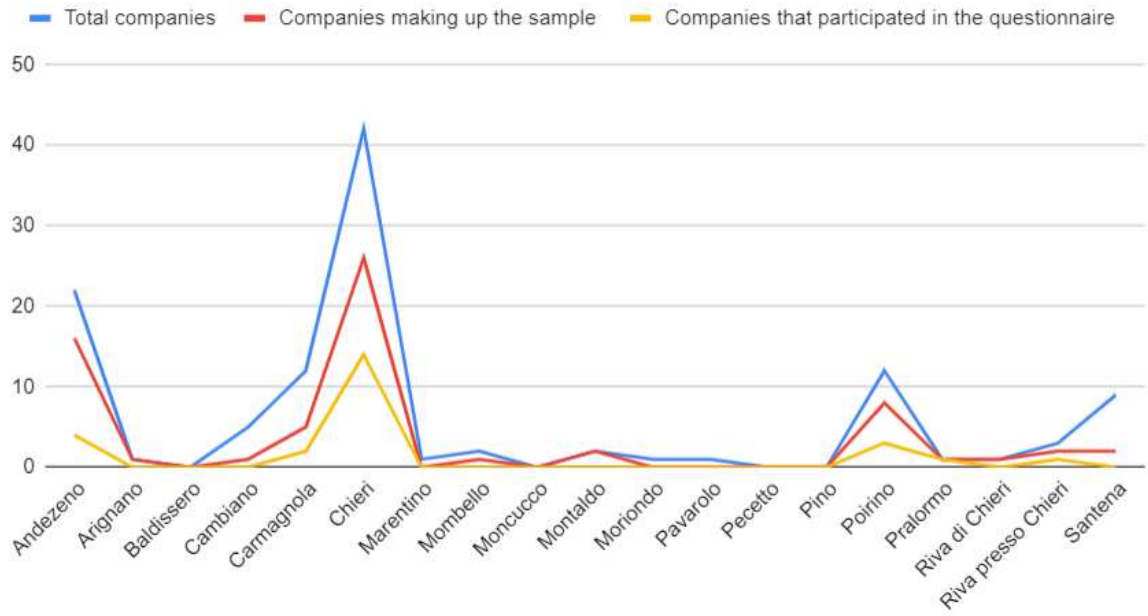
3.4. Results and findings of the research

The collected data must be analysed to obtain useful information. The objective is, on the one hand, to understand what prevents companies from embarking in the ecological transition and to verify the inadequacy of the current company-centred model of implementation of the circular economy, as opposed to the circular ecosystem model, which is a more appropriate model to describe the high level of interdependencies needed to achieve circularity. On the other hand, the goal is to verify the interest of companies in participating in the Reland ecosystem project. The collected data are analysed below.

The initial sample was composed by 66 enterprises, 37 belonging to the textile sector, 19 to the paper sector, and 10 to the plastic sector, distributed in different municipalities. Among the 66 enterprises composing the sample, 25 agreed to share their experience to be part of the research. Thus, the response rate to the questionnaire is 37.88%. Compared to the universe of the 105 companies initially selected, however, nearly 22% of them participated in the questionnaire. The margin of error, or the confidence interval is 17%, so as we have already mentioned the research has an exploratory purpose and is not intended to obtain statistically significant results. The spatial distribution of the total companies belonging to the three

selected sectors, of the companies making up the initial sample, and of the companies that participated in the questionnaire is presented in the following graph.

Table 1 : Comparison between the spatial distribution of the total companies, companies making up the sample, and companies that participated in the questionnaire



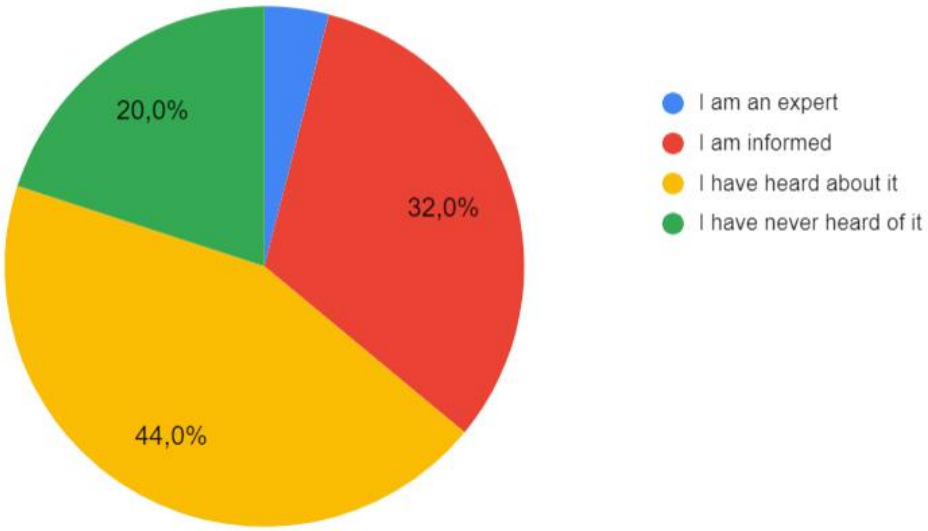
The distribution in the municipalities of the companies that participated in the research mirrors the distribution of the companies that make up the sample as well as the distribution of the total companies. Therefore, the spatial distribution of the companies did not influence the response rate, which is proportional. Therefore, we can state that the municipalities had neither a negative nor a positive influence on the companies.

On the other hand, the manufacturing sector they belonged to influenced the response rate of the companies. Proportionally, the textile sector proved to be the most collaborative, with 17 participating companies (the 46% of the textile companies selected), followed by the paper sector with 6 companies (the 32% of the paper companies selected), and the plastic sector with 2 (the 20% of the plastic companies selected). However, we cannot come to any firm conclusions as the sample is unequally composed of the three manufacturing sector.

