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**SUSTAINABILITY AND NEW TECHNOLOGIES:
FOCUS ON THE SECOND-HAND MARKET**

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Table of contents

Introduction	5
Chapter 1: Towards sustainable futures: embracing Circular Economy principles for corporate resilience	7
1.1 The urgent call for planetary stewardship: addressing climate change and transitioning to a circular economy.....	7
1.2 The Triple Bottom Line approach and sustainable enterprise practices	11
1.3 Gaining competitive edge through Circular Economy	13
1.4 Conclusion.....	19
Chapter 2: Business change through digital technologies	21
2.1 Digital technologies	23
2.1.1 Mobile technology	24
2.1.2 Machine-to-machine communication technology.....	25
2.1.3 Cloud computing	26
2.1.4 Social technology.....	28
2.1.5 Big Data Analytics	29
2.2 Physical technology	30
2.2.1 Advanced recycling	30
2.2.2 Modular design	33
2.2.3 Life and material sciences technology.....	34
2.3 Hybrid technologies.....	35
2.3.1 3D Printing	36
2.3.2 Trace and return system	37
2.4 Conclusions	38
Chapter 3: Sustainable Business Models and the Second-Hand Market.....	40
3.1 Six new sustainable business models.....	40
3.1.1 Circular supply chain.....	41
3.1.2 Recovery and recycling.....	42
3.1.3 Product life-extension business model	44
3.1.4 Product as a Service business model	45
3.1.5 Sharing economy	46
3.1.6 Re-commerce	48
3.2 Second-Hand fashion market.....	54
3.2.1 Analysis of the growth of the second-hand market.....	54
3.2.2 Technologies applicable to the second-hand market	57

3.3 Conclusions	59
Chapter 4: The Second-Hand Clothing Market.....	63
4.1 Target audience and motivations	63
4.2 Trends and challenges	66
4.3 The profitability of second-hand market: key intermediaries	69
4.5 Business cases.....	74
4.5.1 Methodology	74
4.5.2 Vinted	75
4.5.3 Vestiaire Collective	78
4.5.4 OTB Group & Diesel	82
4.5.5 Results	85
Conclusion	88
Bibliography	91

Introduction

The growing awareness of environmental challenges, coupled with the urgent need to address climate change and ecological degradation, is driving businesses to rethink their models from a sustainability perspective. Today's global dynamics require companies to adapt to a context where sustainability is not merely an ethical consideration but a strategic imperative for long-term success. This thesis focuses on the intersection of sustainability and technology innovation within the secondhand clothing marketplace and analyzes how technology is accommodating the shift to more responsible and circular business models.

Chapter 1 opens with a discussion on the pressing need to take action against climate change, examining how human activities have significantly contributed to environmental degradation. This chapter explores the scientific consensus of climate change, its impact on shifting ecosystems and increased extremities in weather. It introduces the concept of the circular economy, a model that promotes resource reuse and recycling to minimize waste and reduce reliance on finite resources. The chapter also explores the Triple Bottom Line (TBL) approach, which encourages companies to assess their performance not only in terms of economic outcomes but also in terms of social and environmental impacts. The increasing need for systemic change is both economically and ethically driven. The companies capable of embedding the principles of sustainability into their operational models enhance their social responsibility and concurrently build considerable competitive advantage. Today, sustainable development is not a moral commitment but a strategic urge that will help companies win the competition in an eco-minded market.

Chapter 2 focuses on digital transformation as a catalyst for change within businesses, emphasizing how the integration of digital technologies is fundamental for maintaining competitiveness in a rapidly evolving market. A rise in digitalization of economies allows companies not only to achieve operational efficiency but also acts as an enabler in the adoption of sustainability measures. The chapter examines various digital technologies, including mobile technology, machine-to-machine (M2M) communication, cloud computing, social media, and big data analytics, exploring how these contribute to more sustainable business operations. For instance, mobile technology facilitates access to information and services that favor the circular economy models of recommerce. Additionally, the chapter discusses the importance of physical technologies, such as advanced recycling and modular design, which improve material efficiency and promote sustainability. Hybrid technologies, including 3D printing and tracking systems, are also presented as innovative solutions to the challenges of production and waste management. In summary, the chapter how digital

transformation, in synergy with sustainable practices, is able to respond effectively to the environmental challenge while opening up new business opportunities.

Chapter 3 goes on to explore those new business models currently being developed in reaction to the challenges facing the world. In particular, it focuses on six business models: circular supply chain, recovery and recycling, product life extension, product-as-a-service, sharing economy, and re-commerce. Each of these has been detailed further, including how they may be helping contribute toward a more sustainable and resilient economy. Re-commerce, in particular, is an interesting example of how the second-hand market can represent new opportunities for economic valorization, in addition to reduced environmental impact. The chapter also deals with the development of the second-hand market for clothes, an area in which online digital technologies and peer-to-peer platforms have especially enabled new purchases and sales of used goods. These innovations have made shopping for second-hand items not only easier but also induce a cultural shift toward responsible and conscious consumption.

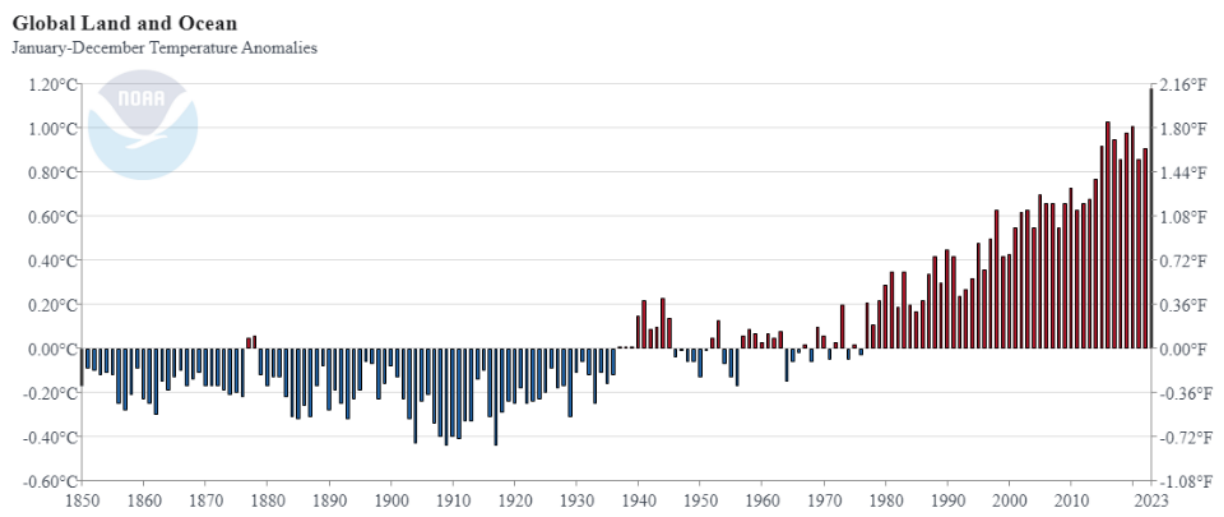
Chapter 4 focuses on the emergence and evolution of the second-hand clothing market, a phenomenon gaining increasing attention in the context of rising environmental awareness and sustainability efforts. At a time when textile production and consumption have surged, contributing to major issues like climate change and pollution, the chapter explores the motivations behind consumers' choices to buy used clothing, particularly among younger generations like Gen Z and Millennials. The key factors driving this choice—such as sustainability, cost-effectiveness, and the uniqueness of items—are analyzed, alongside the challenges faced by the second-hand market, including product quality and inventory management. Additionally, the chapter examines current trends and profit opportunities within the sector, showcasing the innovative business models adopted by market players, ranging from online marketplaces like Vinted and Vestiaire Collective to initiatives by established brands like H&M and Diesel. Finally, through specific case studies, the chapter aims to demonstrate how the second-hand clothing market not only addresses environmental issues but also presents a significant economic opportunity, contributing to a circular and sustainable economy.

The objective of this thesis is to conduct a thorough analysis, using both a literature review and case studies, to investigate how emerging technologies are playing a critical role in enabling businesses to remain competitive in an evolving global marketplace that values sustainability.

Chapter 1: Towards sustainable futures: embracing Circular Economy principles for corporate resilience

1.1 The urgent call for planetary stewardship: addressing climate change and transitioning to a circular economy

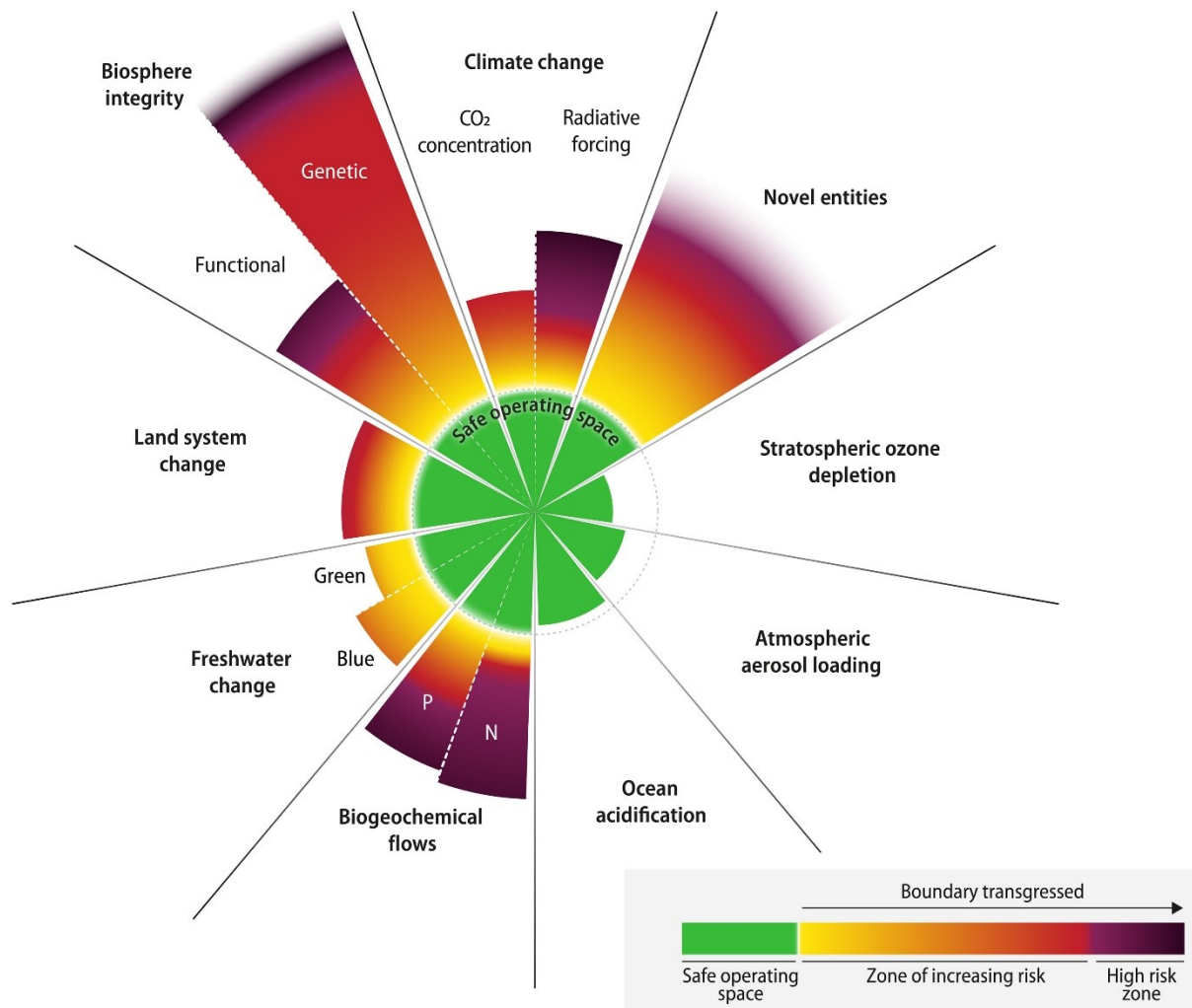
Nowadays climate change is a pressing issue that affects every corner of our planet. The scientific evidence is showing that Earth's climate is changing, and human activities are the primary cause. Some of them include burning coal, oil and gas, cutting down forests, increasing livestock farming, and using fertilizers containing nitrogen and fluorinated gases (European Commission, n.d.). Thousands of studies conducted by tens of thousands of scientists around the world have documented that changes to Earth's climate are driven by expanding human emissions of greenhouse gases, and these are as of now having broad impacts on the environment: plant and animal geographic ranges are moving, glaciers and ice sheets are shrinking, river and lake ice is breaking up earlier, and plants and trees are blooming sooner (NASA, 2021). According to the NOAA's 2023 Annual Climate Report (see figure below), the year 2023 was the warmest year since global records began in 1820 at 1.18°C above the 20th century average of 13.9°C (National Oceanic and Atmospheric Administration, 2024).



Source: National Oceanic and Atmospheric Administration, 2024

Moreover, the planetary boundaries framework, which delineates nine critical processes essential for preserving the stability and resilience of Earth's interconnected systems, reveals that six of these boundaries have been already breached, signifying a precarious state of our planet's environment equilibrium (Richardson, 2023). These nine critical processes identified as planetary boundaries include climate change, biodiversity loss (both terrestrial and marine), disruption of nitrogen and phosphorus cycles, stratospheric ozone depletion, ocean

acidification, global freshwater use, land use alteration, chemical pollution, and atmospheric aerosol loading. Examining the current status, it is evident that six boundaries have already been transgressed, with ocean acidification perilously close to breaching its threshold, and regional aerosol loading exceeding acceptable limits. Encouragingly, stratospheric ozone levels have shown signs of slight recovery (see figure below) (Rockstrom, J., Steffen, W., Noone, K. et al., 2009).



Source: Rockstrom, J., Steffen, W., Noone, K. et al. (2009). A safe operating space for humanity. *Nature*(461), 472-475.

This framework underscores the urgent need for concerted global efforts to mitigate further environmental degradation and safeguard the delicate balance of our planet's life-sustaining systems. Failure to take decisive action risks irreversible damage to ecosystems, loss of biodiversity, disruptions to food and water supplies, exacerbation of climate-related disasters, and profound social and economic upheaval. Through a commitment to environmental stewardship and the implementation of comprehensive sustainability strategies, efforts can be directed towards preserving a habitable planet for present and future generations.

The violation of critical planetary boundaries is only one of the three crises that make the linear growth model unsustainable with our economic development goals (Lacy & Rutqvist,

2015). The term "linear economy" characterizes the prevailing economic growth model, wherein resources follow a one-way trajectory from extraction to disposal, often referred to as "cradle-to-grave". According to the Ellen MacArthur Foundation this model traces its origins to historical disparities in wealth distribution across geographic regions (Ellen MacArthur Foundation, 2013). Concentrated consumption in the most developed regions, primarily Western societies, coupled with the sourcing of material inputs from the global arena, has resulted in industrial nations enjoying abundant access to material resources and energy. Consequently, materials have been relatively inexpensive compared to the cost of human labor. This dynamic has incentivized producers to adopt business models that prioritize extensive material usage while economizing on human labor. The inevitable result of cheap materials and costly labor is the usual disregard of recycling, reusing, and putting considerable attention on waste (Sariatli, 2017).

The global shift away from the linear growth model finds reinforcement in the mounting emphasis on renewables (Lacy & Rutqvist, 2015). One critical facet of this transition is the escalating stress on water resources, driven by burgeoning population growth and the specter of climate change, both of which threaten to reshape the spatial and temporal distribution of freshwater availability worldwide. While surface water remains the primary source meeting human water demands globally, the significance of groundwater is on the ascent, particularly as surface supplies become increasingly unreliable and unpredictable (Richey, et al., 2015). A study published in *Nature* (Jasechko, et al., 2024) delves into groundwater-level trends, comparing data from the late twentieth century (1980-2000) with that of the twenty-first century. Results reveal a concerning trend: in 30% of the analyzed aquifer systems, the decline in groundwater levels has accelerated. However, there is a glimmer of hope as well: the same study elucidates that in 20% of the aquifers monitored, the rate of decline has slowed compared to previous years. Even more promising, in 16% of cases, the trends have reversed entirely, with groundwater levels now on the rise. Such instances offer grounds for cautious optimism, as articulated by Debra Perrone, an associate professor at the University of California Santa Barbara's Environmental Studies Program, who highlights the potential of these aquifers to counterbalance the prevailing narrative of depletion (Erdenesanaa & Rojanasakul, 2024).

Adhering to a business-as-usual approach to economic development is likely to worsen the already fragile imbalance between resource availability and demand, resulting in more severe environmental degradation. The current development paradigm not only fails to solve this issue, but it also causes irreparable damage to the climate and ecosystems. In particular, the linear growth model has a major flaw: it is unable to extend a product's lifespan and preserve

the value of its constituent components, materials, and energy once it has outlived its usefulness. This linear approach continuous a loop of extraction, manufacture, consumption, and disposal, wasting vital resources and causing damage to the environment (Lacy & Rutqvist, 2015).

In response to these issues, it is necessary a paradigm change. Meeting rising global demand requires adopting a new growth model – one that emphasizes substantially higher resource productivity than the linear model could ever deliver, even with major improvements. The new model refers to the circular economy. CE can be defined as an economic system that replaces the ‘end-of-life’ concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes (Kirchherr, Reike, & Hekkert, 2017). It seeks to decrease both virgin raw materials and waste outputs by closing resource flow cycles (D’Adamo, 2019). From this viewpoint, the concept encompasses alterations across various levels: from the production side involving industrial and managerial procedures, products, and sectors, to changes in consumer demand and behavior, as well as impacts on geographical areas, among other factors (Chembessi, 2023). In short words, CE offers a regenerative framework encouraging the incorporation of innovations that facilitate the redesign of production and organizational processes (Batlles-de la Fuente, Franco-García, Belmonte-Ureña, & Plaza-Úbeda, 2023). Additionally, its aim is to reconcile the objectives of sustainability by amalgamating economic growth with environmental preservation. To effectively meet these sustainability objectives, there is a necessity for heightened adoption of circular practices aimed at fostering a waste-free economy. As a result, the concept of circular economy can be correlated with the Life Cycle Sustainability Approach (LCSA), which serves as a theoretical construct examining the principles of sustainable development (Patti, 2023). The life cycle approach is important for integrating sustainability into the design, innovation, and evaluation of products and services, being a central concept in various environmental policies both at the European and international levels. The LCSA framework refers to the comprehensive assessment of the environmental, social, and economic impacts and benefits of a product throughout its life cycle (Zamagni, Pesonen, & Swarr, 2013); this concept, which refers to the Triple Bottom Line framework, will be further explored in the next paragraph.

The LCSA framework and the circular economy go hand by hand. The CE focuses on extending the lifespan of products, promoting reuse, recycling, and resource restoration, thereby reducing reliance on virgin raw materials and limiting overall environmental impacts. Integrating the LCSA framework with the CE approach provides a comprehensive and

synergistic plan for pursuing long-term sustainability, contributing to building more resilient and inclusive economies and reducing negative effects on ecosystems.

1.2 The Triple Bottom Line approach and sustainable enterprise practices

The sustainability-oriented company strives to achieve its long-term goals by minimizing its impact on the environment through environmentally sustainable practices and processes, while at the same time taking care to meet the needs and expectations of its current stakeholders. This approach aims to create value not only for the company itself, but also for society as a whole, without compromising the resources and opportunities of future generations (Pencarelli, 2020). This approach aligns with the vision of the United Nations Brundtland Commission, which in 1987 defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations, 1987). This perspective, moreover, reflects the modern interpretation, given by Professor Nishan Sakalasooriya, who understands sustainability as "the equitable, ethical and efficient use of natural resources for fulfilling the needs of current and future generations of human beings and enhancing their wellbeing" (Sakalasooriya, 2021).