The enterprises that participated in the questionnaire are generally small, with an average of 16 employees. As for the respondents, 40% are business owners, 36% play an administrative role, and the remaining 24% play other roles, mostly relevant from a business strategy point of view. As Table 2 shows, these are mostly individuals

who do not have significant knowledge about the circular economy. Only 4 percent of the sample, corresponding to one individual, said they were experts, while the 32 percent affirmed to be informed. The largest slice, corresponding to 44%, claimed to have heard of the circular economy, while the 20%, (or five individuals) claimed to have never heard of the circular economy.

Table 2 : Level of knowledge about the circular economy (percentage of people identifying in each category)



Considering that most of the respondents hold relevant roles, such as owner, or administrative and management roles, the low level of knowledge of the circular economy is extremely significant. Moreover, because the companies which took part in the research are small, we can assume that the knowledge about the circular economy of any employee is influenced by that of his or her superiors and in general by the company's view on it.

The data collected from the questionnaire show a relationship between the level of knowledge about the circular economy and whether circular economy projects are implemented within the company. For those respondents who describe themselves as experts or informed, 78% of them say that their company has already implemented circular economy projects, for those who have heard of it, the figure drops to 64%, but for those who have never heard of it, the figure, as we might expect, drops to 20%. There is a link between knowledge and the development of a circular business model. Indeed, knowledge management is essential to drive eco-innovation in a circular economy. (Shih et al. 2018) In line with this thinking, the Global Environment Facility (2019) states that knowledge management is essential to create new industries and

green jobs for sustainable development.

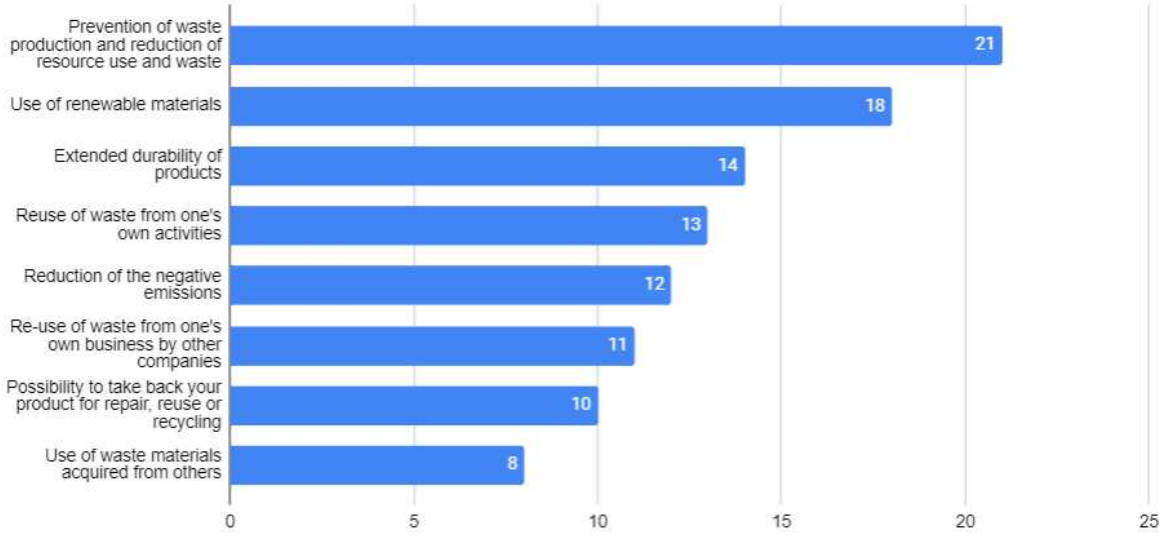
An important aspect of knowledge management is the accessibility of data and the provision of essential information to stakeholders. For example, to promote circularity, knowledge about the 3R policies of the circular economy or the composition of materials, to name a few, must be properly communicated to the different sectors that make up an economy. It is obvious that especially for smaller companies, such as those analysed in this case study, it can be difficult to access a significant level of knowledge.

Therefore, policies need to be put in place to effectively share information in the circularity and sustainability fields. In this way, companies could contribute significantly to sustainable development goals by innovating and developing technologies to advance business projects with efficiency and sustainability as guiding principles. (Sulaiman, 2020)

Despite the link between knowledge of the circular economy and the implementation of circular business strategies, all the companies surveyed have implemented, or intend to implement, at least one strategy related to the circular economy and at least one change in their business model. What is interesting is therefore the fact that even those who have no knowledge of the circular economy or have only a superficial knowledge of it, describe themselves as open to implementing circular economy strategies or to changing their business model, and sometimes they have even already done so. We can therefore conclude that there is a discrepancy between knowledge of the circular economy as a concept, and the good practices that characterise it, which are often associated with quality and profit rather than sustainability.

About the strategies related to the circular economy implemented or intended to be implemented in the future, all companies surveyed are implementing at least one of the strategies listed below. On average, each company is implementing four strategies. The most practised strategy (by 21 out of 25 companies, or 84% of companies) is the prevention of waste production and the reduction in the use of materials and waste. This strategy is followed by the use of renewable raw materials (72%), extending the durability of products (56%), reusing waste from one's own activities (52%), reducing negative emissions (48%), reusing waste from one's own activities (44%), taking back one's own product for repair, reuse, or recycling, and finally there is the use of waste material acquired from others (32%).