In light of this, the sustainable enterprise operates emphasizing the creation of long-term value for all stakeholders. This entails not only maximizing financial returns but also considering environmental, social, and governance (ESG) factors. Environmental management processes are integral to sustainable operations, encompassing initiatives to minimize resource consumption, reduce waste, and mitigate environmental impacts such as pollution and habitat destruction. Effective management of production systems involves optimizing efficiency, minimizing emissions, and adopting eco-friendly technologies and practices to ensure sustainable resource utilization. Human capital management is another critical aspect, focusing on attracting, developing, and retaining talent while fostering a diverse, inclusive, and equitable workplace culture. This encompasses initiatives related to employee well-being, health and safety, training and development, and fair compensation practices (Pencarelli, 2020). Firms are increasingly adopting the concept of CSR as they recognize that their success is dependent on stakeholders rather than shareholders. Furthermore, CSR is not a one-dimensional notion. Instead, it comprises numerous characteristics that corporations should examine while demonstrating their accountability (Pan, Sinha, & Chen, 2020).

While the widely accepted definition of sustainability emphasizes the imperative of meeting present needs without jeopardizing those of future generations, it lacks specificity in guiding organizations on implementation. It offers minimal direction on distinguishing between present and future needs, as well as on effectively managing organizational responsibilities towards various stakeholders. In response, the concept of the Triple Bottom Line emerges as a practical framework that operationalizes the abstract notion of sustainability. By encompassing multiple dimensions, it provides a structured approach for organizations to navigate the complexities of balancing short-term demands with long-term viability, while fulfilling their obligations to diverse stakeholders (Gimenez, Sierra, & Rodon, 2012).

The Triple bottom line (TBL) is a sustainability-related concept that was coined by Elkington in 1997. Driven by sustainability, TBL provides a framework for assessing corporate performance and organizational achievement along three lines: economic, social, and environmental (Alhaddi, 2015). Moreover, in the literature, this idea is alternatively referred to as the 3P concept which encompasses the aspects of people, profit, and planet. It aims to incorporate the environmental and social impacts of business operations into an evaluation system that has previously focused primarily on financial outcomes. The term "bottom line," originally confined to economic performance, is enlarged under the triple bottom line approach to include social and environmental considerations alongside financial results (Zak, 2015).



Figure 1. Three spheres of sustainability

Source: Zak, 2015, Triple Bottom Line concept in theory and practice

Sustainable development is achieved when the three elements are harmonized, resulting in a process with dynamic limits that seeks a harmonic reconciliation of socioeconomic and environmental issues. Economic sustainability should be defined as an economic system's ability to provide long-term growth in economic indicators, particularly the ability to generate revenue and employment to support people. Economic sustainability in a territorial system refers to the ability to develop and retain the highest possible added value within the territory by successfully integrating resources to increase the distinctiveness of territorial products and services. Social sustainability should be defined as the ability to ensure conditions of human well-being (security, health, education) that are equally distributed by class and gender. It emphasizes “the health, safety and general well-being of employees” and “enables firms to act as good citizens in the local community” (European Commission, 2003). Finally, environmental sustainability can be defined as the capacity to maintain the quality and repeatability of natural resources throughout time, as well as the environment's three roles as a source of resources, a waste receptor, and a direct source of utility (Pencarelli, 2020). Social, environmental, and economic CSR are not mutually exclusive, while being separate elements. Bansal, for instance, argued that in order to attain sustainability, the three dimensions should be interwoven (Bansal, 2004). Similarly, Torugsa et al. proposed that while each CSR dimension may focus on a particular facet of socially conscious behavior, the other dimensions actively interact to influence the responsibility and financial success of businesses (Torugsa, O'Donohue, & Hecker, 2012).

Overall, the TBL allows companies to consider not just the economic value that they create, but also the environmental and social value that may be multiplied or diminished, while assessing their actions. This comprehensive approach fosters responsible corporate citizenship, drives innovation, and positions organizations as drivers of positive change in a world where the pursuit of profit must be balanced with environmental stewardship and social responsibility. The TBL may be used to assess and report on the company's performance in terms of business, social, and environmental metrics. In its widest sense, this concept encompasses the full range of ideals, challenges, and procedures that a corporation must consider in order to avoid any negative consequences of its operations while still generating economic, social, and environmental value (Zak, 2015).

1.3 Gaining competitive edge through Circular Economy

In the context explained in the previous paragraphs, adopting sustainable practices has become not just a moral imperative but also a strategic necessity for companies across

industries. By embedding sustainability into their operations, organizations can unlock a host of competitive advantages that extend far beyond traditional profit margins.

Before describing what competitive advantages firms can gain from adopting sustainable business practices, it is useful to give a definition of what is meant by competitive advantage. Starting with the concept that competition is at the core of the success or failure of firms, Porter defined a firm's competitive advantage as the "ability to offer the buyer products or services at lower cost than others, or unique benefits that justify a premium price" (Porter, 1985). In 1980, he outlined two broad categories of competitive advantage that businesses might pursue: low costs and differentiation. A natural question stemming from Porter's general principles of competition is their relevance to environmental challenges. Can the pursuit of a competitive advantage lead to greater environmental practices in firms? More precisely, which sustainability plan fits best within Porter's generic strategies? (Orsato, 2009). Sustainable development can promote innovation, company growth, and competitive advantage (Baumgartner, 2014). It concerns environmental protection, social responsibility, and economic development (Nastanski & Baglione, 2014).

As global challenges such as climate change, resource depletion, and social inequality continue to escalate, the business case for sustainability becomes even more compelling. Companies that proactively address these challenges not only mitigate risks but also position themselves as leaders in their industries, capable of driving positive change and creating shared value for society. In this sense, the implementation of environmental policies at the company level directly benefits shareholders (McWilliams & Siegel, 2001) and can improve competitiveness in a variety of ways. These include cost reduction and optimization achieved by pollution prevention: integrating sustainable practices often leads to cost savings in the long run. Investments in energy-efficient technologies, waste reduction strategies, and sustainable sourcing can lower operational costs and enhance resource efficiency. Another advantage relates to differentiation strategy achieved through the development of greener products; in fact, in an era where consumers are increasingly conscious of environmental and social issues, aligning with sustainable values can differentiate a company from its competitors and attract environmentally and socially conscious consumers. Moreover, sustainability initiatives can drive innovation within the company: this means that the pursuit of sustainability goals often requires creative problem-solving and the development of new technologies or processes. These innovations can not only improve environmental performance but also lead to the creation of new products or services that meet evolving consumer demands (Berrone & Gomez-Mejia, 2009). Furthermore, environmental proactivity enhances stakeholder interactions including investors, employees, and communities, enabling

companies manage risks, including those to their reputations (Cordeiro & M., 2015), or using non-market techniques to influence government legislation, putting their competitors at a disadvantage (Shrivastava & Hart, 1995). In particular, investors are increasingly scrutinizing companies' environmental, social, and governance (ESG) performance, and companies with robust sustainability initiatives are more likely to attract investment, and additionally, employees are often more engaged and motivated when they work for a company that prioritizes sustainability, leading to higher retention rates and productivity (Parmentola & Tutore, 2023).

Renato Orsato has devised a conceptual framework aimed at categorizing various archetypes of environmental competitive strategy (as illustrated in Fig. 1.4). This framework serves to dissect the components integral to competitive environmental management, thereby facilitating the identification of circumstances under which environmental strategies can enhance a firm's competitiveness (Parmentola & Tutore, 2023).



Source: Orsato R. (2009), Sustainability strategies: when does it pay to be green?

The quadrants delineate a classification of specialized environmental strategies that corporations can embrace. The configuration of the industry where a company operates, its standing within that industry, the markets it caters to, and its abilities to obtain resources or implement radically innovative strategies will indicate the suitable competitive emphasis (organizational processes or products/services) and the possible avenue for gaining competitive advantage (cost or differentiation) for the company (Orsato, 2009).

The 'eco-efficiency strategy,' categorized as strategy 1, entails companies aiming to cut costs at the organizational process level. This strategy can be summarized as a management strategy of doing more with less. Academic experts and practitioners term eco-efficiency the

synthesis of economic and environmental efficiency in parallel, where the prefix “eco” refers both economics and environment (Lehni, 2000). This approach proves particularly effective in sectors where consumers are unwilling to pay a premium price for environmental sustainability. Consequently, companies strive to minimize costs by reducing waste in processes (Parmentola & Tutore, 2023). As a pragmatic approach for businesses, eco-efficiency highlights the importance of utilizing resources effectively to promote both economic and environmental advancements by reducing pollution and enhancing resource usage efficiency. This concept includes optimizing resource efficiency to minimize usage per output unit and improving resource productivity to add value through resource utilization. Moreover, the World Business Council for Sustainable Development (WBCSD) promotes the application of eco-efficiency principles throughout all aspects of company operations, aiming to decrease resource consumption, mitigate environmental impacts, and increase the value of products or services (United Nations ESCAP, 2009).

The second strategy, termed as 'beyond compliance leadership', places a stronger emphasis on differentiation as a competitive advantage for the company. In this approach, the company invests in sustainable management systems or intentionally publishes news related to its environmental impact to communicate and advertise its sustainability efforts to stakeholders. These companies strive to showcase their dedication to minimizing operational impacts, surpassing legal requirements to be perceived as environmental leaders by discerning stakeholders (Orsato, 2009). This strategy is particularly well-suited for companies whose consumers are highly conscious of environmental concerns. By emphasizing and publicizing their sustainability initiatives, these companies can enhance their corporate reputation and image, showcasing their proactive efforts in sustainability. This not only helps in building a positive public perception but also positions the company as a responsible and forward-thinking entity in the eyes of its stakeholders (Parmentola & Tutore, 2023). Thus, the 'beyond compliance leadership' approach aims to embed sustainability as a core value of the company, setting higher standards that surpass mere adherence to government-imposed environmental regulations.

The third strategy is defined as ‘eco-branding’: it is a marketing approach that allows companies to inform and promote their pledge to protect the environment (Rostar, n.d.). It aims to differentiate products by emphasizing their eco-friendly attributes, such as reduced carbon footprint, use of renewable materials, or adherence to ethical production practices. Eco-branding seeks to establish a connection between the brand and environmental responsibility, thereby appealing to consumers who prioritize sustainability in their purchasing decisions. Moreover, the importance of eco-branding lies in its potential to meet

the growing demand for environmentally friendly products and services: in fact, as consumer awareness of environmental issues increases, there is a growing market for products that align with eco-friendly values. By adopting eco-branding strategies, companies can capitalize on this trend, differentiate themselves from competitors, and enhance their brand image as socially and environmentally responsible organizations. An example of this strategy is seen in those companies that use phrases such as 'environmentally friendly,' 'eco-friendly,' 'low energy consumption' and 'recycled' to promote their products and services (Ali, Ullah, Ahmad, Cheok, & Alenezi, 2023). The target for an eco-branding strategy is primarily environmentally conscious consumers who prioritize sustainability in their purchasing decisions. Additionally, eco-branding strategies may also target broader consumer segments by emphasizing the quality, performance, and innovation associated with eco-friendly products, thereby appealing to a wider audience beyond just environmentally conscious consumers. These consumers are often willing to pay a premium for products that align with their values and contribute to environmental preservation. For this reason, some companies may abuse the 'eco-branding' strategy, falling into the practice of greenwashing. Greenwashing is a deceptive communication or marketing tactic where companies, institutions, or organizations falsely present their activities as environmentally sustainable, while in reality, they are hiding their negative environmental impacts (Treccani, 2021). This misrepresentation allows organizations to gain undeserved positive recognition and trust from consumers, who often have limited access to detailed information about the companies' operations and the authenticity of their sustainable business practices. This practice may undermine genuine sustainability efforts and can lead to a loss of credibility and trust if exposed: in fact, consumers and other stakeholders are becoming increasingly aware and critical of greenwashing tactics, demanding greater transparency and authenticity from companies. To combat greenwashing and uphold the integrity of the 'eco-branding' strategy, it is essential for companies to provide truthful and comprehensive disclosures about their sustainable initiatives. This involves not only highlighting positive actions but also being honest about ongoing challenges and areas needing improvement. For example, companies should adopt robust reporting standards and third-party verification to ensure the accuracy of their sustainability claims (Gallicano, 2011).

Finally, the fourth strategy is referred to as 'environmental cost leadership'. It is a strategic approach wherein a company aims to minimize its environmental impact while simultaneously reducing costs. This strategy recognizes that sustainability and cost-efficiency are not mutually exclusive; in fact, they can be complementary. By adopting environmentally responsible practices, companies can often streamline operations, reduce waste, and

ultimately cut costs (Parmentola & Tutore, 2023). Moreover, there are several ways of reducing the intrinsic-environmental impact of products: among them are dematerialization, that involves reducing the material inputs required to produce a product, product substitution which entails replacing materials with alternatives that have lower environmental impact, and also eco-design (Orsato, 2009). In particular, design for environment (DfE) is one of the key elements of environmental cost leadership: it is an approach that integrates environmental considerations into the product design and development process. It involves assessing the environmental impact of a product throughout its entire lifecycle – from raw material extraction to manufacturing, distribution, use, and disposal – and then making design decisions that minimize negative environmental effects at each stage (Keivanpour, 2022). By incorporating these principles into product design and development, companies can achieve several benefits: reduced environmental footprint, increased resource efficiency, enhanced brand reputation and regulatory compliance.

Moreover, integrating sustainability into business strategies offers a significant benefit beyond mere economic growth: the extension of product life cycles. Although innovation is crucial for business growth and competitiveness, it often involves considerable investment of financial, time and energy resources without necessarily guaranteeing the expected success. Therefore, enterprises must also consider "mature" products, i.e., those that are established in the market and capable of generating stable profits over time (Ming, 2022). Taking a step back, scholars have analyzed that usually products/services follow their own growth path, which can be defined in four stages: development, growth, maturity and decline. Initially, the adoption of new products is limited to a small circle of innovative consumers willing to experiment, while the "large majority" takes time before accepting and adopting the new product. However, as time passes and adoption spreads, the product reaches its maturity stage, characterized by maximum market penetration (Levitt, 1965). In a perspective of a sustainable company circular economy, it is fundamental for companies to lengthen as much as possible this last phase before its decline, so that new product innovation takes hold among the masses in the meantime. There are countless strategies that companies can adopt to lengthen product end of life, for example through remanufacturing, repair, recondition, repurpose, redesign, refurbish, upgrading and recycling (Alamerew & Brissaud, 2019). These strategies not only promote waste reduction and resource reuse, but also offer numerous benefits for both consumers and businesses. For example, for consumers, prolonged use of a purchased product results in financial savings, as it does not need to be replaced frequently or undergo constant repairs. This translates into higher levels of customer satisfaction and greater consumer trust in the brand. For companies, extending the life cycle of products brings both reputational and

marketing benefits. As we know, a satisfied customer is more likely to recommend the brand to others through positive word of mouth and favorable feedback. In addition, adopting sustainable practices and extending product lifecycle contributes to the creation of a corporate culture geared toward social and environmental responsibility, thereby improving the company's image and competitive position in the marketplace. Finally, a longer product life cycle also benefits society as a whole. At a time when the demand for a change in the use-waste paradigm is increasingly pressing, companies must strive to extend the lifespan of their products, thereby helping to reduce the waste of materials, energy and natural resources (Lund & Denney, 1978).

1.4 Conclusion

The transition to a circular economy provides a powerful opportunity for businesses to not only improve their economic performance but also play an important part in promoting a more sustainable future. This chapter has explored the multiple benefits that this paradigm provides, emphasizing the need of integrating economic, social, and environmental issues. Sustainable development, as achieved via this holistic approach, provides long-term growth and equal well-being while protecting our natural resources.

Nowadays, adopting sustainable practices is both a moral duty and a strategic need. Companies that incorporate sustainability into their core operations get a variety of competitive benefits such as increased profitability and innovations, brand distinctiveness, and improved stakeholder relationships. Businesses that adhere to strategies such as eco-efficiency and beyond-compliance leadership can reduce their environmental footprint while still achieving significant economic rewards.

In terms of acquiring a competitive advantage, it is obvious that sustainability and economic success are not mutually incompatible, but rather complementary. Implementing circular economy concepts, such as remanufacturing, repair, and resource reuse, increases product lifecycles, minimizes waste, and promotes a more closed-loop ecosystem. These strategies benefit all stakeholders – consumers enjoy financial savings, businesses enhance their brand reputation, and society gains from environmental conservation. However, to effectively implement circular economy initiatives, businesses must traverse a complicated terrain of technical developments, digital transformation, and new resource management practices. This change demands a dedication to ongoing improvement, transparency, and authenticity in sustainable initiatives. Companies must prevent greenwashing by incorporating sustainability into their fundamental beliefs, setting high standards and aggressively tackling environmental and social issues.

To summarize, the transition to a circular economy is a path to sustainable development that provides major economic, social, and environmental advantages. Companies that integrate sustainability into their operations may promote positive change, create shared value, and establish themselves as leaders in a fast changing global market. The next chapter goes deeper into the practical elements of applying these strategies inside organizational structures, examining the impact of technological advancements and digital transformation.

Chapter 2: Business change through digital technologies

The rising digitization of economies underscores the significance of digital transformation for maintaining competitiveness in the market. Anticipated trends for 2024 and beyond involve the integration of generative AI, adoption of sustainable practices, enhancement of customer experience, and facilitation of remote work. These trends signify a transition towards technology adaptation, prioritization of customer satisfaction, and cultivation of inclusive work environments amidst uncertain conditions (Marr, 2023). This trajectory necessitates businesses to seamlessly integrate, not merely to survive, but to flourish in competitive landscapes. Such seamless integration is attainable solely through digital processes and collaborative tools (Kraus, et al., 2021). Thus, the concept of digital transformation assumes paramount importance: it entails the reconfiguration of an organization, with the aim of generating value through the continual deployment of technology on a broad scale (McKinsey&Company, 2023). As per a recent survey conducted by the Economist Intelligence Unit, an overwhelming nine out of ten companies acknowledge that digital transformation is important for achieving success. Furthermore, nearly four out of five companies (79%) express concern that without additional digital transformation efforts, they risk facing a competitive disadvantage within the next three years (The Economist Group, n.d.).

In recent years, the business landscape has undergone a rapid and profound transformation, marked by the widespread adoption of new technologies. These advancements are aimed at not only streamlining operations but also enhancing profitability. By seamlessly integrating across multiple channels, these technologies cater to the evolving expectations of customers. They achieve this by automating manual processes, reducing errors, and boosting overall productivity.

Among the array of emerging technologies, artificial intelligence, machine learning, big data, and the Internet of Things stand out. These innovative tools empower businesses to gain invaluable insights into customer behavior, streamline internal operations, and make informed decisions. This can be considered as a win-win both for the company and the consumer: producers will be able to exploit customer's data and will offer new services, the consumer will be able to choose the design of the product in a more personalized way for example (Parmentola & Tutore, 2023). In fact, individual and customer-specific criteria may be included in the design, ordering, planning, manufacturing and operation phases: it brings an enormous improvement in the customer's expectations and experience, since last-minute changes may also be incorporated in the process (Jadertrierveler, Sellσ, & Santo, 2019).

Moreover, amidst the persistent threat of cyber-attacks in business' website and internal network, digital transformation could emerge as a critical ally in bolstering cybersecurity defenses, for example through advanced security protocols like multifactor authentication and encryption. Cybersecurity is extremely important in safeguarding computer systems from a myriad of threats including information disclosure, misdirection, and data theft. Virtually every sector utilizing internet connectivity, from healthcare to finance, transportation, government, and manufacturing, remains vulnerable to relentless cyber threats (Strategic Technologies Program, 2022). Leveraging digital transformation not only fortifies businesses against cyber risks but also ensures resilience against emerging vulnerabilities induced by technology, interconnected systems, human errors, and evolving attack methodologies (Liu, et al., 2022).

Finally, digital technologies render businesses more agile and adaptable. This adaptability enables them to respond swiftly to changing market dynamics and evolving customer demands. Such flexibility grants them a significant competitive advantage over less nimble counterparts in the ever-evolving business landscape (Astapciks, 2023).

Digitization presents a wealth of opportunities by facilitating process flexibility, harnessing the power of data science to manage complexity, and enhancing the coordination of interdependencies among individuals, organizational units, and businesses (Cagliano, 2020). In the ever-evolving area of sustainable business practices, the use of digital technologies can be extremely relevant. In fact, this link is so strong that scholars have renamed the synergies created between digital and green transitions as 'twin transition'. The two significant shifts are garnering attention for their wide-reaching effects on both industrial structures and societal disparities. Firstly, the rise of digital technologies, encompassing Information and Communication Technology (ICT), Artificial Intelligence (AI), Industry 4.0, and blockchain, is deeply influencing economic growth, productivity, and the job market. Secondly, investment in environmental technologies and products - crucial for advancing towards a low-carbon economy - has the potential to rejuvenate the competitiveness of developed economies as already described in the first chapter (Diodato, Huergo, Moncada-Parternò-Castello, Rentocchini, & Timmermans, 2023). In today's world, the growing difficulties of climate change and resource depletion are quickly becoming top priorities for both society and corporations. Companies are presently under increased scrutiny from politicians and consumers for their considerable contributions to greenhouse gas emissions, resource use, waste management, and other environmental concerns. As a result, there is an urgent need for businesses to rethink existing operations and adopt sustainable alternatives, hence stimulating the creation of innovative business models. This paradigm shift has the potential to

fundamentally revolutionize a wide range of corporate processes, from product development to supply chain management and organizational structure. Achieving such a broad change necessitates a multidimensional strategy that includes process optimization, structural rearrangement, cultural adaptation, and the use of cutting-edge technology. To achieve such an ambitious objective, the expansion of digital technology is a powerful facilitator, which provide new opportunities to push sustainable manufacturing processes (De Carolis, Macchi, Negri, & Terzi, 2017). These technologies not only promise to solve environmental challenges, but also have the ability to produce beneficial social and economic consequences, putting businesses at the vanguard of a more sustainable future (Spaltini, Terzi, & Taish, 2024).

Incorporating new business models presents companies with compelling opportunities to adopt principles of the circular economy. However, the scalability of many of these models hinges on the integration of innovative technologies. This symbiotic relationship underscores the intertwined nature of digital and green transitions. Furthermore, digital advancements across various domains such as social media, mobile platforms, analytics, cloud computing, and machine-to-machine (M2M) communication are particularly effective in bridging the gap between physical and digital realms while facilitating seamless interactions between individuals and the Internet of Things (IoT) (Lacy & Rutqvist, 2015). Emerging technologies like 5G networks are fostering expansive ecosystems that encompass universal architectures, technologies, and solutions. For example, artificial intelligence, edge computing, and smart energy harvesting empower intelligent applications, blockchain solutions, and quantum communication. Consequently, these advancements present opportunities for both enhancing existing business models and catalyzing the development of novel ones (Fuerst, Sanchez-Dominguez, & Rodriguez-Montes, 2023). According to Peter Lacy and Jakin Rutqvist, there are ten main disruptive technologies, which fall into three principal categories (digital technology, physical technology and a blend of the two) which can be used by circular economy company's leaders (Lacy & Rutqvist, 2015). Below, each category will be thoroughly examined, shedding light on the prevalent utilization of technologies and elucidating the efficiency and effectiveness advantages they offer within sustainable business models.

2.1 Digital technologies

Giving definition of digital can be complicated. From a customer's perspective, digital means everything on the Internet (for example, social media, advertising and websites) or more in general, anything a person can do, see or engage with the use of connected devices such as

smart TVs, personal computers, mobile phones and wearables. In our world, digital is everywhere, but it becomes really powerful when we extend its definition to the company's level. At the enterprise level, digital could mean every element of the company's entire IT infrastructure: from product and inventory management, and running the supply chain to every aspect of HR, marketing and communications (Herbert, 2017). Digital technologies enable real-time information flow between consumers, machines and management systems. Five main types of digital technologies are generally recognized: mobile technology, machine-to-machine communication technology, cloud computing, social technology and big data analytics (Lacy & Rutqvist, 2015). The potential of each technology in reducing environmental impact, optimizing resources and fostering long-term sustainable growth will be explored below.

2.1.1 Mobile technology

Starting with mobile technology it can be defined as a wireless technology which work with radio waves and it has the great advantage of being able to be used anywhere. Mobile phones have operating systems to run applications, access the internet, allow downloads, support multiple e-mail accounts, create and edit documents, create playlist and even provide location/direction via GPS. Mobile technologies have made communication and information access very convenient and timely to users from the comfort of their own homes and offices, and from wherever they are (Jharotia, 2015). For instance, mobile phones are almost considered indispensable in everyday life: they have in fact enabled people to be connected at all times and encapsulate in one object many functions that were previously performed by different objects, such as the camera, television, landline phone, maps, and even encyclopedias.

2.1.1.1 Its application to sustainability

Mobile technology spurs adoption of circular business models by enabling universal and low-cost access to data and applications. For example, it can be used to match supply and demand by letting consumers to easily search for availability, spare capacity, price of goods and location, and allowing them to communicate with suppliers (Lacy & Rutqvist, 2015). Another example is considering sharing economy, which is one of the circular economy models: for years and years sharing among families and friends has been a traditional form of exchange. Now, however, this exchange, can also be enhanced to the nth degree by new technologies, including the use of apps on smartphones that connect strangers for them to exchange clothes,

objects, furniture, and whatever else they can trade (Mont, Palgan, Bradley, & Zvolska, 2020). Mobile technology is a key driver of long-term economic and a significant contributor to the achievement of the United Nations' 17 Sustainable Development Goals (SDGs). These objectives, adopted by all 193 UN member nations, seek to build a more sustainable future by addressing concerns including poverty, hunger, and climate change (United Nations, 2024). Currently, more than 5 billion people—approximately two-thirds of the global population—are connected to mobile networks. This figure is increasing as mobile carriers discover new ways to deliver inexpensive services to low-income and distant people. As a result, many people are accessing the internet for the first time, unlocking a range of life-enhancing services and opportunities. Finally, another case that exemplify how mobile technology can promote environmental sustainability is the use of pay-as-you-go (PAYG) solar systems in off-grid locations, which has facilitated the transmission of renewable energy throughout Africa, Asia, and Latin America since the early 2010s. Between 2014 and 2017, PAYG solar sales surged sixfold, reaching more than 1.6 million units. This expansion has given an estimated 8.5 million people access to safe and dependable electricity in their homes, considerably increasing their quality of life in a variety of ways (World Economic Forum, 2018). Concluding, mobile technology has not only simplified daily life but has also catalyzed innovative business models and has promoted resource efficiency and sustainability.

2.1.2 Machine-to-machine communication technology

Wireless connectivity is rapidly extending beyond traditional mobile devices used by humans. In the near future, countless wireless devices such as sensors and actuators will be interconnected within the Internet of Things (IoT). The concept of machine-to-machine (M2M) communications, also known as machine-type communications (MTC), is designed to manage the transmission of data across a vast network of devices. In particular, M2M communication refers to mobile nodes communicating over a network with little to no human intervention. This technology facilitates seamless interaction among devices, enabling more efficient and autonomous systems (Song, Niyato, Han, & Hossain, 2015). The related market is projected to grow from USD 2.9 billion units in 2024 to USD 5.3 billion units by 2029, registering a CAGR of 12.7% during the forecast period (Research and markets, 2024). This is given by the fact that M2M communication offers substantial benefits for companies by reducing overall service and maintenance costs through automated data transmission from products to the manufacturer's management system. This technology not only creates new business opportunities but also enhances user experiences with existing services. For

instance, lighting systems can now synchronize with the music being played in the environment, showcasing the potential for innovative and responsive applications (Lacy & Rutqvist, 2015). Amongst the vertical markets and sectors of M2M are the automotive industry, the smart home market, intelligent buildings, smart cities and public transport, healthcare, consumer electronics, the retail industry, manufacturing & supply chain, utilities & energy and security applications (Vailshery, 2024). M2M communication is used to connect equipment, products, factories, and supply chains, combining with big data analytics to drive efficiency and productivity.

2.1.2.1 Its application to sustainability

M2M technology can significantly enhance sustainability by enabling more efficient resource management, reducing waste, and optimizing processes. For example, considering energy management, M2M technology enables the creation of smart grids that can optimize energy distribution, reducing losses and integrating renewable energy sources more effectively. In agriculture, M2M technology allows for precise monitoring: sensors in the field can measure soil moisture, nutrient levels, and weather conditions, enabling farmers to apply water, fertilizers, and pesticides more efficiently, thus reducing waste and environmental impact. Moreover, in almost every industry, machine-to-machine technology helps to reduce scrap rates and improves quality assurance with potentially lower lifecycle costs (Linke, Garcia, Kamath, & Garretson, 2019). Finally, a last example, in transportation and logistics, M2M enables real-time tracking and management of vehicle fleets, optimizing routes, reducing fuel consumption, and lowering emissions. By integrating M2M technology into various sectors, businesses and governments can achieve significant improvements in resource efficiency, reduce environmental impact, and promote sustainable practices, ultimately contributing to a more sustainable future.

2.1.3 Cloud computing

Cloud computing has revolutionized the IT industry by adding flexibility to the consumption of Information and Communication Technology (ICT) services. This innovation allows organizations to pay only for the resources and services they actually use (Khatib & Salman, 2018). According to the National Institute of Standards and Technology (NIST), cloud computing is “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage,

applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Paul & Ghose, 2012).

2.1.3.1 Its application to sustainability

Cloud computing has led to significant cost efficiencies and operational savings while optimizing resource utilization. However, the potential of cloud-powered technologies to help companies achieve their decarbonization goals has only recently begun to receive attention. The cloud provides virtually limitless computing, storage, and networking capabilities, along with advanced software applications, including increasingly prevalent generative AI solutions. By leveraging these tools on the cloud, companies can gain new decarbonization-related capabilities that would have been too costly or time-consuming to develop on-premises. According to McKinsey research, cloud-powered technologies can accelerate the implementation of 101—or 47 percent—of the 217 representative decarbonization initiatives needed to achieve the global 1.5° pathway by 2050. These technologies could contribute to abating up to 32 metric gigatons of CO₂ equivalent (GtCO₂e), nearly half of the total 65 GtCO₂e required to reach net-zero emissions by 2050 (Betley, et al., 2023). Many companies already recognize the cloud’s potential to reduce IT-related carbon emissions. Cloud computing enhances efficiency and cost savings by migrating applications to ultra-efficient data centers powered by renewable energy, thus reducing IT carbon emissions (Müller, Sonehara, Echizen, & Wohlgemuth, 2011). Moreover, digital twin technology, which utilizes IoT sensors, helps transition physical assets to more efficient, low-emission alternatives by providing real-time insights into asset performance. This leads to reduced energy consumption and faster transitions. Cloud-based machine learning models optimize the use of resources such as materials, energy, and labor, and support complex simulations. These models aid in product redesign and efficient energy transition planning, significantly reducing costs and emissions in manufacturing and transportation sectors. Finally, cloud-powered technologies facilitate compliance with evolving sustainability regulations by improving data collection, reporting, and target setting. These technologies help companies establish realistic sustainability targets, avoid greenwashing, and streamline the compliance process, particularly with regulations like the EU’s Corporate Sustainability Reporting Directive (CSRD) (Betley, et al., 2023).

With increasing sensitivity toward environmental issues, companies are now expected to take greater responsibility in making sustainable development a reality. Cloud computing, given its significant role in reducing carbon emissions, offers substantial benefits to both companies and society. Consequently, it is prudent for companies to reconsider their business plans to

incorporate sustainable development strategies into their organizational frameworks (Issa, Chang, & Issa, 2010).

2.1.4 Social technology

Another technology, now well established, is social media. Since their emergence, social network sites like Facebook, MySpace, Bebo, and Cyworld have attracted thousands and thousands of users who have seamlessly woven these new platforms into their daily routines. Social networks are defined as web-based services that enable individuals to create a public (or semi-public) profile within a confined system, compile a list of users with whom they share connections (called 'friends' or 'followers'), and explore and navigate their list of connections and those made by others within the system (Boyd & Ellison, 2008). Today social media are instrumental in the digital transformation of businesses. They play a key role in enhancing the relationship between companies and customers; for instance, customers are now more connected with their favorite brands, making them better informed about product options and more influential in buyer-selling interactions (Dwivedi, Ismagilova, Rana, & Raman, 2021). Additionally, social media enable organizations to incorporate SNS into their business strategies, resulting in benefits such as increased customer traffic, greater customer loyalty and retention, improved brand awareness, and enhanced reputation (Sivarajah, Irani, Gupta, & Mahroof, 2020).

2.1.4.1 Its application to sustainability

Social network can significantly improve sustainable business models by fostering customer engagement, improving service quality, and driving innovation. Instagram, Facebook, Tik Tok and many others social media help businesses to gather real-time feedback, understand customer needs, and adapt their products and services accordingly, leading to increased satisfaction and loyalty (Lacy & Rutqvist, 2015). Analyzing social media data provides valuable insights into market trends and consumer behavior. Businesses can use these information to identify emerging needs, tailor their marketing strategies, and develop new products or services that align with sustainable practices. This approach ensures that business offerings are not only current but also responsible. Moreover, social media can be a powerful tool for educating consumers about sustainability issues and promoting responsible consumption (Pappas, 2018). Campaigns that highlight the environmental and social impacts of products can significantly influence consumer behavior towards more sustainable choices, thereby fostering a culture of sustainability. In times of crisis, such as environmental disasters or social issues, social media provides a quick and effective way to communicate with

stakeholders: timely updates and proactive engagement can mitigate negative impacts and demonstrate a company's commitment to sustainability.

2.1.5 Big Data Analytics

The digital age has ushered in an era of unprecedented data generation. By 2025, estimates suggest a daily deluge of 463 exabytes – a number so vast it surpasses human comprehension (Desjardins, 2019). This explosion stems from our online interactions, social media footprints, and the constant whirring of server logs. This avalanche of information has birthed a new challenge – big data – and with it, a powerful solution – big data analytics (Singh & Singh, 2012). Big data analytics is the art of extracting hidden gems from this massive information trove. It is like sifting through a mountain of sand to uncover glittering gold nuggets.

2.1.5.1 Its application to sustainability

Through advanced technologies like machine learning and artificial intelligence, big data tools unlock valuable insights that were previously obscured. These insights empower businesses and organizations to make data-driven decisions that are not only faster and more efficient but also environmentally responsible, aligning perfectly with the objectives of sustainable development (United Nations, n.d.). Environmental monitoring is a prime example of big data's transformative power. Real-time data from satellite imagery, drones, and strategically placed sensors equips governments and NGOs with the power to track deforestation, illegal fishing, and other environmental threats with unprecedented speed and accuracy. This allows for quicker intervention and better resource allocation, safeguarding our precious planet. Big data is also revolutionizing agriculture. By analyzing a multitude of factors – weather forecasts, soil conditions, temperature, moisture levels, and even expected harvest times – automated systems can optimize irrigation and fertilizer application. This data-driven approach minimizes waste, reduces water usage, and promotes sustainable farming practices, leading to a future where we can cultivate more with less (Vijay & Fekete Farkas, 2018).

The rise of the Internet of Things (IoT) and the Internet of Services (IoS) has transformed the way businesses interact with customers. These interconnected devices create a direct line of communication, allowing companies to collect and analyze vast amounts of data on customer preferences and buying habits. Big data analytics empowers businesses to leverage this knowledge to personalize services and product offerings, leading to a more satisfying customer experience and ultimately, increased customer loyalty (Parmentola & Tutore, 2023).

The marriage of big data and IoT also offers innovative solutions for urban planning and environmental management. By analyzing anonymized mobile network usage data, we can gain valuable insights into traffic patterns and population movement. This information can be used to optimize public transportation systems, reducing congestion and emissions. Additionally, projects like Telefónica's big data initiative in São Paulo demonstrate the potential for predicting traffic pollution, allowing cities to take preventive measures and create a cleaner, healthier environment for all (Granryd, 2018). Big data analytics stands as a cornerstone tool for navigating the complexities of the digital age. Its applications extend far beyond the examples mentioned here, influencing everything from healthcare to finance to scientific research. By harnessing the power of big data, we can unlock a future with better decision-making, increased efficiency, and a more sustainable approach to living on our planet. Big data is not a challenge to be overcome, but rather an opportunity to be seized, paving the way for a brighter tomorrow.

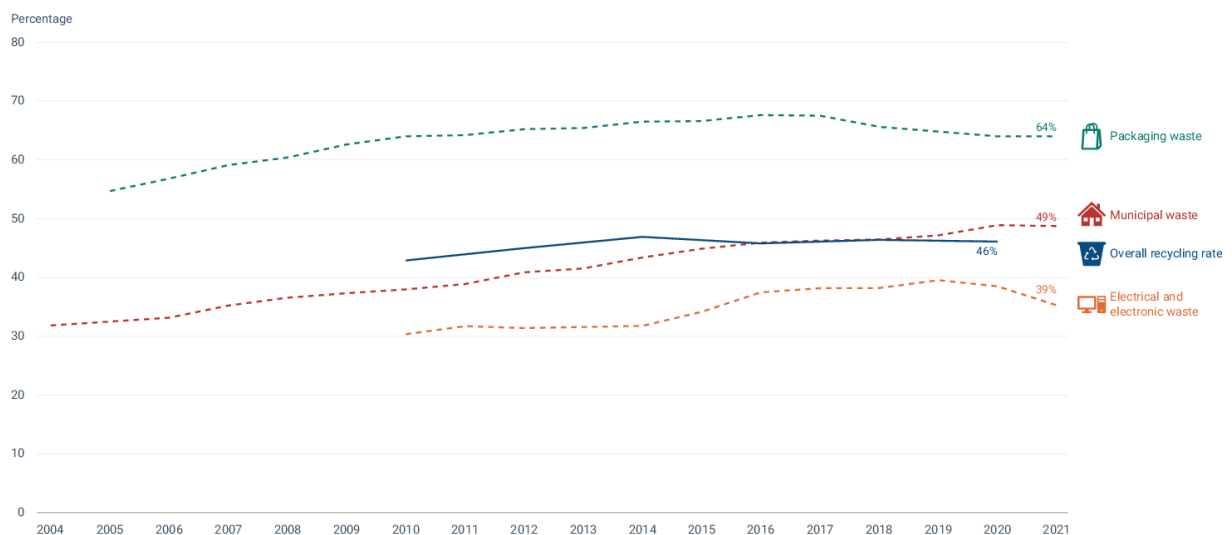
2.2 Physical technology

Engineering technologies encompass a diverse range of fields and specializations that apply scientific principles to the design, development, and improvement of systems, devices, and processes (Lucietto, Tan, Russell, & Johnson, 2020). Unlike digital technologies, which primarily revolve around software and information systems, engineering technology is tangible and physically existent. Due to the immense growth and influence of the software industry, the term "technology" has become almost synonymous with digital technology. Therefore, to distinguish these two domains, we can use the term "physical technology" to specifically refer to technologies that extend beyond software and include tangible engineering innovations (Spacey, 2023). According to Peter Lacy and Jakob Rutqvist there are three main types of engineering technologies that are especially important to effectively deploying circular business models and can be helpful in gathering sustainability: advanced recycling, modular design, and life and material sciences (Lacy & Rutqvist, 2015).