Table 3 : Number of enterprises that are implementing or intend to implement each circular economy strategy (possibility to choose more than one option)



The strategies most implemented by the interviewed companies are in line with the priority strategies of circularity within the production chain, i.e., those related to the use and manufacture of smarter products. In fact, the three strategies most frequently implemented by the companies are all related to production strategies and thus to the prevention of the use and waste of raw materials. These data, as we have already mentioned, seem extremely positive, denoting a certain awareness of circular economy strategies on the part of companies. However, it is necessary to consider that the most implemented strategy (prevention of waste production and reduction of resource use and waste) brings considerable economic benefit to the companies that implement it; and the third most implemented strategy (Extended durability of products) is considered synonymous with quality and therefore essential, regardless of the principles of the circular economy, as stated by the interviewees themselves. Interestingly, however, one company stated that product life extension is an almost absurd strategy because it reduces sales. It is therefore likely that in most cases these strategies are not implemented with an awareness of their actual environmental and social impact, but because of economic reasons.

Reuse is the fourth strategy implemented, again in line with the order of the nine R, but this only applies to the reuse of waste from one own activity. The exchange of secondary raw materials with other companies does not record a high percentage, being the last and third last strategy implemented by the companies. We can therefore imagine that it is currently difficult for companies to implement collaborations with other

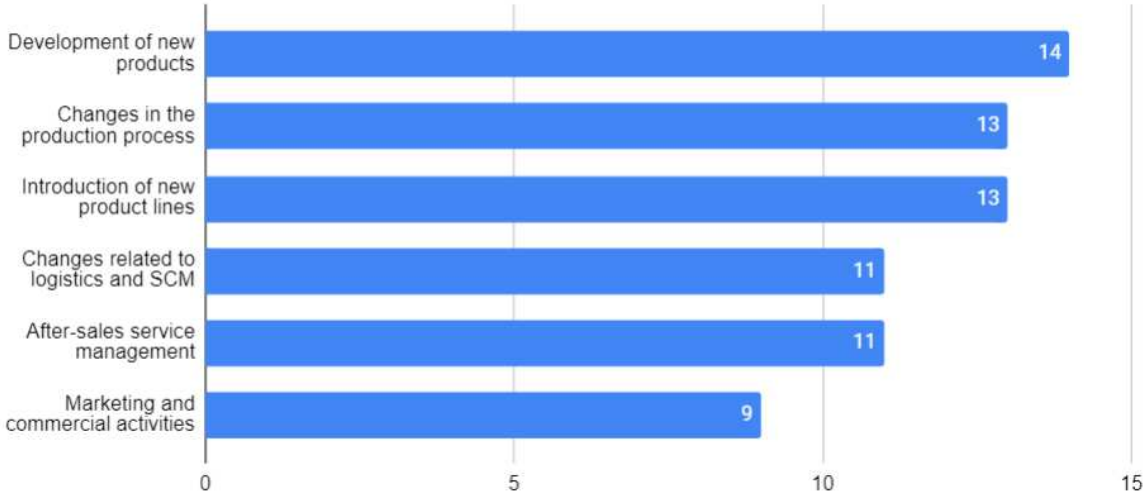
supply chain companies.

In fifth place is the reduction of negative emissions. Many companies, especially those belonging to the textile sector, stated that they did not implement this strategy as their production process does not involve any emissions.

In the penultimate place in order of implementation is the possibility of taking back the product for repair, reuse and recycling, the dialogues with companies showed that the possibility of repairing the product is mainly offered.

As we have seen in previous chapters, the implementation of circular strategies requires companies to transform their business model. This operation is not easy, companies face various obstacles, moreover the business model to be implemented varies from company to company, so everyone must have its own strategy. The question related to changes in this direction is therefore intended to investigate whether the companies in the area have already made some changes or intend to do so in the future. Again, all 25 companies have made, or intend to make, at least one change in their business model. On average, each company changed its business model in three ways, with the most implemented activity being the development of new products (56%), followed by changes in the production process and the introduction of new product lines (52%), changes related to logistics and SCM and after-sales service management (44%), and finally marketing and sales activities (36%).

Table 4 : Number of enterprises that is making or intends to make different changes in the business model (possibility to choose more than one option)



The types of changes in the business model are congruent with the data on circularity strategies, and there is no significant difference in the implementation rates of the

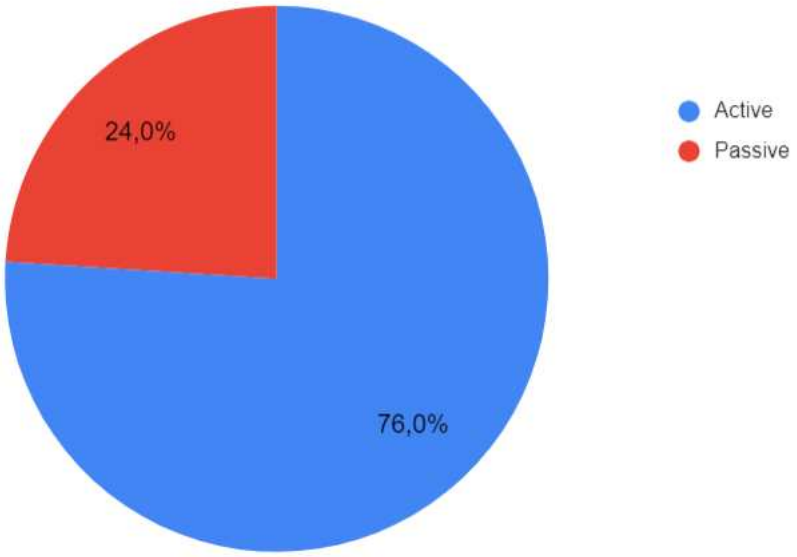
different business model. However, we can observe that marketing and commercial strategies have been underestimated, even though they are very important as they enable companies to communicate their value to the consumer, who plays a crucial role in the circular economy. Indeed, companies have a great power in shaping the demand for products, so the communication of a circular business strategy can raise the awareness of consumers and make them responsible for their purchases. Not by chance, one of the four requirements for a sustainable business model is a customer interface that motivates consumers to take responsibility for their consumption. Furthermore, marketing and communication strategies can improve the competitiveness by enhancing the effort of the company which, among other things, often must bear high costs to innovate its products. Companies must therefore communicate with their costumers to show them their commitment to initiatives with reduced environmental impact, and in turn consumers must become more aware of the fact that a reversal of route in the choices of every day is possible. Thus, the fact that the role of marketing is underestimated by companies demonstrates that there is no adequate and conscious knowledge of circular business models, but rather that companies are fumbling around, at the risk of implementing strategies and changes that are inappropriate for their business.