2.2.1 Advanced recycling

The EU's ambitious recycling targets, such as the Packaging Directive which aims to prevent the generation of packaging waste and promote reuse or other forms of recovery of packaging, setting a target of 70% recycling by 2030 (European Recycling Platform, 2023), the commitments of the chemical industry and brands, as well as the demands of customers are placing immense evolutionary pressure on the recycling sector (Advanced Recycling

Conference, 2024). As shown in the figure below, recycling rates for waste categories such as municipal, packaging, and electronic waste in the EU have been gradually rising, signaling progress toward a more circular economy. In 2020, the overall recycling rate, defined as the proportion of total waste generated (excluding major mineral wastes) managed through recycling, was 46%. In 2021, packaging waste achieved the highest recycling rate at 64%, followed by municipal waste at 49% and electronic waste at 39% (European Environment Agency, 2023).



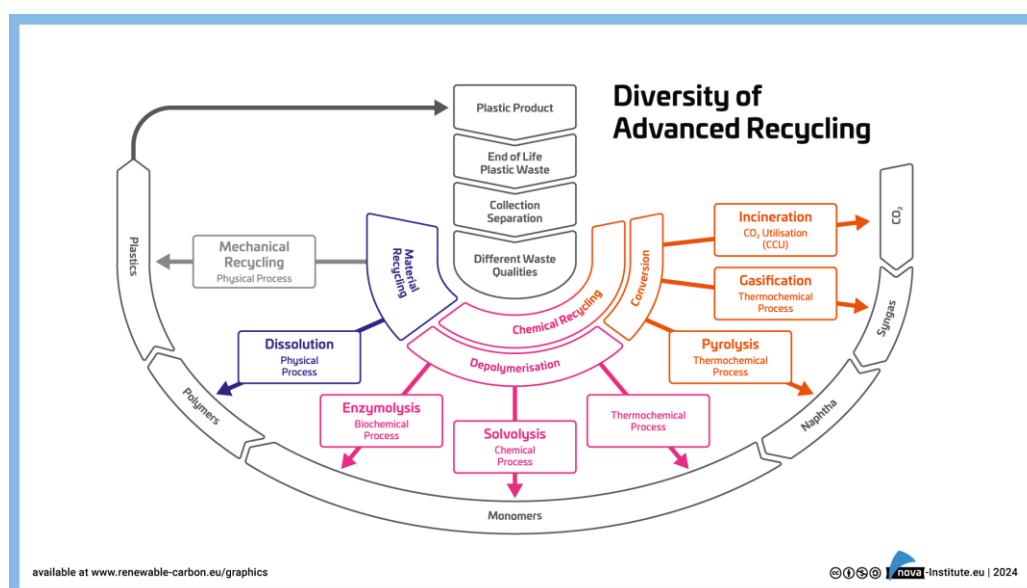
As previously mentioned, EU targets are fundamental drivers of increasing recycling rates. Other directives imposed by the EU include the Waste Electrical and Electronic Equipment (WEEE) Directive, which sets targets for the separate collection and recycling of electronic and electrical waste, and the Waste Framework Directive, which includes targets for the recycling and preparation for reuse of municipal waste. Altogether, EU waste legislation encompasses over 30 mandatory targets for the years 2015-2030 (European Environment Agency, 2023).

2.2.1.1 Its application to sustainability

As always, new technologies can improve recycling efficiency: aside from traditional mechanical recycling, and in light of recent discussions on improving recycling rates, a broad range of advanced recycling technologies is gaining attention. Mechanical recycling alone provides limited options; therefore, both its further development and the advancement of new technologies will continue, underscoring the necessity for a diverse array of complementary recycling solutions. Mechanical recycling cannot remove contaminants from plastic waste streams, which is why mechanically recycled plastics are not approved for food contact applications. Additionally, repeated mechanical recycling degrades the material's quality and performance characteristics, depending on the number of recycling cycles and the specific

polymer. For this reason, in fact, materials such as plastic are defined as downcyclable: this means that plastic has a limited number of recycling cycles (Eriksen, Pivnenko, Faraca, Boldrin, & Astrup, 2020). These issues cannot be resolved through mechanical recycling alone. An even greater limitation arises from the raw materials that can be used. In cases of mixed plastic waste or mixed waste containing various plastics and organic matter, mechanical recycling is not viable or only offers partial solutions with significant pre-treatment efforts. Consequently, these waste streams often end up in landfills or are incinerated rather than being further processed into new feedstock. This highlights the critical importance of advanced recycling technologies for the circular economy (Recycling magazine, 2024).

With advanced recycling techniques, a variety of adaptable technologies are available to manage different types and qualities of plastic waste. These technologies transform plastic waste into various raw materials that can be reintegrated into different stages of the polymer and plastics value chain (refer to the figure below). These methods include dissolution-based material recycling, a physical process that yields polymers. Additionally, there are several chemical recycling technologies capable of breaking down specific polymers into their basic units (monomers) through enzymatic processes (biochemical), solvent-based processes (chemical), and thermal depolymerization (thermochemical). Another set of chemical recycling technologies involves thermochemical processes, currently offering the highest capacities. These methods utilize pyrolysis, gasification, and incineration combined with Carbon Capture and Utilization (CCU) to convert plastic waste into secondary valuable chemicals, naphtha, syngas, and CO₂, which serve as raw materials for producing new polymers (Recycling magazine, 2024).



These innovative technologies are essential for cultivating a circular economy, where materials are continually recycled back into production processes. This approach not only reduces waste generation but also fuels innovation and economic growth within the recycling sector. Furthermore, it broadens the spectrum of recyclable materials, reduces dependence on virgin resources, and helps mitigate environmental impacts linked to waste disposal.

2.2.2 Modular design

Modular design involves breaking down complex systems into simpler modules to better manage intricate designs and processes. Martin Kenneth Starr first introduced this concept, suggesting the use of modular products in production as a novel approach to develop variety. This allows for modifications to specific modules to meet new requirements without affecting the core infrastructure, thereby decomposing complex issues into manageable parts (Tseng, Wang, & Jiao, 2019). From a product management perspective, the modular system is overseen as an integrated whole, ensuring that individual technical projects for module variants do not compromise the overall value creation of the modular product portfolio for both the company and the customer (Pakkanena, Juutia, Lehtonen, & Mammela, 2022). This approach is crucial in the context of current market production patterns: while mass production has evolved into customized production, we are now in an era of personalized production. Consequently, manufacturers must be able to respond swiftly and with increased flexibility: modular design meets these changing customer demands and cost constraints (Habib, et al., 2023).

2.2.2.1 Its application to sustainability

Modular design can also offers significant benefits in terms of sustainability and the circular economy. It has gained renewed importance as a design strategy aimed at drastically reducing waste by designing products from a 'make to remake' perspective, facilitating disassembly to extend product life and, as a last resort, recycling materials into high-quality secondary materials (Pietroni, Di Stefano, & Galloppo, 2023). The fundamental principle of modular design is to enable the combination of distinct modules through defined interfaces to create products. For instance, Xerox has pioneered the design and operation of circular product lifecycles for its printers and photocopiers. The table below illustrates Xerox's transition from selling printer and copier products to offering office automation services (pay per use). The savings from remanufacturing were doubled when Xerox adopted a modular design for its copiers (Kwant, n.d.).

	Xerox 5100 Copiers (Non-modular)		Xerox DC 265 Copiers (Modular)	
	% Saving	Reduction Factor	% Saving	Reduction Factor
Material Consumption (kg)	25	1.3	49	1.9
Energy Consumption (MJ)	27	1.4	68	3.1
Water Consumption (l)	19	1.2	38	1.6
Landfilled Waste (kg)	35	1.5	47	1.9
CO ₂ Equivalents (kg)	23	1.3	65	2.9

There are various concepts related to this topic, but according to Stewart and Yan, the key characteristics of modularity include structural independence, functional independence, minimized interfaces and interactions with other modules, and reduced external influences. Modularity supports upgrades, adaptations, modifications, and easy assembly and disassembly of products. It also enhances product variety, enables economies of scale, and reduces production time (Sonego, Echeveste, & Debarba, 2018).

2.2.3 Life and material sciences technology

Materials provide the essential foundation for our sophisticated society. Significant advancements in materials science and engineering over the past centuries have resulted in the development of intricate and high-performing products, construction methods, and technologies (Berggren, et al., 2022). Nowadays, technologies from life and material sciences are fundamental in shaping new sustainable business models.

Materials science is a field of research focused on the discovery, design, and characterization of novel materials. It delves into the chemistry of life, examining the structure and properties of materials at the molecular or atomic level. Manipulating these structures at such a microscopic scale opens up numerous possibilities for altering materials' characteristics and creating desired properties (Lacy & Rutqvist, 2015). Initially, materials science was largely derived from metallurgy and the study of minerals and ceramics; however, recent breakthroughs in high-tech materials have expanded its classification to include semiconductors, functional materials, biomaterials, heterostructures, reduced-dimension materials, topological materials, and nanomaterials (Berggren, et al., 2022).

2.2.3.1 Its application to sustainability

There are numerous innovative ways that materials science will drive us towards a cleaner and healthier future. For example, the advent of new chemical configurations and

compositions to produce advanced materials is already paving the way for a future defined by innovation and sustainability. Entrepreneurs and scientists are combining their intellect and creativity with chemical compounds to enhance buildings' capabilities to combat pollution and mitigate climate change (Forbes, 2024).

Globally, people and businesses are committed to developing materials that will significantly impact our way to produce new products and services. For example, polymers (like plastics) and soft materials such as foams, emulsions, and gels are being further refined for various consumer products and high-tech applications that enhance both business and environmental performance. Nanotechnology and nanomaterials present huge opportunities for sustainable technologies: from conserving raw materials, energy, and water to reducing greenhouse gases and excess waste, nanotechnology in various products, processes, and applications can support environmental and climate protection. Industrial waste, which poses a severe environmental hazard, can be converted into advanced materials with the potential to reduce CO₂ emissions. Finally, innovations such as acid-enhanced fertilizers to boost agricultural yields and improved plastics to cut transformation costs are also emerging (Forbes, 2024).

In conclusion, materials science is at the forefront of driving technological progress and sustainability. The ongoing research and development in this field hold the potential to revolutionize various industries, leading to a cleaner, healthier, and more sustainable future. As we continue to explore and innovate, the intersection of materials science with life sciences and other technologies will undoubtedly yield transformative solutions for some of the most pressing environmental challenges of our time.

2.3 Hybrid technologies

Hybrid technologies represent the convergence of digital intelligence and physical engineering, offering a new approach to managing materials and assets (Lacy & Rutqvist, 2015). By combining the power of data-driven insights with precise physical control, companies can achieve unprecedented levels of efficiency, sustainability, and innovation. Moreover, by leveraging the strength of both realms, hybrid technologies enable a comprehensive and dynamic method of overseeing the lifecycle of materials and goods which, as we know, it is fundamental to create new sustainable business models. According to Peter Lacy and Jakob Rutqvist the most promising hybrid technologies are 3D printing and trace and return systems.

2.3.1 3D Printing

Three-dimensional (3D) printing is an innovative technology revolutionizing manufacturing by creating three-dimensional objects layer-by-layer under computer control. This method offers significant advantages over traditional techniques, including the ability to produce highly customized products, complex structures, and lightweight designs due to the expanded freedom of design it affords (Khan, Koç, & Al-Ghamdi, 2021). Furthermore, 3D printing boasts benefits in speed, flexibility, sustainability, risk reduction, and accessibility, making it a valuable tool across numerous industries (Nadagouda, Ginn, & Rastogi, 2020).

2.3.1.1 Its application to sustainability

The economic and environmental benefits of 3D printing are extensive. One key advantage is the ability to use only the necessary amount of material, minimizing waste and reducing both material and production costs (Sandhu, Singh, Prakash, Subburaj, & Ramakrishna, 2022). This technology's versatility extends to various sectors, with the construction industry presenting a particularly compelling case study. The construction sector, in fact, faces a growing challenge: the vast amount of waste it generates. Recent research suggests that 3D printing with recycled construction and demolition waste (CDW) as a building material can offer significant environmental advantages. Compared to traditional brick-and-mortar construction and even 3D printing with virgin materials like concrete, using recycled CDW can dramatically reduce a building's environmental footprint. The key lies in geopolymers, a new class of sustainable building materials created by recycling waste materials. Moreover, studies show that 3D-printed structures using CDW-based geopolymers boast a lower global warming potential than traditional methods, translating to a significant reduction in greenhouse gas emissions associated with construction activities. Additionally, by utilizing recycled waste, this approach reduces our reliance on virgin materials, lessening the environmental impact of resource extraction and processing (Khan, et al., 2023).

Beyond construction, 3D printing fosters sustainable industrial practices by improving operating efficiency. This new technology reduces costs associated with design, production, inventory, storage management, distribution, and transportation. Additive manufacturing, as 3D printing is also known, eliminates unnecessary supply chain operations and the need for additional tools. Furthermore, it enables the repair and remanufacturing of obsolete or damaged tools and dies, eliminating scrap and environmentally hazardous processes (Sandhu, Singh, Prakash, Subburaj, & Ramakrishna, 2022).

In conclusion, 3D printing presents a transformative technology with the potential to revolutionize various industries. Its ability to utilize recycled materials and minimize waste makes it a powerful tool for promoting sustainable practices.

2.3.2 Trace and return system

The burgeoning online retail landscape faces a growing challenge: high product return rates. This stems from the inherent limitations of remote transactions, where customers might order multiple items with the intent to keep only one, or where the inability to physically interact with products before purchase leads to a higher likelihood of returns (Frei, Jack, & Krzyzaniak, 2020). These returns pose an important obstacle to businesses, impacting profitability and creating logistical headaches. Sustainable businesses, particularly those embracing the principles of a circular economy, require innovative solutions to address these return challenges. For this reason trace and return systems offer a promising approach. These systems, encompassing both digital and physical components, enable the tracking and movement of products from end-users back to the manufacturer or a designated third-party (Lacy & Rutqvist, 2015). At the core of a trace and return system lies a user-friendly return portal. This online platform empowers customers to initiate return requests seamlessly. Once a return request is submitted, the system assumes control, meticulously tracking the product's journey back to its origin.

2.3.2.1 Its application to sustainability

This comprehensive tracking provides real-time status updates, facilitates inventory adjustments, automates refunds, and generates valuable data reports on return trends (ReturnGo, 2024). The true strength of trace and return systems lies in their ability to promote a more cost-effective approach to handling returned goods. The system empowers a shift from simple disposal to a focus on recovering value. Through efficient sorting technologies, trace and return systems enable the identification of returned products suitable for servicing, repair, refurbishment, or even recycling. This not only minimizes waste but also facilitates the reintroduction of valuable materials back into the production cycle (Lacy & Rutqvist, 2015). Additionally, the ability to remotely evaluate returned goods through the system fosters scalability in reverse logistics, a crucial aspect of managing large-scale returns in online retail. In conclusion, trace and return systems offer a compelling solution for sustainable businesses navigating the complexities of online product returns. By facilitating efficient return processes, promoting value recovery, and enabling the adoption of circular economy

principles, trace and return systems empower businesses to operate more sustainably while enhancing customer satisfaction through a streamlined return experience.

2.4 Conclusions

Twin transition is no more a myth. The dual approach between sustainability and new technologies is increasingly recognized as a powerful strategy for achieving long-term sustainability and competitive advantage. The digital transition is an ongoing process that continues to transform the way we live: in fact, it has the potential to further transform dominant practices in the economy and society. On the other hand, the green transition is an opportunity to transform today's unsustainable activities towards a just future (Muench, Stoermer, & Jensen, 2022). This chapter has explored the transformative power of various digital and physical technologies in empowering businesses to adopt sustainable practices. The digital revolution offers a plethora of tools and methodologies that can be leveraged to achieve significant environmental benefits. In order to summarize, the table below shows the technologies discussed in the chapter and the related inputs that they offer to companies that aim to operate in a more sustainable manner.

Type of technology	Name	Impact to sustainability
Digital	Mobile technology	- Promotes sharing economy: connects strangers for exchanging goods - Deliver inexpensive services to low-income and distant people - Expand access to renewable energy: uses pay-as-you-go systems - Enhances quality of life by providing universal and low-cost access to data and applications - Reduces the need for physical infrastructure and material resources through digitalization
Digital	Machine-to-machine communication technology	- Energy management: creation of smart grids for optimized energy distribution - Agriculture: precise monitoring of weather conditions and efficient application of water, fertilizers, etc. - Industry: reduction of scrap rates and improvement of quality - Transportation and logistics: real-time tracking
Digital	Cloud computing	- Reduces operational costs by optimizing resource utilization - Migrates applications to ultra-efficient data centers powered by renewable energy, lowering IT-related carbon emissions - Provides virtually limitless computing, storage, and networking capabilities - Facilitates compliance with sustainability regulations by improving data collection, reporting, and target setting - Machine learning models optimize the use of materials, energy, and labor
Digital	Social technology	- Educates consumers about sustainability issues and promotes responsible consumption - Demonstrates a company's commitment to sustainability - Improves service quality by tailoring products and services to

		meet emerging needs
Digital	Big Data Analytics	- Data-driven decisions are faster, more efficient and environmentally responsible - Environmental monitoring: real-time tracking of deforestation, illegal fishing, etc. - Analysis of traffic patterns and population movement to optimize public transportation system, which lead to reduction of congestion and emissions - Quick intervention and better resource allocation to safeguard the environment
Physical	Advanced recycling	- Handles a wider variety of materials, improving overall recycling rates - Produces higher quality recycled materials and prevents degradation of materials through repeated recycling cycles - Reduces the volume of waste reducing pollution and environmental damage - Reduces dependence on virgin resources by creating new raw materials from waste
Physical	Modular design	- Facilitates disassembly to extend product lifecycles and allows for recycling into high-quality secondary materials - Facilitates repair and maintenance - Minimizes material use and optimizes resource consumption
Physical	Life and material sciences technology	- Enhance building's capabilities to combat pollution and mitigate climate change - Nanotechnology and nanomaterials conserve raw materials, energy and water - Transforms waste into advanced materials, reducing CO2 emissions - Acid-enhanced fertilizers boost agriculture yields
Hybrid	3D printing	- Uses only the necessary amount of material, minimizing waste - Reduces greenhouse gas emissions associated with construction activities - Fosters innovation and supports circular economy principles
Hybrid	Trace and return system	- Shifts focus from disposal to value recovery, reducing costs associated with waste - Identifies products suitable for serving, repair, refurbishment, or recycling

By strategically integrating these technologies into their operations and fostering a culture of environmental responsibility, businesses can contribute to a cleaner planet while simultaneously enhancing efficiency, innovation, and customer satisfaction (Eugenio, et al., 2023). This win-win scenario underscores the fundamental role that technology can play in building a more sustainable and prosperous future for all.

Chapter 3: Sustainable Business Models and the Second-Hand Market

3.1 Six new sustainable business models

As anticipated earlier in the first chapter, the growing shadow of environmental degradation and social inequality underscores the need for a transformation towards a more sustainable economic system (Geissdoerfer, Vladimirova, & Evans, 2018). We already consume more resources than the world can regenerate, therefore we must develop methods to use less energy, water, materials, and resources in general. That is why transitioning from the present linear model of the economy to a circular one has lately gained significant interest from big global corporations, such as Google, Unilever and Renault (Lewandowski, 2016). Sustainability challenges and regulations drive enterprises to rethink how they organize, manage, collaborate, and interact with new and diverse stakeholders and ecosystems. This shift is prompting the development of new theoretical models and empirical research to better understand and implement sustainable business practices in an interconnected global society. These new models must transcend traditional institutional boundaries and national borders to address the complex and multifaceted nature of global sustainability challenges (Aagaard, 2019).

Green and Sustainable Business Models (GnSBMs) are developing as important frameworks for incorporating economic, social, and environmental principles into core operations. Unlike traditional business models, GnSBMs put sustainability first by including socio-environmental issues into their value propositions. This method seeks to create, deliver, and collect value not only economically, but also in ways that benefit society and the environment. The increase of GnSBMs can be due to a combination of external pressures and technological advances. In fact, on the one hand, growing worries about climate change, resource depletion, and social inequity have prompted governments and society to demand more sustainability from enterprises: for example regulatory frameworks, environmental laws, and stakeholder expectations are coming together to form a strong economic case for implementing GnSBMs. On the other side, the rise of disruptive technologies such as blockchain, digital sharing platforms, and renewable energy solutions has enabled firms to rethink their operations and create innovative, sustainable models. These technologies give the tools and infrastructure required to develop new value propositions that are consistent with environmental and social objectives (Najmae & Sadeghinejad, 2023).

Lacy and Rutqvist propose five new business models for circular growth: circular supply chain, recovery and recycling, product life-extension business model, sharing economy business model and product as a service business model (Lacy & Rutqvist, 2015). There is also another important business model that is gaining important success among companies, which is re-commerce. The characteristics of each of these models will be explored below.

3.1.1 Circular supply chain

In today's intensely competitive, international economy, characterized by demanding consumers and fast developing products and services, organizations must excel at managing processes, information, and connections that frequently cross-national borders. The effective management of complex supply chain interactions is a critical component of success in this climate (Montag, 2022). According to Ahi and Searcy Sustainable supply chain management is the practice of incorporating economic, environmental, and social issues into the key business processes that regulate the purchase, manufacture, and distribution of products and services. By doing so, organizations can meet stakeholder requirements while enhancing their profitability, competitiveness, and resilience in both the short and long term. Sustainable supply chain management is thus fundamental for companies striving to maintain a competitive edge and achieve long-term success in an increasingly complex and demanding market landscape (Ahi & Searcy, 2013). In other words, a circular supply chain is a production model designed to be regenerative and sustainable: this model involves taking back products at the end of their lifecycle and reusing them as raw materials for new production. Circular supply chains require three things (Ellen Macarthur Foundation, 2023). First, they must have distributed and interconnected networks. These networks enable collaboration with a wide array of local and global partners, including suppliers, customers, and industry peers, and such collaboration ensures that the resources and expertise needed to repurpose materials are readily available. Second, circular supply chains depend on the multidirectional flow of information, goods, and money. This means that data about the location, material composition, and potential for disassembly of products must be shared seamlessly among all network partners. This transparency ensures that materials can be efficiently retrieved and reprocessed. Lastly, the ability to capture and deliver value by keeping products and materials in use. This involves designing products for longevity, easy disassembly, and reusability. It is important because by doing so, companies can maintain the value of materials, reducing waste and the need for virgin resources.

A painful reminder of traditional linear supply networks' fragility has been forcefully given by recent geopolitical shocks and economic uncertainty, reviving interest in the concept of circular supply chains as the basis of corporate resilience. One such remedy lies in the fact that circular supply networks reduce the reliance on natural resource extraction and create security in material supply, with reduced price volatility. A good example of circular business models in supply chains is found in the global textile and apparel industry. This industry is notoriously resource-intensive, coupled with complex linkages of suppliers, and associated lack of transparency that very often gives rise to huge environmental degradation and unethical labor abuses, coupled with waste intensification. Since fast fashion and its seasonal trends breed wastefulness, so too does a large proportion of textile waste in the United States end up in landfills. In response to these issues, Rien Otto, the creator of Dutch aWEARness, set out to transform the business by embracing fair trade methods, utilizing organic cotton, and conducting life cycle analyses to investigate alternative materials. In 2010, Otto met Michael Braungart, a pioneer of the cradle-to-cradle (C2C) concept, who encouraged Otto to apply C2C ideas to the textile supply chain. The opportunity was created by Backhausen, who is an Austrian business using recyclable polyester to produce furniture certified as C2C. Otto used this breakthrough to create a way for using recyclable polyester, known as Returnity, in apparel manufacture. This procedure entails collecting worn-out clothing, shredding them into fibers, spinning the fibers into new yarns, and weaving them into new fabric. Surprisingly, this procedure may be performed indefinitely without compromising material quality. In fact, Dutch aWEARness manufactures garments out of 100% recyclable polyester, considerably lowering environmental effect. Their manufacturing approach uses 95% less water, 64% less energy, and produces 73% less carbon emissions per garment than standard cotton production. This example not only demonstrates the actual implementation of circular supply chains in a resource-intensive business, but it also emphasizes the environmental and economic benefits that can be obtained via innovative, sustainable methods (European Union, 2014).

3.1.2 Recovery and recycling

One of the prime drivers of environmental degradation is our current economic model, exemplified by a "take, make, dispose" mentality. Production and consumption patterns are unsustainable and result in resource depletion and pollution due to large quantities of waste generation. In this light, the idea of the circular economy becomes very interesting because it bolsters the concept of a closed-loop system by revaluing waste as a resource. Thus, at the heart of the circular economy lies the goal of minimizing the use of virgin materials while maximizing reuse and recycling, reducing its ecological footprint dramatically (Calvo-Porrall

& Lévy-Mangin, 2020). The Recovery & Recycling model is one of the cornerstones of the circular economy. It fundamentally re-imagines traditional production and consumption systems, turning what was once treated as waste into new business opportunities. Firms can recover end-of-life products for recapture of valuable components and materials, or reclaim by-products created during manufacturing; this model thereby lengthens the life cycle of resources, reduces the need for virgin raw materials, and sets the parameters for a more sustainable economic system (Lacy & Rutqvist, 2015). From the strictly economic point of view, direct reuse and recovery is always preferable to recycling, whenever possible. This is because much of the added value from the original product manufacture is preserved in the reused components (Lahti, Wincent, & Parida, 2018). Of major importance, however, is the differentiation of the different forms of material reintroduction: upcycling, recycling, and downcycling. Though all have the same overall effect on the achievement of a more circular economy, they differ in other ways. Upcycling is the best-case scenario in which waste materials are reworked into other new products with higher values than the original. In this way, upcycling gives life to materials that have been discarded: “It can be purely artistic, scientific, or anything simply useful” (Pol, 2010). Upcycling is based on sustainable consumption, and the main idea is to revitalise old material by placing it into new constellations and by suggesting new ways of using it while, at the same time, keeping its essence intact as a main value-adding feature of the process (Wegener, 2016). On the other hand, recycling is done in a manner where the material would be reprocessed into its pure, original form and it is ready for use again. An example is aluminum metal, which can be recycled infinitely without losing much in regard to its quality. The final stage is downcycling, whereby materials end up in the form of products of lower qualities. In spite of the reduction of waste generated in this process, the material itself loses some value and, at the end, cannot be further recycled to its original form. An example could be turning plastic bottles into carpets or fabric (Helbig, et al., 2022).

Regardless of the method in question, recovery and recycling bring many benefits to companies and consumers alike. Businesses will make radical savings in the reduced fees for waste disposal and the potential money earned from selling recovered materials. Besides, through reusing, companies will reduce dependence on virgin materials, hence reducing their environmental impact. On the other side, consumers are also gaining with this business model of Recovery & Recycling. For example, increasingly companies come up with facilities for take-back and recovery that, in most cases, have pick-up services, drop-off facilities, or even buy-back schemes. In such a way, consumers are allowed to remove unneeded products without much hassle, sometimes even with a financial gain from such actions. In these ways,

businesses and consumers move into mutual win, encouraging good practices in responsible waste management (Lacy & Rutqvist, 2015).

Ultimately, the Recovery & Recycling model is a critical element of a sustainable economy—circular economy. The fact that this strategy places value on use, rather than waste, has therefore served to increase resource efficiency and thus contributed further to achieving a more sustainable economic system. Circular economy brings across an effective, alternative pathway to today's unsustainable consumption model of economic growth, opening toward a future where waste would become a resource.

3.1.3 Product life-extension business model

Within the past century, product lifetimes have become shorter and shorter, and there is no indication that such development will come to a halt anytime soon. Planned obsolescence is a business strategy incorporated into the design phase of products to systematically and rapidly make them inadequate and in need of frequent replacement. This strategy encourages repetitive consumption through three simple mechanisms: shortening product lifetimes by using weak materials; making products increasingly non-repairable; and integrating psychological elements through the designing of constant consumption based on changing styles and fashion. Green and Sustainable Business Models have developed in response to this challenge of obsolescence by addressing product life extension as a resource efficiency strategy. This approach aims at returning products to some functional state for a second life, while maintaining part of their market value (Milios, 2021) . As argued by John Donahoe, at the time of writing CEO of eBay Inc.: “The greenest product is the one that already exists, because it doesn’t draw on new natural resources to produce” (eBay Inc., 2014). Businesses applying this concept are interested in designing products to last and thereby open up the market for previously used goods. This would correspond to using the product for an extended period of time through service loops involving reuse, maintenance, repair, technical upgrades, or a combination of these strategies.

"Design for Maintenance and Repair" is an important concept, as it ensures that products are kept at their best conditions. Maintenance refers to the activities of inspection and servicing performed to retain the functional capabilities of products, while repair deals with bringing a product back to good working condition after decay or damage. Another strategy in this course is making a product upgradable for future expansion and modification so that under changing conditions, it is able to stay useful by enhancing its quality, value, and performance. “Design for standardization and compatibility” involves the development of products whose parts or interfaces match other products to enable easier upgrading and repair. Likewise,

"Design for dis- and reassembly" ensures that products and parts are easily separable in order to be put together again, hence increasing the rate of material and component reuse in the future (Bocken, Pauw, Bakker, & Grinton, 2016).

Because a longer product lifespan means fewer purchases over time, this may seem like a bad idea for original-equipment manufacturers. However, durability justifies premium pricing, as companies like Patagonia and Miele have done for long-lasting outdoor clothing and luxury home appliances, respectively. Second, PLE stops the degradation of the customer base to that of rivals. For instance, Bosch Power Tools gives its used tools a second life by remanufacturing, thereby elongating their lifetime and making them competitive with new products from low-cost/low-quality producers (Atasu, Dumas, & Wassenhove, 2021).

3.1.4 Product as a Service business model

A service-oriented approach revolutionizes the way firms interact with their value chain, consumers, and overall market strategy. While companies have long provided services in addition to their goods, it is only in recent years that the potential for product and service integration has been fully recognized as a method of driving development and increasing competitiveness. Different research communities have addressed this integration under different terminologies, such as "servitization," "service-dominant logic," and "product-service systems" (Barquet, Oliveira, Amigo, Cunha, & Rozenfeld, 2013). Despite the different terminology, all these concepts tend to refer to some basic notion, which may be explained as follows: a product-service system (PSS) is a business model wherein the manufacturer sells a package of products and services rather than the product alone. PSS may be divided into three categories depending on the service ratio and product ownership: product-oriented, use-oriented, and result-oriented PSS. A product-oriented PSS sells items while also providing maintenance, consulting, insurance, repair, and training. In a use-oriented PSS, the supplier keeps ownership of the goods while selling their usefulness, availability, or function via leasing, renting, sharing, or pooling. Meanwhile, in a result-oriented PSS, the provider sells the product's outcome, which implies that the provider also utilizes the items. For example, selling "comfortable room temperature" instead of air conditioners (Hockerts & Weaver, 2002).

PSS has recently been acknowledged as a pioneering business model capable of transforming production and consumption from a linear to a circular economy. These business models considerably minimize environmental impact by prolonging product life through professional services such as maintenance and repair, which avoids the wasteful disposal of items or

components (Yang & Evans, 2019). Moreover, PSS enhances resource and energy efficiency, as both customers and manufacturers have incentives to maximize efficiency during product use: customers save costs by paying per use or per service unit, while manufacturers, who often own or use the products in result-oriented PSS, aim to minimize material and energy costs (Baines, Lightfoot, & Wilson, 2007). Moreover, PSS business models enable dematerialization: fewer materials and less energy can do the job—with fewer products—to serve more people's needs (Lin, Shih, Lu, & Lin, 2010). It also opens up individualized offers with new functionalities and plurality of product-service combinations, better matching the needs of customers. In fact, PSS-operating companies gain additional differentiation, for both technologies and mass-market products begin to resemble one another. In this vein, through service integration, firms can engender a distinctive offering which would assist in building closer customer links, throwing barriers to entrants, or locking out competitors (Cavalieri & Pezzotta, 2012). In conclusion, the Product as a Service business model presents a powerful paradigm shift for businesses. PSS not only fosters a circular economy and environmental responsibility but also unlocks a new frontier of value creation for both firms and consumers.

3.1.5 Sharing economy

In 2008, San Francisco witnessed the launch of two pioneering platforms that would become cornerstones of the sharing economy: Uber, a co-riding service that coordinates travelers heading to the same destination, and Airbnb, which connects people offering accommodation with those seeking temporary stays (Öberg, 2023). This emergence signaled the beginning of a business model based on the sharing of goods and services, leveraging underutilized resources via technology to maximize social, economic, and environmental benefits (Haqqani, Elomri, & Kerbach, 2022). A study conducted by Hamari, Sjöklint, and Ukkonen tried to define what is collaborative consumption, a synonym for sharing economy, by studying 254 websites related to this concept. These websites were identified after a systematic search of the categories in directory.collaborativeconsumption.org, which aggregates the different platforms on CC and the sharing economy. The researchers mapped these platforms according to different modes of exchange, including sharing, purchasing (both new and second-hand), renting, donating, swapping, lending, and borrowing. The analysis revealed that the activities may be separated into two main categories of exchange: access over ownership and transfer of ownership (Hamari, Sjöklint, & Ukkonen, 2016). The table below summarizes an overview of the results.

Mode of exchange	Trading activity	Monetary transaction	Market allotment	Example
Access over ownership	Renting	Yes	131 platforms	Renttherunway.com
	Lending	No	60 platforms	Couchsurfing.com
Transfer of ownership	Swapping	No	59 platforms	Swapstyle.com
	Donating	No	59 platforms	Freegive.co.uk
	Purchasing used goods	Yes	51 platforms	TheDup.com

Source: Hamari, J., Sjöklint, M., & Ukkonen, A. (2016). The Sharing Economy: Why People Participate in Collaborative Consumption. *Journal of the Association for Information Science and Technology*, 67(9), 2047 - 2059.

The sharing economy facilitates the exchange of goods and services between different parties, enabled by technological platforms that connect those in need of a product or service with those who can provide it. Historically, the concept of pooling resources for high-value goods has been evident within tight-knit communities, but the contemporary sharing economy expands this interaction to individuals who do not know each other, thereby broadening the scope of shared resource utilization. This shift transforms services traditionally offered by accredited firms into those provided by individuals (Barbu & Bratu, 2018). The sharing economy has been defined as a disruptive socioeconomic system that offers considerable challenges to established economic paradigms, which are often centered on hyper-consumption and private ownership. This 'collaborative economy', often known as the sharing economy, aims to encourage a shift away from owning and toward renting, trading, or giving (Česnuitytė, Klimczuk, Miguel, & Avram, 2022).

The sharing economy is a complex and multifaceted concept that encompasses both collaborative production and collaborative consumption. Collaborative production, an important element of this economy, refers to a network of peers who are cooperating in the design, production, or distribution of goods. Collaborative production activities, such as collaborative design and dissemination, rely on sharing economy platforms. These platforms effectively create sharing markets by facilitating trades, with the primary objective of generating profits. The way in which profits are shared and allocated is determined by this goal, leading to increased income and assets for profitable platforms (Schor, 2014). While traditional business models focus on the purchase, leasing, or selling of a product or service, in the sharing economy, collaboration, facilitation, and relationship-building take precedence. This trust, in these relationships, rests on the basis of participants working together to share less intangible assets like money, workforce, knowledge, education, data, and information. It is pro-social by nature because people with similar interests share for common benefits by joining resources (Plewnia & Guenther, 2018). The sharing economy is almost the same as collaborative consumption that takes place in organized systems or networks of people and entities sharing goods, services, transportation solutions, space, and money. This would mean cooperating in renting, lending, trading, buying, selling, and exchanging a variety of goods

and services. Sharing does not just convey the act of sharing; it also means reducing personal costs and using shared goods effectively to reduce the impact on the environment (Möhlmann, 2015).

The sharing economy is now being hailed not only as an economic breakthrough but also as a conduit that can bring about environmental and social benefits (Curtis & Mont, 2020). Through reduced demand for new products, the sharing economy reduces production, thus achieving improved material efficiency. The core underlying concept of the business model is to exploit idle resources better, which inherently brings about resource efficiency: this would trigger more responsible and sustainable use of resources (Laukkanen & Tura, 2020). Moreover, this collaborative nature of the sharing economy has huge impacts on the environment in the form of reduced greenhouse gas emissions and better utilization of physical goods. Socially, it makes new social links easier to create, hence providing a feeling of community and social cohesion for the neighborhoods. The collaboration not only sparks innovation but also has the potential to generate jobs and strengthen communities. By sharing and collaboration, the sharing economy is in a position of bringing the people closer and reinforcing social cohesion towards a more connected society (Görög, 2018).

Generally, by granting businesses new access to resources, this business model provides significant advantages: this includes a substantial reduction in environmental burdens which is a pressing issue in today's business landscape. Sharing cuts down on a huge amount of waste and resource use by pushing resource use efficiencies. Not only does a business more sustainably and efficiently make use of resources by adopting this framework, but it also easily responds to the increasing call of society for environmentally friendly practices.

3.1.6 Re-commerce

Recommerce, popularly known as second-hand or reverse commerce, represents a business model in which a certain used or pre-owned good is resold. In contrast to traditional commerce, where merchandise is sold for the first time, during recommerce, merchandises that were previously owned are bought and resold, often after being refurbished or repaired (Li & Sundararajan, 2024). Reverse commerce was described for the first time in an interview with The New York Times in 2005 by George F. Colony, founder of Forrester Research: it refers to the online resale of used goods through websites specializing in such transactions. Such platforms include eBay and Vinted, for example, where consumers buy and sell secondhand goods; and programs like Amazon Warehouse or Zalando Second Hand, in which brands themselves offer pre-owned products for sale. Re-commerce can take the form of C2C transactions, where a consumer is selling his or her used goods to another consumer, or B2C

transactions, where a company markets refurbished or secondhand goods directly to the consumer, such as the case of Apple's Certified Refurbished program (Bello, n.d.). Although recommerce has been in existence for several centuries, it never had a structured format in the past. People have exchanged all types of goods - from art and luxury items to farm tools and baby clothes - through unofficial markets for quite some time now. Until recently, however, technology developments gave recommerce the structure it needed to finally go professional. The emergence of user-friendly ecommerce platforms, tending to build trust in buyers' minds, significantly catalyzes the growth of this market. The trade that traditionally used to be a casual weekend activity has grown into a thriving industry, underlining the fact that recommerce is now a serious business (Samok, 2024). Moreover, the Covid-19 pandemic, and lockdown in particular, has led to a significant change in people's shopping behaviors: millions of people have approached eCommerce for the first time, discovering the convenience and necessity of online shopping. In this context, the re-commerce business model has seen remarkable growth; for example, many have taken advantage of time spent at home to tidy up, sell forgotten items, or buy second-hand items, contributing to the increased prevalence of this type of sustainable commerce (Il Sole 24 Ore, 2022).