From the data that emerged regarding circularity strategies and changes in business models, it might seem that companies are doing a lot to move from the linear to the circular economy. However, it must be noted that only fifteen of the twenty-fifth surveyed companies claimed to have already implemented a circular economy project and that of these, most, if not all, claimed to be at the beginning of the implementation. It should also not be forgotten that one of the criticisms levelled at circular business models is the fact that they often transform only a part of their operations, while the main activities continue as usual, and this is exactly what we see happening in the companies interviewed. This aspect takes on greater relevance considering on one hand the economic reasons that often drive companies to change and, on the other hand, the unawareness of their actions.

The consumer is often perceived in a simplified manner, this is a critical aspect of circular business models. 19 companies, however, believe it plays an active role, and only the remaining 6 believe it plays a passive role. A good portion of the companies that believe the consumer has an active role wanted to underline their position, stating

that especially in recent years the consumer drives the market and therefore it is essential to take this factor into consideration.

Table 5 : The role of the consumer according to respondents



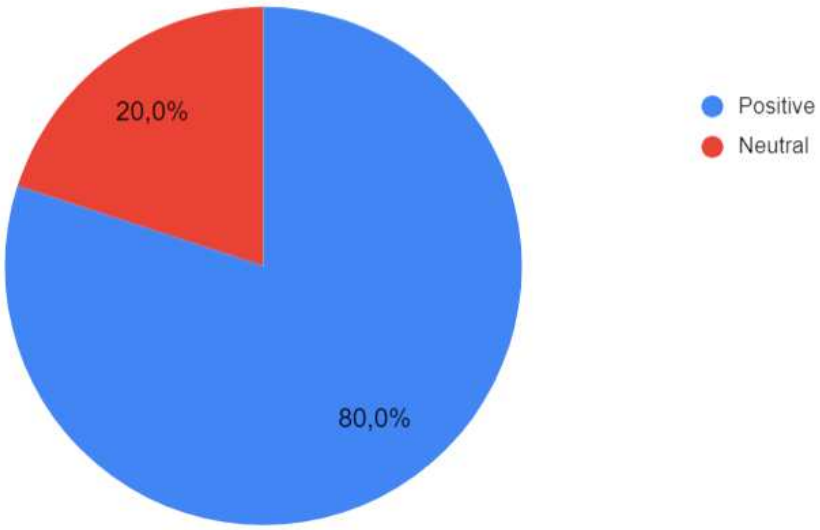
This indicates that most of the companies have acknowledged the role of citizen, which is no longer to accept what the market offers, but on the contrary to direct the market through demand. This may be due to the fact that the consumer, in recent years, has become increasingly aware of the importance of its choices. Some of the companies have also stated that if products are not made of a certain percentage of recycled material, the product will not be sold. Therefore, if the company wants to grow, it must adapt to consumer demand. Consumers' purchasing choices now promote the principles of the circular economy, increasing the demand for goods and services that are more consistent with the principles of sustainability. This factor indicates the transition from the push to the pull orientation. Push marketing is a proactive form of marketing whose objective is to bring one's brand or products to customers. Pull marketing, on the other hand, is about creating value for the consumer, who is the one who demands the product. Pull marketing therefore means being aware that there are already users actively searching for your products, services or information and making it easier for them to find it.

Despite this, nearly 25% of businesses, a significant percentage, do not consider the role of the consumer to be important. It is likely that these enterprises have an outdated view of their business model. Indeed, in the past, the consumer was considered solely for the monetary contribution he or she could make to the company, and his or her role

was to accept the market offer. Changing the business model, as we have seen, can be difficult, plus it is possible that the companies in question have not yet felt a decline in sales and therefore see no reason to change. However, it is important for companies to acknowledge the changes taking place and built a corporate culture that align with the values of people and society.

The social impact of the circular economy is another hot topic. The circular economy has great potential for solving the current environmental crisis and achieving sustainability but has been criticise because the way it is implemented often only consider environmental and economic aspects, leaving out the social ones and thus not really deviate from the linear economy. What emerges from this research is that 80 per cent of respondents believe that a circular economy project has a social impact, while according to the remaining 20 per cent it has no social impact at all.

Table 6 : The social impact of a circular economy project according to respondents