Recommerce over these years has attracted much attention in the retail industry, with various products such as clothing, fashion accessories, electronic gadgets, and books (Sandonnini, 2023). Such growing interest is evidenced by survey data reported by TechCrunch: it estimates that about 82% of consumers worldwide take part in purchasing or selling secondhand products. The appeal of recommerce is driven majorly by the need of consumers to get bargains, thus getting high-quality and often luxurious branded products cheaper. Besides, selling second-hand items gives extra income, which contributes to the popularity of this trend (Albamonte, 2023).

The recommerce economy has obvious benefits. Product resale opens up quality goods that are often new in appearance and functionality to new markets that may otherwise end up in landfills. By very nature, recommerce is sustainable; it extends product lifespan through its contribution to the circular economy and decreases demand for new production. In a world that is setting trends on everything, from fashion to food, where sustainability informs a lot of consumer choices, resellers stand to benefit by positioning themselves as an eco-friendly brand for better value and attractiveness to customers. Further to the environmental benefits, recommerce makes lots of economic sense: customers get to enjoy quality products at a lower price, hence very attractive, especially to budget-conscious customers. For business, recommerce cuts new revenue streams and reinforces customer loyalty through ongoing value exchange well beyond the moment of sale. In buying back and reselling merchandise, a

company initiates a recursive purchase-repurchase cycle that engenders an enduring, closer relationship with their customers (Bigcommerce, 2024).

Recommerce has been an important concept of late in the business world, with sustainability and circular economy practices drawing much attention. The approach enables the extension of a product's life, minimizes waste, and unlocks new revenue streams for the brand. The following sections look into the three different types of recommerce: peer-to-peer marketplaces, in-house branded recommerce, and managed recommerce (Ruben, 2023).

3.1.6.1 Peer-to-Peer Marketplace

The peer-to-peer economy, increasingly powered by digital platforms, has become a significant force in the global economy. This economy of peers directly exchanging goods and services has grown very fast from its traditional sectors like retailing and file sharing into a wide array of human-centric services, be it short-term accommodations and urban transportation, local logistics, peer-to-peer lending, equity crowdfunding, or decentralized manufacturing (Cohent & Sundararajan, 2017). In particular, second-hand peer-to-peer platforms seem to encourage sustainable consumption between consumers by giving objects a second life, avoiding storing them uselessly, compared to other households that buy new ones (Parguel, Lunardo, & Benoit-Moreau, 2016). Precisely, in the fashion industry, these platforms act as digital marketplaces where individuals can list and sell their used clothing directly to others, bypassing traditional retail systems and fostering a community-based approach to buying and selling. The peer-to-peer economy typically has three types of persons involved in the transactions: platforms, entrepreneurs, and consumers. Platforms are peer-to-peer marketplaces that allow people to exchange products and services. Entrepreneurs are individuals or small enterprises that provide goods and services in these marketplaces. Consumers are those who make demands, such as buying, renting, or consuming. Typically, the platform acts as a middleman between the customer and the entrepreneur, charging a commission to one or both parties (Sundararajan, 2014).

While the second-hand market is nothing new, technological innovation has made it much more plausible as a result of drastically cutting down search and transaction costs. The same would not have been possible without the online marketplace, mobile platforms, electronic payments, or two-way reputation systems, which are technologies that allow users to rate providers and vice versa, extending the reach of exchanging opportunities beyond local networks to include distant strangers (Benjaafar, Kong, & Li, 2019). Crucial to this process is the dimension of connectivity. Internet-based platforms are capable of providing—something self-organized networks and socially bounded relationships too often cannot—knowing a

critical mass of connections and the efficient systems for reputation and compensation. Such platforms handle large numbers of transactions through decentralized mechanisms of exchange, hence attaining large economies of scale. They also allow for a more lush, direct flow of information between peers, eschewing hierarchical controlscape (Benkler, 2004). Another critical dimension in recommerce economy is trust; in fact, in a peer-to-peer exchange, there are risks of opportunistic behavior in exchange. Peer-to-peer platforms, hence, make heavy investments in formal and informal mechanisms to engender trust in user communities. Probably the most formal is the use of insurance or refund systems, which are now standard across most platforms but certainly were not at the beginning. Much more commonly however, as in the case of second-hand markets, platforms rely on what is referred to as digital reputation systems made up of user ratings, references, and feedback. These are supplemented with efforts to personalize exchanges in such a way as to make them less anonymous and hence more relational. Indeed, many platforms have users describe themselves through online profiles displaying their interests, backgrounds, and social affiliations, much like a social media profile. Moreover, these sites tend to underline their users' social affinities by building a community that shares not only economic exchange but also ethical identity and prosociality (Hendrickson, Celata, & Sanna, 2016). That is the case of Poshmark, a social commerce platform where users can buy and sell clothing, accessories, home goods, and more. Founded in 2011, it resembles a social network as sellers create profiles, sell products, and interact with the community through 'likes,' comments, and 'Posh Parties.' Through the opportunities Poshmark offers its users, who can sell new or second-hand items and connect with others based on their interests and common styles, the platform is able to blend the social aspect with e-commerce, creating an interactive and personalized shopping experience (Cuofano, 2024).

In essence, the digitally enabled peer-to-peer economy is transforming the way goods and services are exchanged, shifting from traditional commerce models to one where peers can buy and sell by themselves. This shift has been fueled by technological advancements that reduce transaction costs and enhance connectivity. Despite these changes, trust remains a cornerstone, reinforced by reputation systems and insurance mechanisms that reassure users. As the peer-to-peer economy continues to grow, it disrupts traditional economic structures, fostering a new sense of community and shared values among all participants. In doing so, it not only redefines economic models but also has broader implications for social interactions and the future of work.

3.1.6.2 Managed Recommerce

Since the second-hand market keeps developing under the increasing awareness of consumers about environmental and financial benefits of sustainable consumption, now, large companies are increasingly adopting resale models so they may meet new market opportunities and a clientele which cares about both ecological consciousness and savings (Fredriks, Coen, 2023). Another type of recommerce is managed recommerce: it refers to partnering with specialized recommerce service providers that handle various aspects of the process on behalf of the brand. They are responsible for different parts of the resale process and, depending on whether the provider is full-service, provide end-to-end solutions comprising technology, logistics, pricing, and customer support (Ruben, 2023). Many recommerce platforms handle the full transaction, which includes suggesting retail price and arranging shipping to ensuring quality by inspections via workshop technicians and responsibly recycling items no longer usable (LaFleur, 2022). Managed recommerce solutions take a more comprehensive approach compared to general or specialized peer-to-peer marketplaces, primarily due to the stringent brand verification processes each product undergoes, along with offering multiple purchasing options such as tiered memberships, rentals, and direct purchases. A product, when sold, is shipped directly from the recommerce company and not from the original owner or seller (Ryder System Inc., 2022). Realizing that most products far outlive the upgrade cycles of most consumers, original equipment manufacturers have started providing their own paths for products to re-enter the secondary market. Retailers like Amazon, Best Buy, and Target have programs for trading in used products for credit or discounts (LaFleur, 2022). The best example of such activity in the second-hand market is represented by the pre-owned program of Zalando where the company takes items as good as new, not showing any signs of use, from more than 3,000 popular brands. The process is easy: users need only upload a photo of each item and select the proper category and brand. If the item was bought originally from Zalando, it would appear automatically in the "owned items" section of their account, with all details prefilled. After that, the trade-in credit available will be displayed, and users can select if they want to have this amount as a Zalando gift card or donate it to either of their two charitable partners like the Red Cross or WeForest (Zalando, 2021).

Managed recommerce can provide a raft of very significant benefits to brands, largely through the experience and supporting services of specialist service providers. Such knowledge and experience help the service provider to better negotiate often complex recommerce processes and maximize efficiency and effectiveness. Besides, managed recommerce will enable the scaling of brand operations without substantial investments in technology or personnel since most of the operational load falls to the provider. This outsourcing not only streamlines the

recommerce tasks but also frees up resources for the brand to focus on core business activities. However, there are a few drawbacks to the approach: first of all, this method reduces the level of control that a brand has over certain areas of recommerce because they will be forced to depend on the provider in order to manage those components. Moreover, brands depend on the performance and reliability of the recommerce provider, which may hurt the former's recommerce activities and, in turn, lead to a loss in customer satisfaction (Ruben, 2023). Still, managed recommerce is a valid option that companies should consider when approaching to new sustainable business models.

3.1.6.3 In-House Branded Recommerce

In-house branded recommerce is a strategy in which businesses establish and maintain their own recommerce channels or platforms, rather than outsourcing these tasks to third-party vendors. This provides the brand with full control throughout the recommerce process; thus, giving them the potential to shape and improve the customer experience in a manner that perfectly fits their standards and brand identity (Ruben, 2023). Third-party recommerce mostly attracts numerous brands due to the several benefits associated with this kind of recommerce. For instance, brands can curate which products are available for resale in order to make sure that only such products that meet their quality and brand image are sold. Among the most successful in-house branded recommerce is Patagonia's-very well-recognized because of its commitment to environmental sustainability. Yet, for over forty years, Patagonia has been a kind of industry leader, and an original founding member of the "One Percent for the Planet" organization in 1986 (Patagonia, 2024). Besides, they have initiated the 'Worn Wear' program, which encourages customers to repair, reuse, and recycle their garments to make them last longer. As such, they allow customers to bring used Patagonia items into their stores or mail them in, for store credit towards new purchases. Those items that are collected are then repaired and resold through the Worn Wear channel or recycled if they cannot be repaired anymore. Thanks to this program, Patagonia minimizes the environmental footprint from manufacturing attire, since in this way, it also supports a more circular and sustainable model of consumption (Patagonia, 2021). IKEA also launched an initiative known as Buy Back & Resell program, whereby IKEA Family members can earn the chance to sell back their used IKEA furniture for a store credit in exchange. With the help of this facility, contributors are able to resurrect their used furniture items by reselling them in the store's AS-IS area, therefore giving a new lease on life for more sustainable and cost-effective reasons to a wide category of customers (IKEA, 2021).

Another advantage with in-house recommerce is that it facilitates the control of logistics. The brands will be able to handle the logistics of collecting, refurbishing, and shipping out the products to ensure it meets their sustainability goals and a great level of customer service. This possibility of direct involvement in logistics once more enhances the facility for quicker turnaround times and better communication with customers to enhance the customer experience in general. Moreover, recommerce with in-house branding enables a brand to tap customer data efficiently, especially by leveraging new technologies such as big data analytics and cloud computing. Managing their own platforms gives them the power to collect and analyze valuable data concerning consumer behavior, preference, and buying patterns in recommerce. As a matter of fact, this data provides an opportunity for personalization of marketing efforts, enhancement of product offerings, and even an avenue through which to inform primary market strategies. Finally, with this type of recommerce, brands can retain a better percentage of resale revenue, by eliminating the need for any third-party fees, which could thereby give them an improved profit margin (Ruben, 2023).

3.2 Second-Hand fashion market

3.2.1 Analysis of the growth of the second-hand market

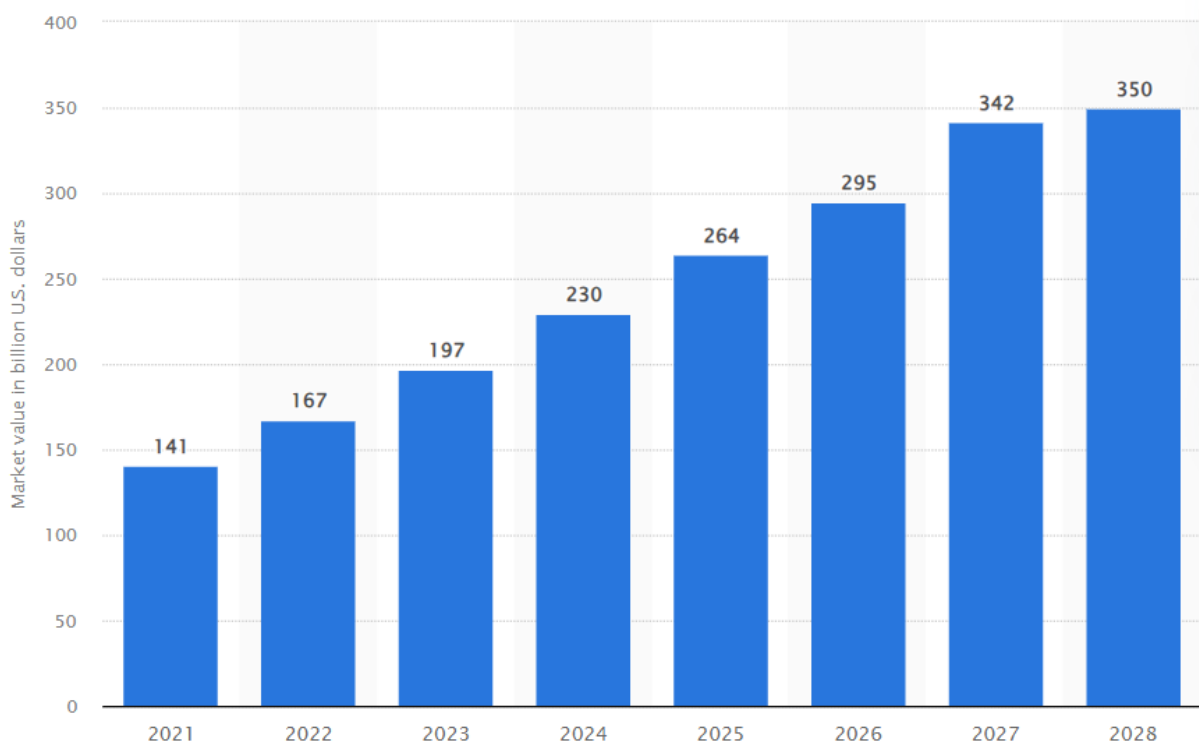
A classic example of the recommerce business model, as mentioned earlier, comes from the world of fashion and, in particular, from second-hand markets. Taking a step back, it is important to analyze how the clothing industry is nowadays considered one of the most polluting in the world. Specifically, the rise of fast fashion has led to a dramatic increase in both the production and disposal of clothing, resulting in significant environmental consequences, particularly in terms of textile manufacturing and waste. Considering that to produce a simple cotton t-shirt, 2,700 liters of fresh water are required according to estimates, enough to meet one person's drinking needs for a couple of years, we easily realize that in 2020 the textile sector was the third largest source of land use and water degradation (European Parliament, 2020). Using statistics, textile production contributes to 20% the world's clean water pollution attributed to the dyeing and finishing processes of fabrics; in fact, a single laundry load of polyester clothes can discharge 700,000 microplastic fibres, which may ultimately infiltrate the food chain. When synthetic materials are washed, more than half a million tons of microplastics reach the seabed every year. Aside from this pervasive impact, the pollution caused by garment production poses serious health consequences for the local residents, wildlife, and ecosystems around production locations. The cumulative carbon emissions attributed to the fashion industry are estimated to be 10%, exceeding the total of international aviation and maritime shipping combined (Maiti, 2024).

According to the European Environment Agency, textile purchases in the EU in 2020 resulted in approximately 270 kg of CO₂ emissions per person. This means that the textile products consumed within the EU were responsible for generating 121 million tonnes of greenhouse gas emissions.

To make up for this problem, many companies have adopted recommerce as a sustainable business model. Since textiles in general and particularly clothing are a fundamental part of everyday life and an important sector in the world economy, companies had to define a new way to do business without polluting. Humans, being endowed with the capabilities to reason and adapt, should be better placed to act in a more proactive manner in support of alternatives that underline sharing and collaboration, promote more solidarity, and are more environmentally cautious. Recommerce and sharing economy become very real since they advocate aspects of increased citizen participation that would let the citizens network virtually in order to share or exchange goods and services (Ruiz-Navarro, 2024). The rise of online peer-to-peer (P2P) platforms, like eBay and Facebook Marketplace, has greatly enhanced the exchange of unused or seldom-used products, making it easier for consumers to resell or purchase items. Central to the recommerce, these platforms empower individuals to buy, sell, or trade goods directly with one another, thus increasing the accessibility and affordability of second-hand items. In this way, P2P platforms help in green consumption and contribute to the extension of the life cycle of products through transfer of ownership and promotion of sustainable resale behavior, reducing waste by encouraging a culture of reuse (Tan, Makkonen, Kaur, & Salo, 2022).

Climate change and growing environmental concerns have pushed customers to rethink their perceptions and motivations regarding current risks, leading to shifts in their attitudes and intentions toward purchasing second-hand products (Styvén & Mariani, 2020). As a result, the value of the second-hand market has risen sharply in recent years and is expected to continue its upward trajectory, with projections estimating it will reach \$350 billion by 2028, as illustrated in the figure below.

Second- hand apparel market value worldwide from 2021 to 2028 (in billion U.S. dollars)



Source: P. Smith. (2024, April 29). *Statista*. Retrieved from Secondhand apparel market value worldwide from 2021 to 2028: <https://www.statista.com/statistics/826162/apparel-resale-market-value-worldwide/>

In the last decade, buying used clothes has been normalized and even glamorized, with celebrities getting in on the action through exchanges and sales of their pre-owned luxury clothing (Wicker, 2024). Although people have always worn clothes handed down by others, second-hand clothing has entered a whole new dimension of fashion. That which was once a badge of poverty and lack of choice in clothing has turned into a badge of rebellion against consumerism. Today, second-hand fashion is considered responsible: it is led by profound ecological awareness and a commitment to the sustainable, mindful use of environmental resources (Bovone & Mora, 2007). There is therefore a desire to bring discarded items back into circulation, to give new life to out-of-use garments with the aim of revitalization and reuse (Università Cattolica del Sacro Cuore, n.d.). In the midst of a broad societal change fueled by millennials' focus on sustainability, fashion brands are looking for ways to a new, promising growth alternative and now they may have found it in the recommerce business model. Over the past 15 years, the frequency with which a garment is worn has dropped by 36%. As a result, consumers are increasingly attracted to consignment shops, where they can acquire vintage clothing at a fraction of the original (Gosselin, 2019). It is thanks to the advent of new technologies that companies can now respond to the needs of new market trends in the fashion industry and adopt new business models, such as the

collaborative economy and recommerce, that allow them to remain profitable while being careful not to harm the environment. The following section will explore some of the most effective technologies that can help companies achieve these goals.

3.2.2 Technologies applicable to the second-hand market

Especially in recent years, the second-hand market has grown significantly, thanks to the introduction of new technologies. The shift toward purchasing and selling pre-owned clothing has become remarkably simple, particularly with the rise of online resale platforms and mobile applications. These tools enable consumers to effortlessly turn their unwanted garments into cash by selling them on various savings apps (Brightly, n.d.). The continued rise of e-commerce, which is expected to account for 24.5% of global retail sales by 2025, has accelerated the growth of online secondhand marketplaces. This transition exemplifies the evolution of second-hand markets from traditional brick-and-mortar storefronts to online marketplaces (Bae, Choi, Gantumur, & Kim, 2022). The mobile technology discussed in the second chapter has the capacity to effectively align supply with demand by enabling users to search for the availability, location, surplus capacity, and pricing of products. Moreover, it also facilitates communication between buyers and sellers: this technology allows individuals to monetize unused items by making them available for sale or lease but also ensures that others are aware of the newly available offerings (Lacy & Rutqvist, 2015). Second-hand fashion apps drive the resale—fundamentally transforming consumer habits and purchasing behaviors. Online peer-to-peer fashion resale platforms, over the past decade, have elevated the exchange of pre-owned clothing to a far more established business model (Bittner & Eisenberg, 2021). NA-KD.com's Circle is the perfect example of a successful peer-to-peer solution. When sellers list items from previous collections, NA-KD utilizes the original images and product descriptions, quickly restocking the item being sold. Additionally, NA-KD provides sellers with a packing slip and manages the payment process, all while leveraging the platform to promote their own returns or off-season items (Fredriks, 2024).