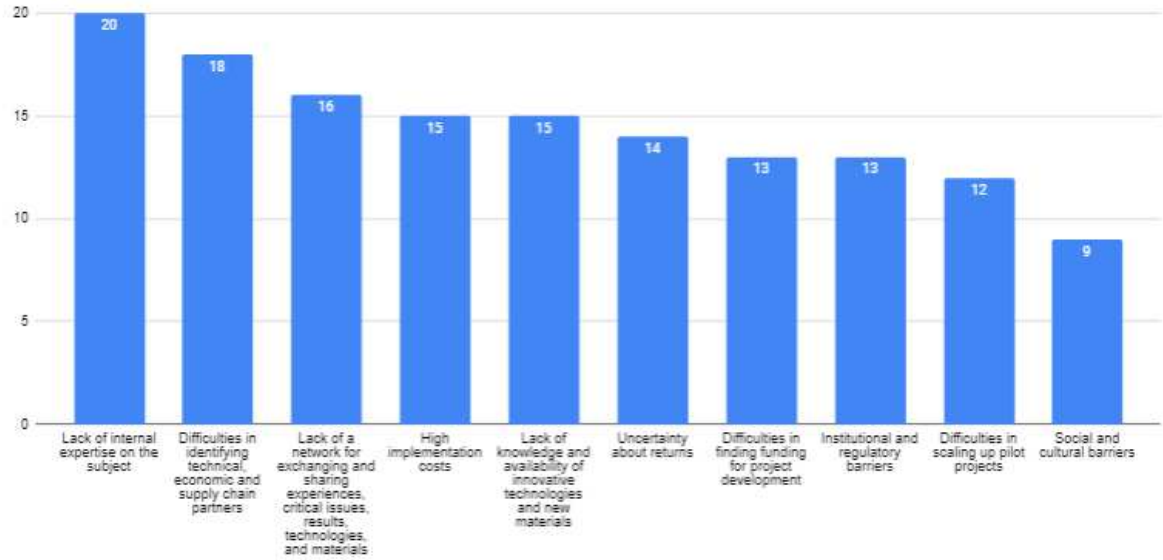


Many respondents, however, emphasised that they believe that a circular economy project should have a social impact, rather than actually having one. This may indicate that companies are aware of the importance of the social component of the circular economy, but do not know how to integrate it into their business model. Indeed, we often refer to the social impact of the circular economy by referring only to employment, and therefore in a very limited way, while the circular economy should have a positive impact also on other aspects such as child and forced labour, discrimination, health

and safety, accessibility, community engagement, fair trade, and women's rights, just to name a few.

The barriers to the implementation of circular business models for companies are manifold and are one of the reasons why companies fail or only partially implement the ecological transition. This is true especially for small businesses like in this case, which often lack the capacity to take such a step. All the interviewed companies experienced at least two of the listed difficulties, with an average of five per company. The most frequently encountered difficulty is represented by the lack of internal expertise on the subject, a difficulty faced by 80% of the companies, followed by the difficulty in identifying technical, economic, and supply chain partners (72%), the lack of a network for exchanging and sharing experiences, critical issues, results, technologies, and materials (64%), the high implementation costs and the lack of knowledge and availability of innovative technologies and new materials (60%), the difficulty in finding useful funding for project development and institutional and regulatory barriers (52%), the difficulty in scaling up pilot projects (48%), and finally social and cultural barriers (36%).

Table 7 : Number of companies that perceive different barriers and obstacles to the implementation of circular strategies (possibility to choose more than one option)



In line with the numbers, many companies emphasised the need to improve their knowledge of the circular economy to meet market demands, and thus the need to access quality training. But they also stated they were left alone in this step. To implement a circular business model, in fact, it is not enough to be knowledgeable

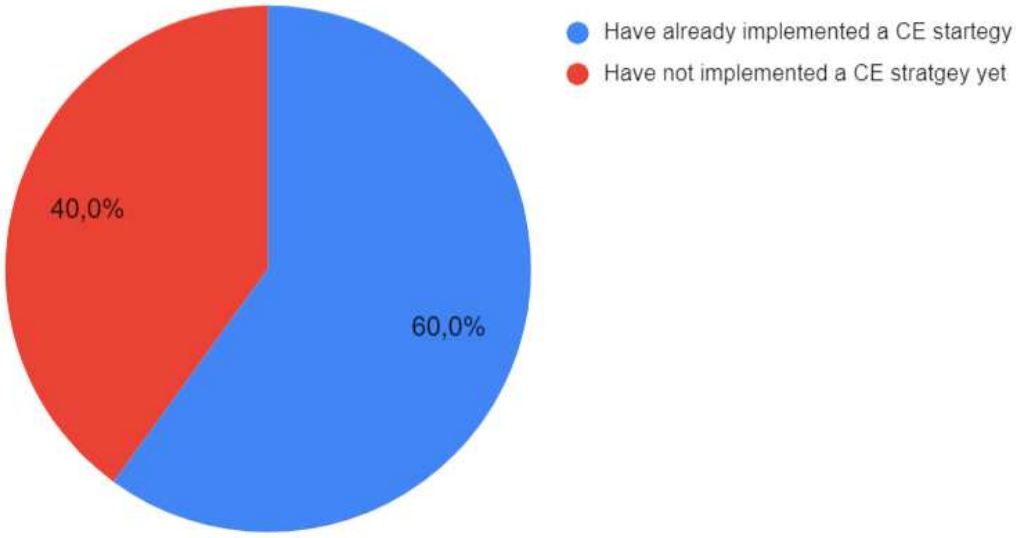
about the topic, but it is necessary to have an in- depth knowledge of it. Moreover, each company must implement different strategies and business models; there is no one-size-fits-all, therefore implementing the right strategy is even more difficult, and implementing the wrong one can bring great damage to the business. While for some companies this problem is easily bypassed by hiring qualified personnel or by training their staff, this possibility does not apply to all companies that may already be experiencing financial or other type of difficulties. Thus, the risk is that companies do not implement any circular strategy, transform only part of their operations while the main activities continue as usual, apply a simplified conception of the circular economy, which boils down to recycling, or fail to translate concept into concrete operations. The second and third most frequently encountered barriers are those related to the difficulty in identifying economic and technical supply chain partners, and the lack of a network for exchanging and sharing experiences, critical issues, technologies, etc. This is very significant for the research as it denotes the need for companies to interface with other actors.

Next, we find the problem of costs, related to that of uncertainty about returns, and that of institutional and legislative barriers. These barriers affect a smaller percentage of companies, but still more than half of them. The legislation, still inadequate and contradictory, contributes to companies' hesitation to invest in strategies that are not supported at the national level. According to some interviewed, the legislation on the disposal of waste materials is inconsistent and thus ends up putting companies in a difficult position. The uncertainty about the economic returns and success of a circular strategy, while justified, denotes a lack of knowledge about the circular economy and at the same time a mistake in the way the circular economy is communicated. Indeed, it is commonly believed that the transition from linear to circular economy is an expensive process, yet we know that it brings several benefits to companies.

The least encountered difficulty among the surveyed companies is related to social and cultural barriers. This is not surprising, as it reflects the data on the city of Turin presented earlier. Indeed, Turin society is increasingly attentive and sensitive to issues concerning sustainability. The figure, however, is slightly at odds with that on uncertainty about returns (which concerns a higher percentage) as a caring society should be willing to make sacrifices to support a sustainable product. Thus, it can be hypothesized that the problem is not so much the awareness and importance attached to environmental issues, but instead how much this is then accompanied in practice by attention in purchasing and everyday actions and choices.

Despite these difficulties, 60% of the companies interviewed, or 15 of them, say they are already implementing some sort of circular economy practice, while the remaining 40% say they have not yet started any project. Most of the companies that are already implementing a circular economy practice emphasised that the implementation of such strategies is in its infancy and that the company is more in an experimental phase, difficulties are indeed many and this certainly make the process longer, more difficult, and riskier for companies.

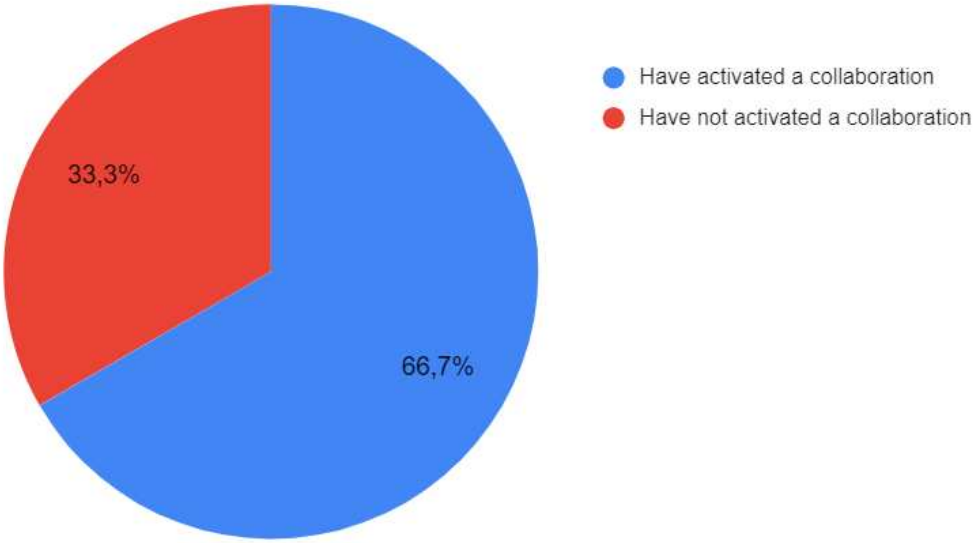
Table 8 : Implementation of circular economy strategies by companies



There is no link between the size of companies and the implementation of circular economy projects, but we can assume that is especially the weaker companies, already experiencing times of crisis, that fail to implement circular economy strategies (however, this aspect should be investigated further). This not only affects companies, but also the economy, the environment, and society, and thus the sustainable development goals. It is therefore a collective problem.

Of the fifteen companies that are already implementing a circular economy project, 66.7% of them, or ten companies, have already activated a collaboration, while the remaining 33 % have acted autonomously.

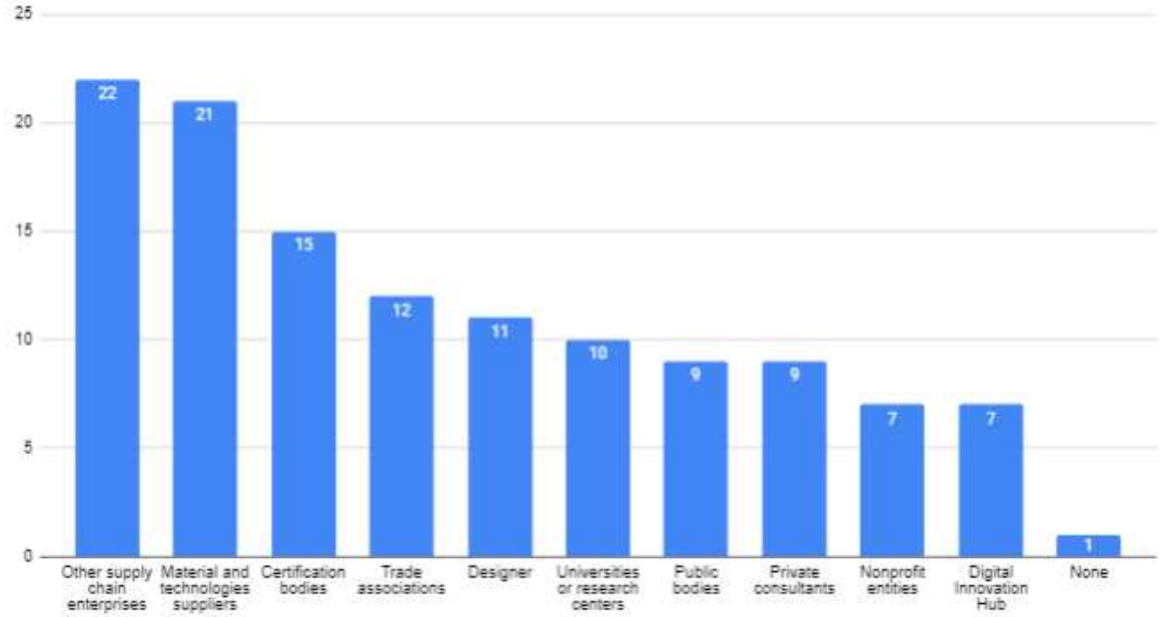
Table 9 : Activation of collaborations by companies



This means that moving from a linear to a circular business model requires stepping out of the single enterprise optic. Collaborations with other entities may not be essential, but they certainly lead to benefits and a greater and more sustainable impact.