Moreover, more peer-to-peer consumer applications are developed for better customization and increasingly combined with social media in most cases with a social cause; business-to-business models are being designed to integrate more seamlessly within retailer's mainstream business; innovative AI applications for retail and fashion industry are being implemented to assist consumers when shopping virtually for second-hand clothing as body scanning and virtual try-on technologies become more widely available (Mohr, Fuxman, & Mahmoud, 2022). Social technology is fundamental in building trust among consumers. It joins people and forms communities within which individuals can share their experiences, exchange

reviews on services and products, recommend them, and seek further information. This social dimension is inherently part of trust, the basic requisite of the sharing economy and recommerce and hence the second-hand business model. A prime example of this is Depop, which has more than three million registered users who interact with the site almost more like a social media than just a place to buy and sell second-hand goods. Basically, it is a little like a mashup between eBay and Instagram: sellers amass a following, build out profiles in a prodigy-like fashion, make use of hashtags, and even have direct messaging with prospective buyers. According to Depop's chief brand officer, Peter Semple, what truly brings value to the thrift market is allowing users to style their clothes, make profiles, and create an online persona. "Digital platforms like Depop now empower consumers to connect on a global peer-to-peer level, transforming thrifting from a traditionally localized market into a global phenomenon," he says (Dumais, 2022).

Additionally, mobile apps combined with other digital technologies like M2M communication and big data analytics, from business perspective, solve the problem of the high costs of management and maintenance of stocked products. Every time some product changes hands, somebody from the supplier's team has to find an item personally, verify its condition, authorize access, etc. All these tasks can raise expenses incredibly high and make the service less attractive. Modern technologies, however, address these challenges by allowing remote management, predictive maintenance, mobile transactions, and automated surveillance (Lacy & Rutqvist, 2015). M2M technology also automates transactions through smart contracts and secure payment systems, streamlining processes and reducing the need for intermediaries which is particularly relevant in peer-to-peer social platforms typical of new second-hand markets.

Summarizing, the rapid growth of the second-hand market, driven by the integration of new technologies, has fundamentally transformed the way consumers buy and sell used clothing. Online resale platforms and mobile apps have made it easier than ever for individuals to participate in the circular economy, not only by purchasing pre-owned items but also by reselling their unwanted clothes. Second-hand P2P platforms are seen as encouraging sustainable consumption as they offer second life to products, avoiding to latter to be stored in some place, meanwhile other households would buy new items (Parguel, Lunardo, & Benoit-Moreau, 2016). The shift from traditional brick-and-mortar stores to online marketplaces reflects broader trends in e-commerce, which is poised to make up a significant portion of global retail sales in the near future.

3.3 Conclusions

This chapter has explored the urgent need for sustainable business models to combat environmental degradation and social inequality. It has been examined the shift from a linear to a circular economic model, emphasizing the importance of reducing resource consumption and enhancing sustainability. This transition is driven by a blend of external pressures, technological advancements, and regulatory demands, compelling major corporations to reevaluate their operations and adopt eco-friendly practices. The chapter highlighted the emergence of Green and Sustainable Business Models (GnSBMs), which integrate socio-environmental concerns into their core operations, creating value that extends beyond economic benefits to include social and environmental gains. Key models discussed include circular supply chains, recovery and recycling systems, product life extension business model and the product-as-a-service approach. These models repurpose waste into resources, minimizing reliance on virgin materials and reducing environmental impact. Further, we explored the sharing economy and recommerce, which leverages technological platforms to connect individuals seeking products or services with those who can provide them. These models encourage a move away from hyper-consumption towards a more sustainable and equitable approach to resource utilization. The chapter emphasized the necessity of collaboration and transparency in business operations, advocating for a fundamental transformation in how companies operate amidst global sustainability challenges. By adopting these sustainable practices, businesses not only contribute to a healthier planet but also open new avenues for growth and innovation. The table below summarizes each strategy discussed:

Business model	Description	Key characteristics
Circular supply chain	A business model focused on minimizing waste and maximizing resource efficiency through the entire supply chain, from raw materials to end-of-life recycling.	- Focus on closed-loop systems where materials are reused or recycled - Aims to reduce waste and carbon footprint by reusing raw materials - Emphasizes design for disassembly and reuse
Recovery & Recycling	Involves recovering products at the end of their life cycle and processing them into reusable raw materials or products.	- Focus on extracting value from used products or waste - Includes processes like recycling, remanufacturing, or refurbishing - Reduces the demand for virgin

		materials and minimizes environmental impact
Product Life-Extension	Extends the lifespan of products through repairs, refurbishing, and upgrading to avoid waste and delay the need for new products.	- Focuses on repair and maintenance services - Refurbishing and reselling products to extend their useful life - Invest in the durability of products in production
Product-as-a-Service	Instead of selling products outright, companies provide access to products for a fee, retaining ownership and responsibility for maintenance and end-of-life management.	- Shifts from ownership to focus on performance - Includes leasing, subscription, or rental models - Encourages more sustainable use by enabling product returns and refurbishing at end of service
Sharing Economy	A peer-to-peer model that allows individuals to share underused assets, such as cars or homes, often facilitated by online platforms.	- Facilitates resource-sharing among individuals - Focuses on maximizing the utility of existing goods - Often enabled by digital platforms that match supply and demand - Encourages collaborative consumption
Recommerce	Involves the resale of used products through online platforms, either in peer-to-peer (C2C) or business-to-consumer (B2C) models.	- Focus on buying and selling second-hand products - Can involve businesses reselling refurbished items or individuals selling directly to others - Supports sustainability by extending product life and reducing the need for new production
Peer-to-Peer Marketplace	A model where individuals exchange goods or services	- Platforms act as intermediaries, facilitating direct transactions

	directly with each other, typically facilitated by digital platforms.	between individuals - Use of digital reputation systems to build trust (ratings, feedback, etc.) - Reduces transaction costs through technology - Focus on community and prosocial exchanges
Managed Recommerce	Companies partner with specialized service providers to manage the resale process on their behalf, including logistics, pricing, and customer service.	- Managed by third-party providers - Full-service solutions including technology, logistics, and quality assurance - Brands may lose some control over the process - Allows scaling without major investments in technology or personnel
In-House Branded Recommerce	Brands create their own recommerce channels or platforms, giving them full control over the resale process and customer experience.	- Full control over recommerce process (branding, quality, logistics) - Enhances customer loyalty and brand identity - Greater potential for data collection on customer behavior - No third-party fees, leading to higher profit margins

The chapter also delved into the transformative role of the second-hand market, which has been revolutionized by new technologies. Online resale platforms and mobile apps have simplified the process of buying and selling pre-owned items, fostering sustainable consumption by extending the lifecycle of products and reducing waste. In fact, this digital shift from traditional brick-and-mortar stores to online marketplaces represents a significant change in consumer behavior. Finally, we discussed technology acting as the catalyst for this transformation: mobile apps, social media, M2M communication, and big data analytics make processes greener by smoothing them and minimizing the costs, hence enhancing efficiency in

the second-hand market. Advanced technologies, including AI-driven body scanning and virtual try-on features, will further enhance the consumer experience and support the adoption of sustainable practices.

Chapter 4: The Second-Hand Clothing Market

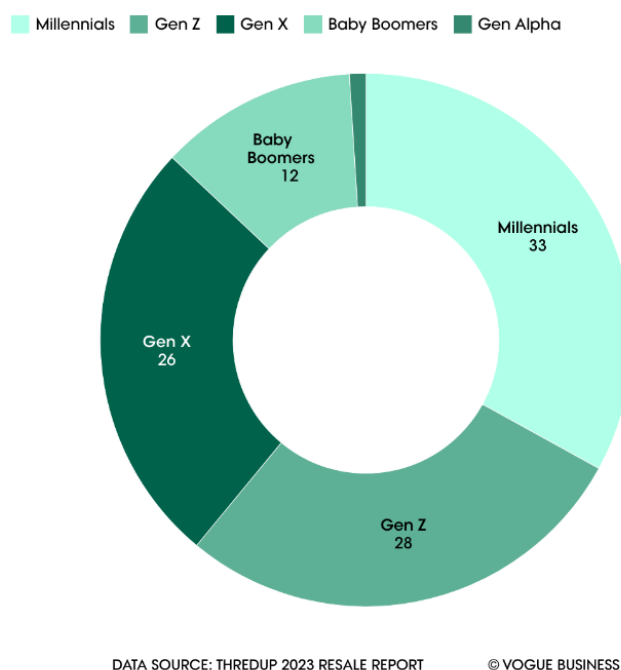
4.1 Target audience and motivations

As discussed in the previous chapter, the production and consumption of textiles are steadily increasing, leading to negative implications for climate change, water usage, energy consumption and environmental degradation. In the past two decades, global consumption and manufacturing of textiles have almost doubled. While talking about design and manufacturing in a way that would align consumer trends with sustainability goals, clothes are now designed to last for the length of a trend cycle – that is, with the view of quick obsolescence, followed by discarding – it makes rapid profits at huge waste generation (Centobelli, Abbate, Nadeem, & Garza-Reyes, 2022). Probably the best reflection of the boom in textile production and fashion consumption is the exponential growth of fast fashion, a business model based on offering new trendy clothes and shoes to consumers. In most cases, fast fashion and just-in-time manufacturing entail the duplication of current fashion at incredibly rapid rates, which means high volumes of cheap, low-quality clothing. An example of fast fashion is provided by high-street retailers like H&M, Zara, and Uniqlo that introduce new collections of highly affordable fashion items every two to three weeks (Evans, Grimmer, & Grimmer, 2022).

The growing awareness of fashion's significant negative environmental impact has led to a rise in consumers advocating for more sustainable practices (Arora & Dhama, 2023). One effective way to promote sustainability is through purchasing second-hand clothing: this approach entails buying pre-owned or previously worn items, which are resold at prices typically lower than new garments. Compared with buying new apparel, second-hand shopping contributes to the reuse of clothing by consumers as a means to have garments integrated into a circular economy (Mazanec & Harantová, 2024). Besides, second-hand purchasing helps customers avoid mainstream fashion channels, hence reducing fashion industry waste (Stanescu, 2021). In particular, second-hand shopping has gained significant popularity among Gen Z and Millennial consumers, who, as noted by Reda and Kapoor (2021), are leading the charge in making more ethical and sustainable purchasing decisions compared to other demographic groups (Ahmed & Kapoor, 2021). Another recent study established by Simon-Kucher and Partners (2021) showed that younger consumers are more aligned with embracing sustainability practices (Simon Kucher & Partners, 2021). The study indicates that 39% of Generation Z and 42% of Millennials are more prepared to overspend when it comes to sustainable goods and services compared to Generation X (31%), or Baby

Boomers (26%) (Manley, Seock, & Shin, 2023). Thredup, important leader marketplace that specializes in buying and selling secondhand clothing, in its 11 th annual resale report, says that in the future years, Gen Z and Millennial consumers will account for nearly two-thirds of incremental secondhand spend as their purchasing power will increase (see figure below). According to Anthony Marino, Thredup president, “Gen Z is a digitally native generation. Their communication, entertainment and shopping habits are all mobile-first so it makes sense that this generation is leading the growth of the market,” considering that online marketplaces are nowadays fundamental (Benissan, 2023).

Secondhand growth by generation through 2027



Source: (Benissan, 2023)

Generation Z, more than any other group, is notably committed to the health of the planet and tends to make well-informed purchasing decisions that prioritize sustainability (Wood, 2022). In fact, sustainability is a key driver behind the growing trend of purchasing second-hand products. Several studies (Han & Stoel, 2017) (Paul, Modi, & Patel, 2016) indicate that consumers are increasingly attuned to environmental issues and are developing stronger emotional connections to ecological challenges, motivating them to shift their consumption behaviors in order to safeguard the planet. Environmental concern can be defined as the "degree to which people are aware of environmental problems, support solutions, and indicate a willingness to take personal action to mitigate them" (Xiao, Dunlap, & Hong, 2018). Accordingly, purchasing used products is a way to reduce a person's impact on the

environment, since it decreases the demand for new products and hence diminishes the use of more natural resources (Rodrigues, Proença, & Macedo, 2023).

Another significant reason for purchasing second-hand clothing is driven by economic factors, primarily linked to price consciousness. This involves the rewarding aspect of securing good deals, the pursuit of price fairness, and the enjoyment of bargain hunting. For instance, economic considerations were shown to be the dominant motivation behind second-hand clothing purchases during the early stages of the second-hand clothing business (Wang, Fu, & Li, 2022). Many studies have consistently indicated that affordability is a central factor influencing the decision to buy second-hand clothing (Diddi, Yan, Bloodhart, Bajtelsmit, & McShane, 2019). A study conducted to identify key drivers informing young Australian women's (N = 48) secondhand clothing purchasing decisions, based on the Theory of Planned Behavior and Prototype Willingness Model, shows that terms like "cheaper", "save money", and "less expensive" were often used to describe the advantages and encouragements of purchasing secondhand clothing. Participants emphasized that the lower cost of secondhand clothing allowed them to experiment more freely with their style, stating that they "can discover a wide range of styles for relatively little expense" by shopping secondhand (Taylor, White, Caughey, Nutter, & Primus, 2023). In fact, the availability of used fashion products helps people to broaden their fashion options at a lower cost, while also allowing them to purchase specific fashion pieces that would otherwise be out of reach (Hasan, Lang, & Xia, 2023).

Another key factor that consumers take into consideration when purchasing secondhand products is their uniqueness: essentially, consumers can discover items with a rare value and a sense of scarcity. Many people desire products that are unique, extraordinary, and exceptional in various ways (Arora & Dhama, 2023). Vintage pieces, in particular, are often seen as symbols of individuality and authenticity, embodying a unique personal style that no one else replicates (Veenstra & Kuipers, 2013). This desire for unique items is also connected with the great variety in secondhand shops. Second-hand fashion offers a very broad range of clothing fitted to different tastes, trends, and needs. From vintage to designer garments, from casual wear to special-occasion outfits, customers will find an enormous variety across time, brands, and price points. This broad spectrum of styles gives more imagination and room for individuality in fashion, therefore making it easier to find pieces that really resonate with personal taste (Willersdorf, Krueger, Estripeau, Gasc, & Mardon, 2020).

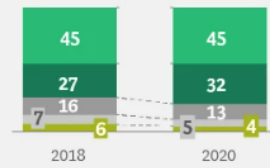
The figure below summarizes what are the main motivations that lead consumers to buy second-hand products. The survey, based on 7,000 individuals from six countries, was conducted by BCG in collaboration with Vestiaire Collective.

Secondhand consumption is increasingly driven by sustainability and affordability

% of respondents who identify the following reasons as drivers of their secondhand consumption

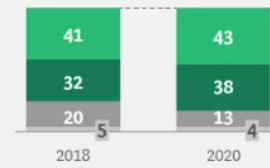
Affordability/ purchase power

I buy items I can't afford at full price



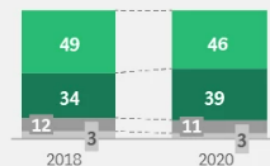
Trend and uniqueness

I find unique pieces to enhance my style



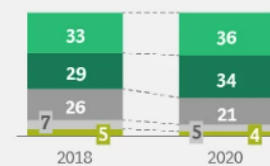
Offer/choice

I am able to find a large selection of items and brands



Environmental consciousness

I like the sustainable aspect of purchasing secondhand items



Strongly agree Slightly agree Neither agree nor disagree Slightly disagree Strongly disagree

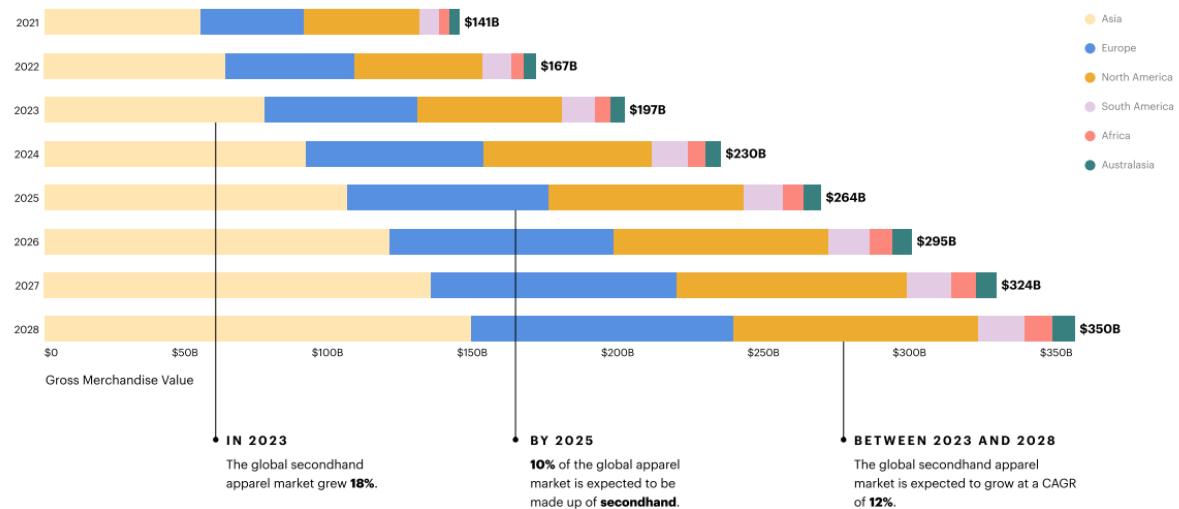
Source: BCG x VC Resale Survey, mid-May to mid-June 2020.
Note: Because of rounding, not all figures sum to 100.

Source: (Willersdorf, Krueger, Estripeau, Gasc, & Mardon, 2020)

4.2 Trends and challenges

The exchange of used or previously owned items has deep historical roots, dating back to the era of bartering when people used to exchange things that were of no use to them in lieu of getting something desirable. Recent research around the globe says that the trend of re-commerce has been accelerated due to digitalization and new technologies: the changing consumer values, innovation in trading models, social media, and the Internet, together with environmental sustainability, are the reasons for this increase. These forces have made the second-hand goods market grow phenomenally over the past decades, making it a billion-dollar global market (Hristova, 2019). Global market trends indicate a rising growth rate for the second-hand goods sector, which is emerging from the shadow of traditional new products. ThredUp's report clearly demonstrates this tendency:

Global Secondhand Apparel Market To Reach \$350 Billion by 2028, Growing 3X Faster Than Overall Global Apparel Market



Source: (ThredUp, 2024)

According to a study conducted by The Independent Journal and involving 2000 UK adults, in 2023 the average consumer in London purchased 6.6. second-hand clothes. On average, money spent on pre-owned clothing purchases reached £91.60; for 18- to 34-year-olds, this average surges to £120.40, and for those living in London, £133.20. The main factor in deciding to buy second-hand clothes was low cost, which, against the background of the continuing cost-of-living crisis, was mentioned by 36% of buyers. Also, 16% chose used goods because it is more environmentally friendly and an alternative to fast fashion, while 9% of them were driven by the style and quality of the clothes, simply because they found new clothes to be less durable. Lastly, 8% of all customers are buyers because used apparel is "cool" (The Independent, 2024). These are statistics that in fact agree with the motivations for consumers to buy second-hand, which we analyzed in the previous paragraph.