All 25 companies were then asked with whom they had activated a collaboration or with whom they would like to activate it. Only one of the companies surveyed said they would not activate any collaboration. All the other companies, even those that are already implementing a circular strategy without having activated a partnership, would like to do so. On average, each company would activate a collaboration with 5 actors. 88% of companies would activate a collaboration with other supply chain companies, in second place, a collaboration would be activated with material and technology suppliers (84%), followed by certification bodies (60%), trade associations (48%), designers (44%), universities or research centres (40%), public bodies and private consultants (36%), non-profit bodies and digital innovation hubs (28%).

Table 10 : Number of companies that have activated a collaboration with different actors (possibility to choose more than one option)



To realize a circular business model, nearly 90 percent of companies would like to partner with other supply chain enterprises and suppliers of materials and technologies. This finding is interesting, as the identification of supply chain partners and the lack of innovative technologies and materials are among the most perceived difficulties for companies.

Many companies, in line with data, emphasised the essential role of certification bodies, which are, however, expensive.

Considering that the most perceived difficulty is that related to the lack of in-house expertise on the subject, it is surprising that the percentage of enterprises that intend to initiate a collaboration with universities and research centres or private consultants is one of the lowest. While there may be economic reasons for the reluctance to collaborate with private consultants, for universities and research centres the reasons should be investigated further.

Collaboration with non-profit entities also does not score well, ranking second to last with only 28 percent of companies that would activate a collaboration with this type of actor. While it is true that it is not necessary for a company to collaborate with non-profit organisations to have a positive social impact, it is also true that it would be an added value and therefore the fact that most companies do not intend to enter such a collaboration gives pause for thought.

Regarding public entities, which play an important role in a circular ecosystem, distrust in them has emerged. From the data collected, it is not possible to understand whether there is a connection with the municipality and the trust in it, however this finding is surprising given that the municipalities that are part of the Consorzio Chierese per i Servizi should have a focus on circular economy issues.
Trade associations do not seem to play a relevant role, and there is no link to the sector to which companies belong and the importance given to this type of actor; something we might have expected given the link between the sector they belong to and the implementation or not of circular economy strategies.
In general, it seems that companies, although intend to establish collaborations with other actors, give more importance to actors who, although external to the company, are part of the production chain. There is thus a tendency to follow the best-known path and a brake on innovation.

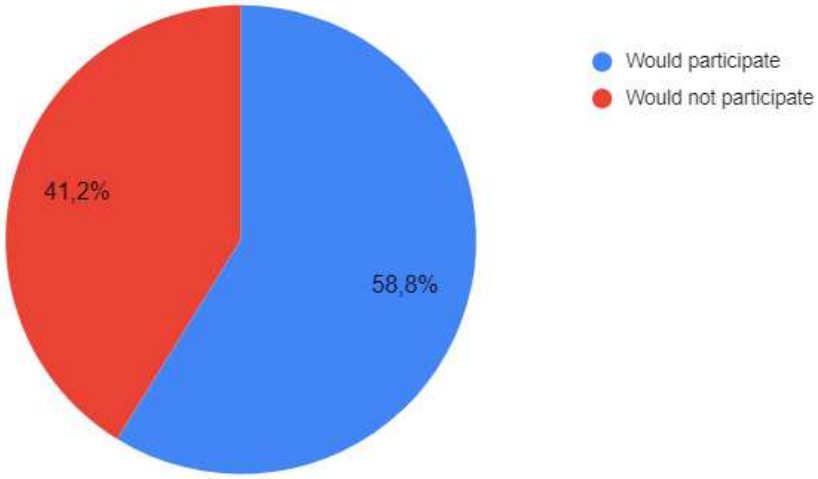
At this point, the research changed course to try to verify the possibility of starting a collaboration with one of the companies to which the questionnaire was administered. Since in this case the potential collaboration is based on the use of waste materials to find a new life for them on the one hand, and to realise projects with a high social impact on the other, the first step was to check whether the companies' production process included secondary raw materials.
The production process of 68% of the companies involves waste, while the remaining companies either do not involve any kind of waste or the waste produced has already found its way to recycling and reuse. The waste materials of companies are of various kinds, there is both the waste coming from the materials used directly for the production and the waste coming from the packaging with which raw materials arrive at companies. Some suppliers offer to take back the packaging materials for reuse or recycling, but this does not apply to all. The quantities of waste materials vary between companies and range from a few kilos to several quintals per month. The tendency that has emerged from companies is to think that the recycling of waste materials is the only and best solution, or at least the first strategy to be applied.

The questionnaire then ended for the companies that do not foresee any waste material, while the others were explained the Reland ecosystem project to be implemented in the area of the Consorzio Chierese per I Servizi, and they were presented with the Reland's collaboration with the Cartotecnica Cambianese as an example. They were then asked if they were willing to send a photo of their waste,

receive a visit to the company, and finally if they were willing to participate in the project by providing their own waste materials.

The 59% of companies, 10 out of 17, agreed to share photos of their waste, to receive a visit to the company, and said they wanted to participate in the circular ecosystem, while the remaining companies were not interested to undertake a collaboration. The figure is significant considering that many of the companies that did not say they were willing to participate in a circular economy project did so because of a distrust of their waste materials. Many companies believe that they do not produce enough waste for it to find a new life, while others believe that their waste materials are not suitable for recycling or reuse. There is therefore a tendency to minimise the possibility of finding a new life for waste materials, despite the desire to do so. As a matter of fact, the reason why many companies responded negatively to the possibility of starting a collaboration for the implementation of a circular ecosystem was not disinterest, but rather the reasons stated above. On the contrary, the companies that responded positively to the possibility of starting a collaboration were enthusiastic. Many of them stated that they would be very happy to find a new life for their waste and most emphasised that they were not interested in having an economic return.

Table 11 : Percentage of companies that would participate in the circular ecosystem



Data show that in the territory of the Consorzio Chierese per i Servizi there are the basis to implement the Reland ecosystem. To date contacts have been made with the interested companies to discuss a possible collaboration.

Finally, some respondents emphasised the importance of acting in a coordinated manner, stating that to achieve significant goals, stating that achieving meaningful goals requires the cooperation of businesses, the public sector and citizens as they are interdependent.

Companies therefore want to become circular but struggle to do so. From the research emerges a picture of more conscious companies compared to the literature, attentive to the role of consumers and to social as well as environmental sustainability. However, the data collected show that businesses cannot tackle the ecological transition alone. While circular business models are strong promoters of the circular economy, the current implementation model based on a single firm view does not consider the systemic implementation of circular economy principles that often spans across multiple firms and different actors.

Conclusions: what possibilities for new circular economy models?

The current model of production and consumption is unsustainable for the planet, people, and the economy, as it prioritizes profit over sustainability. The need for a paradigm shift is therefore unquestionable.

The circular economy is considered and has the potential to be one of the main tools for achieving sustainability, which is why it has become increasingly popular among scholars and policymakers. However, the concept has also received some criticism from practitioners and researchers. Moreover, only 8.6 percent of the world economy is circular, and the global circularity rate fell from 9.1% to 8.6% between 2018 and 2020.

This thesis research represents a first attempt to understand the reasons behind this situation, where the circular economy fails to take hold and to generate a sustainable impact.

The starting hypothesis was that the current business-focused model for implementing the circular economy is inadequate, and that a more appropriate model is the circular ecosystem. According to this model, circularity should be understood as a property of a system rather than of a single product or a single enterprise; it follows that the implementation of circularity requires the collaboration of multiple actors at the territorial level to achieve a common goal.

This hypothesis is supported by both the literature and by the exploratory research developed within the thesis, which revealed limitations and shortcomings of the current implementation model on the one hand, and the need to act cooperatively and synergistically to overcome these issues on the other.

Not only, in fact, the transition from the linear to the circular economy is not easy for companies, that must overcome various difficulties, both internal and external to the company, to implement a circular business model; but when they do manage to do so and succeed to implement circularity, the impact they have is nevertheless limited. There are various reasons for this, e.g., companies often transform only parts of their operations, fail to make a social impact, focus only on recycling ignoring other strategies, fail to educate consumers, and so on.

To solve these problems, the research highlights the need for the different stakeholders involved in the transition from the linear to the circular economy to cooperate and align their effort towards a shared goal. Companies, as well as other relevant actors, need to collaborate with research centres and universities to improve

the knowledge of the circular economy, with municipalities and trade associations to develop a shared plan that fits the needs of the territory, with other companies in the supply chain to exchange best practices, tips and materials, etc.

Considering all these aspects, we can state that the circular economy concept requires an expansion of the firm-level perspective to an ecosystem-level perspective. The circular ecosystem, thus, appears to be the most appropriate model for implementing the circular economy at the territorial level. This is also confirmed by the willingness and desire of companies to be part of the circular ecosystem, and thus by the concrete possibility of developing a circular ecosystem in the Turin area, found in the exploratory research. Circular ecosystems are a more appropriate concept to describe the high level of coordination among different stakeholders, not just firms, needed to implement circular systems and strategies. Indeed, to enable circularity, resource efficiency, and environmental sustainability in markets and society, flows of material, energy, and value must change at the system level. This systemic change requires multiple different actors, such as diverse organizations, cities and municipalities, consumer–citizens, and companies to interact in a complex multi-actor setting.

As we know, circular ecosystems are inspired by biological ecosystems, which are made up of a number of habitats (the place where organism lives), and communities (all the living organisms that live within a habitat) which are directly and indirectly dependent on each other and work together to form a bubble of life. This is what should happen in a circular ecosystem, where the actors that make up the different communities, hierarchically independent, yet interdependent, work synergistically and cooperatively to achieve circularity.

The circular economy and the impact it can have on sustainability does not depend on individuals. The current implementation model focused on individual companies is therefore doomed to failure and it is necessary to move to an ecosystem approach. The value system of all the communities that make up the ecosystem must change in a sustainable direction, companies continue to play a fundamental role in this view, and will have to work to change their value system, culture, and production process, but they must do so in a favourable context, where every component of the ecosystem, and each community, plays its role not according to their own logic, but according to the logic of the ecosystem, to achieve a greater positive impact.

Just as in nature, where ecosystems are connected to each other in larger biomes, circular ecosystems must cooperate with each other to achieve a global impact. Circularity begins locally, from there, you can expand it to encompass the region, country, and hopefully one day, the world.

Recommendations for future research

The data obtained in this thesis constitute an important step, both for this research and for the Reland project, but it is only the first of many.

In the future, it will be necessary to involve in the research companies from other sectors and different actors such as municipalities, associations, citizens, and all those who can potentially be part of the ecosystem and contribute to achieving a positive impact.

The reasons behind some of the data the research failed to detect need to be further investigated so that the circular ecosystem can be designed and implemented in most appropriate way.

It will also be necessary to understand to understand how to enable ecosystem actors and communities to communicate with each other and to understand how the ecosystem can communicate and collaborate with the outside world, particularly with other potential ecosystems.

Finally, it will be crucial to assess the impact of circular ecosystems and weather it can be considered a sustainable model for implementing the circular economy.

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ANNEXES

Declaration of originality

Il candidato dichiara che il presente lavoro è originale e non è già stato sottoposto, in tutto o in parte, per il conseguimento di un titolo accademico in altre Università italiane o straniere.

Il candidato dichiara altresì che tutti i materiali utilizzati durante la preparazione dell'elaborato sono stati indicati nel testo e nella sezione "Riferimenti bibliografici" e che le eventuali citazioni testuali sono individuabili attraverso l'esplicito richiamo alla pubblicazione originale.

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