However, despite the growth of second-hand clothing market, challenges still remain. As this business expands, a large proportion of the clothing being donated or resold comes from fast fashion brands. These clothes are usually of lower quality and make use of cheaper materials, not designed to last long. As these goods find their way to the resale market, their relative durability decreases the appeal and value of secondhand clothing. This shift contrasts with older, vintage items that were often made to last longer and retain their quality (Jackson, 2020). This very uncertainty causes a long-lasting problem of moral hazard in the buying of secondhand products because usually, sellers have more product information about quality than buyers. Luckily, new technologies can help alleviate this risk: indeed, many companies recently developed a scalable protocol rooted in blockchain technology, which gives

consumers access to trustworthily tracked product quality and supply chain information (Shen, Xu, & Yuan, 2020).

Another related issue regards authentication and trust: the more luxury resale grows, the more difficult it is to really ensure that goods sold are what they seem. Mechanisms built by platforms specializing in high-end second-hand fashion, such as The RealReal and Vestiaire Collective, allow item authentication, but it is a labor-intensive and costly effort. Missteps in this area, such as the sale of counterfeit products, can severely damage consumer trust in the platform and the industry (Hollerbach, 2023). A way to fight this would be to trace every single article and fit them with a digital ID. For example, Eon Group Holdings Inc, is a U.S.-based technology company that focuses on creating digital identities for physical products, particularly in the fashion and apparel industry. These digital passports create a record of the whole life cycle of the garment. This includes material usage information and composition details, such as what the clothing is made of and what sustainability credentials would show whether the product is made of recycled material and what impact it had on the environment during its production process. The passports also verify the authenticity of a garment and trace the ownership of it, thus working as a sort of digital certification. Moreover, they also guide recycling, resale, or upcycling of the product, thereby contributing to circularity in fashion (Eon Group Holdings Inc., n.d.).

Finally we consider a last big challenge for second-hand clothing which relates to the uncertainty of supply chain and operational demands in controlling used inventory. In stark contrast to traditional fashion retailers, who can forecast demand and ensure a balanced flow of new items into their supply chains, second-hand retailers rely on sporadic streams of donations, trade-ins, or buybacks and hence function to an overwhelming extent under uncertainty in inventory management (Ross, Bolton, & Meloy, 2023). The quality, condition, and amount of the apparel that second-hand retailers acquire might vary greatly, sometimes resulting to an irregular and mismatched inventory that does not necessarily correlate with client demand (Estribeau, et al., 2022). This unpredictability means that stores may either find themselves overwhelmed with stock or struggling to meet customer needs, particularly when it comes to seasonal items or specific sizes and styles. As so often happens, a real-world solution lies in new technology—for instance, inventory management software features greatly improve second-hand supply chain intricacies. These are mostly cloud-based systems that enable tracing of inventory in real-time, providing an overview of stock levels, item locations, and the flow of goods within the supply chain (Gartner, 2023). Through these types of systems, used merchandise retailers can better cope with the fluctuating nature of their inventories; for example, each time items are donated or received through buybacks, the

software automatically updates the inventory inflow, categorizing it by attributes like size, style, condition, or seasonality. This provides the retailer with an exact picture of what is available at any moment in time (Belloni, 2021). Furthermore, big data analytics can aid in forecasting and trend analysis. By analyzing the past trends, retailers can project the future trends and prepare to respond to any change in demand. For instance, if analytics brings out the conclusion that different types of seasonal items always see a peak of donations or sales at particular times of the year, retailers can alter their inventory management accordingly (Deloitte, 2024). This would help in at least controlling some of the problems related to overstock and understock, assuring that an approximately balanced quantity is maintained in the inventory. For example, if this software recognizes an overflow of winter coats during summertime, the retailer will be better placed to stock these commodities efficiently until a higher demand characterizes the market (Deloitte, 2024). In conclusion, inventory management software integrated with big data analytics can connect with other operational systems, such as point-of-sale (POS) systems and e-commerce platforms, to provide a seamless flow of information. With each sale, the inventory count is automatically depleted, providing an accurate accounting of inventory items (ReatailDive, 2023).

4.3 The profitability of second-hand market: key intermediaries

As previously mentioned, traditional second-hand consumption is assumed to be associated with the low-income earners of the high-income countries and for some the stigma associated with poverty can still attach itself to secondhand goods. However, nowadays, recommerce is an increasingly popular commerce for all varieties of consumers. The idea that the second-hand market is reserved for people from the lower and middle classes is no longer accurate (Muthu, 2023). Indeed, in his study, Scitovsky revealed that individuals of any income category, including the rich, are actively involved in the second-hand market (Scitovsky, 1994). For many consumers, purchasing secondhand fashion is a way to embrace a more sustainable lifestyle. Opting for pre-owned items instead of new ones is a step toward circular fashion, as it extends the life cycle of garments and helps reduce waste (Khusainova, 2021).

This marked interest on second-hand clothes is also reflected in the policy domain, as is attested by an intention of the European Commission to extend the producer responsibility for textiles across the EU by 2025. Now, the Commission pursues legislation that will hold manufacturers responsible for the full lifecycle of textile products and ensure effective waste management across the EU (European Commission, 2023). Furthermore, traditional retailers with business models found on the sales of new products are developing a growing interest in reselling second-hand items (Persson & Hilton, 2023). The Garment Collecting Initiative by

H&M gives its customers a discount on their future purchases in return for recycling their old clothes. Any garment from any brand is taken under the program, which helps the world be a little bit more sustainable while giving an incentive to people. Items unsuitable for resale are recycled into new textiles, among other usages, while some of the collected items are resold through H&M's second-hand platform. This dual approach (resale and recycling) supports the circular economy and cuts down on waste while extending the life of apparel. Most importantly, this program was scaled across the world by H&M to show how sustainability could be part of its core operations (Vedeikytė & Lechmanová, 2019). Another case is provided by Levi's: in fact, it is a strong example of a retailer embracing second-hand fashion not only through digital platforms but also through physical stores. Recently, a pure pop-up store called Levi's Haus Miami has been dedicated to the sale of second-hand and vintage Levi's products. Levi's will be selling to a younger, more sustainability-conscious audience that's looking for iconic pieces with unique, worn-in character. This pop-up model will help Levi's venture into the business of secondhand clothing sales without having to commit to long-term retail space-a nod to their sustainability goals-while tapping into a growing desire for vintage fashion (Levi's, 2021).

Even though, historically, the second-hand markets in Western European countries and North America have been largely dominated by not-for-profit organizations such as the Red Cross and the Salvation Army; clothing market is now undergoing significant changes, with increasing consumer interest in used products and new commercial players entering the market (Persson & Hilton, 2023): this market, once dominated by charitable organizations, has transformed into a more diverse landscape, incorporating for-profit companies with different business and sales models. According to a study by Turunen and Gossen, there are many services and business models of second-hand companies; we will analyze here below some of them (Turunen & Gossen, 2024).

Starting from donation-based companies, these are organizations that manage the sorting, preparation for sale, and storage of donated items. Once these donations are made, the items become the property of the company. Revenue is generated by processing and selling these donated goods, serving both individual consumers (B2C) and businesses (B2B). An example of such a company is Goodwill Industries International, a nonprofit organization based in Rockville, Maryland. Goodwill raises funds by selling donated items, using the proceeds to support programs such as job training, employment placement services, and other community initiatives aimed at helping individuals with barriers to employment. Goodwill operates through a network of over 150 autonomous, community-based organizations across the U.S. and Canada, and it has expanded its presence to other countries, including Brazil, Finland, and

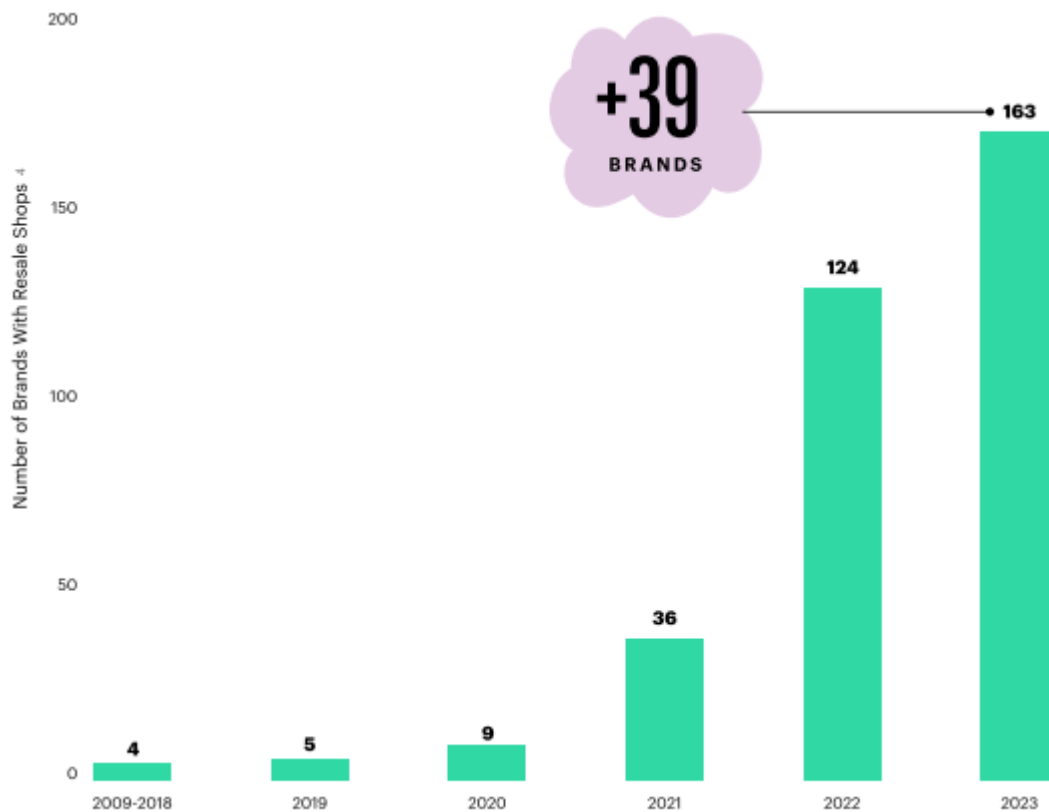
Italy. With more than 3,300 retail stores and an online sales platform, Goodwill supports its mission by assisting individuals in finding employment (Goodwill Industries International, n.d.).

Another business model is the consignment store. These stores offer physical retail space for selected, consigned goods, often with optional third-party authentication to verify the quality or authenticity of the items. The company curates a collection of items, selecting brands or styles that fit a specific aesthetic. While the items still technically belong to the original seller, the store handles their storage and sale. The company generates revenue by offering these selling services, charging a commission that typically ranges from 30% to 50% on sold items (Lebby, 2022).

In the case of curated second-hand and vintage stores, the company either buys or pays in advance for very well-chosen items and then offers a curated collection to potential buyers. It does not provide the service to the sellers but rather earns its revenue by selling the selected items they have obtained from the owners, so, in general, a second-hand business primarily aims at facilitating buying and selling used products, and pricing the services associated with the transaction considered as the base of income sources of the business (Turunen & Gossen, 2024). In general, the core offering of a second-hand business is to facilitate the transactions of used products, and the pricing of these second-hand services generates the revenue streams for the second-hand business.

Finally, last business model is, as discussed in chapter 3, peer-to-peer online platforms or smartphone apps that offer an online marketplace for the sale and buying of goods second-hand. The consumers maintain full ownership of the product for storage and sales. The platforms derive their revenues from a commission on sales in a range from 0% up to 12% per sale, plus an additional service charge of €1. Along with visibility, a seller also can buy additional services. Some websites also give premium monthly subscriptions. Depop is another famous marketplace site and app originating from Italy, predominantly used within the fashion industry. Depop specializes in unique pieces: clothes, design objects, and accessories are sold, many of which are second-hand. It was founded by Simon Beckerman in collaboration with H-FARM, a business incubator based in Venice. Currently, Depop has 30 million users spread across more than 150 countries. A product is uploaded every half second while a fashion item is sold every three seconds on the platform. It is pure e-commerce, with no physical stores or warehouses but just a direct link between sellers and buyers. As recently as 2020, Depop had 1 billion items sold on its platform. In the same year, it has recorded sales of \$650 million and brought in revenue of \$70 million (La Repubblica, 2021).

The second-hand market has become increasingly attractive to companies due to the significant profits it generates. According to ThredUp's 2024 resale report, several brands, among them TOMS, American Eagle, H&M, and J. Crew, started resale programs last year. For consumers, this means an opportunity to buy high-quality, branded products at a more reasonable price while contributing to sustainability. In sum, this shift has contributed to a 31% YoY growth of the branded resale market in 2023, as represented by the figure below.



Source: (ThredUp, 2024)

Indeed, according to the report by ThreadUp, resale programs result in 87% of the brands surveyed claiming that such initiatives help them reach their high sustainability goals. Further, 80% of those surveyed are realizing more revenue, and 67% claim they attract more customers through resale. Moreover, 67% believe resale will be more than 10% of revenue within the next five years. This development was in tune with the more general evolution of consumer behavior, increasingly reflecting ecological sensibility. The consequence of the situation is that customers are becoming more open to different sales models, which until recently-just a couple of decades ago-were virtually non-existent. Today, a company can benefit from the emergence of the secondhand market through a variety of means; customer preferences for sales platforms are as shown in the chart

below.

SHOPPERS GRAVITATE TOWARDS BUYING SECONDHAND ONLINE¹

63% of consumers who bought secondhand apparel in 2023 made a purchase online, **up 17 pts** from 2022.
— Compared to 71% of Gen Z and Millennials

45% of Gen Z and Millennials prefer to buy secondhand apparel online, compared to 38% who prefer to shop at a brick-and-mortar store.

Of those who prefer to buy secondhand directly from a brand's website:

- ★ More than **half** say they trust brands more than marketplaces.
- ★ **44%** say they can more easily compare items side by side.
- ★ **41%** say they like to shop a more curated selection from a specific brand.



Source: (ThredUp, 2024)

The second-hand market in the fashion sector is also growing steadily in Italy, with several intermediaries having developed business models focused on this segment. Second-hand shopping is now the third sustainable behavior disseminated among Italians: in 2023, 60% practiced it, up 3 percentage points over 2022, and even a remarkable +16 points compared to 2014. It comes after waste sorting, carried out by 91%, and purchasing LED light bulbs, adopted by 68% (Scalise, 2024). As evidence, a survey conducted in 2022 by CNA Commercio found that 57 percent of Italians had purchased at least one second-hand item, with 38 percent of these sales taking place online (Bernardini, 2023). It is possible to see from the Second Hand Economy Observatory, carried out by BVA Doxa for Subito.it, that 24 million Italians bought second-hand goods in 2022, with a total value of 25 billion euros, 1.3 percent of the nation's gross domestic product. Subito.it, a made-in-Italy digital platform focused on buying and selling various products, recorded a +14.5% increase in the second-hand market in the time period from June to December 2020 compared to the same period last year. Visits to the "Clothing and Accessories" category surged by 18% and totaled more than 23.5 million searches. This means Italians, even in fashion choices, are increasingly turning to secondhand options (The Map Report, 2021). From trend to lifestyle, pre-owned is growing thanks to the power of the web, the return of the physical store and markets, and the clearing of prejudice and stigma about second-hand items. Pre-owned, in fact, is not limited to neighborhood stalls, vintage markets and specialty stores. In fact, in Italy, second-hand e-commerce reached 11.9 million euros of turnover, equal to 47 percent of the total market. From this perspective, today, thousands of platforms, marketplaces, and apps are enabling second-hand shopping. One example is the phenomenon platform Vinted with 65 million users and a brand valued at \$1 billion. It also fosters eco-friendly operations, from a network of pick-up/drop-off points-PUDOs-to a fleet of hybrid and electric cars to cover the last mile

of delivery. Other players in the second-hand space include Zalando, Wallapop, Depop, BuyDifferent, Deesup, Thrift+, Refurbed, The RealReal, and Vestiaire Collective, besides more established names like eBay, Etsy, and Amazon Second Hand (Zoppo, 2023). It has been important for companies to alter this shift in consumers' preference by the integration of the second-hand market into their business models. As sustainability and circularity become more prevalent today, businesses have to reciprocate to such values if they want to remain competitive. Just as the increasing demand for second-hand fashion creates new opportunities for profits, the same demand calls for flexibility and innovative ways of sale channels.

4.5 Business cases

This section now delves into three case studies, which exemplify the recommerce phenomenon for the fashion industry, namely Vinted, Vestiaire Collective, and OTB Group with a focus on the Diesel brand. Although these firms are very different regarding market targets and operational strategies, they have in common the objective of exploiting the growing interest in circular economy and sustainable fashion. Vinted represents the "peer-to-peer platform" model, where the consumer can sell directly to the consumer. On the other hand, Vestiaire Collective operates under a "managed recommerce" model where authenticity and curation of products are handled by the platform itself, therefore giving much greater assurance of quality and authenticity, especially in relation to luxury goods. Then there is Diesel of the OTB group, with "in-house branded recommerce" which is a model whereby one resells used merchandise under one's own brand name, handled directly by oneself. These three models reflect various, yet complementary, approaches to recommerce at a time when consumers do seem to pay more and more attention to sustainability.

4.5.1 Methodology

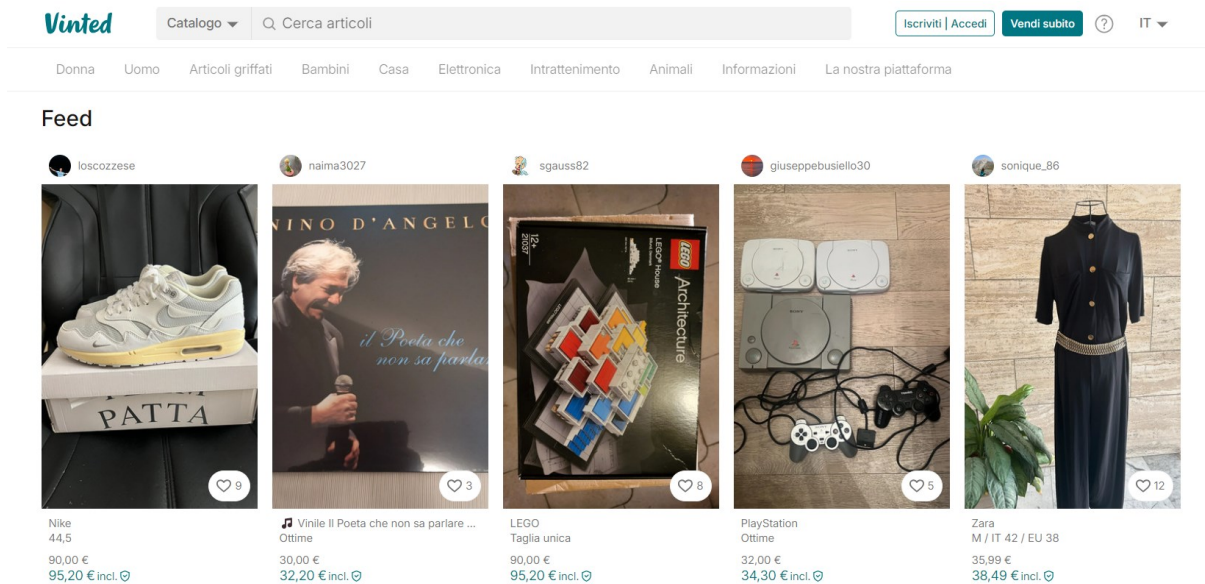
Vinted, Vestiaire Collective, and Diesel will be used as case studies due to their ability to represent different recommerce models, each illustrating varied ways in which sustainability can be integrated into the fashion industry. Each company is selected based on its singular contribution to and relevance for the evolving secondhand marketplace.

Vinted is chosen because it is the first and most important peer-to-peer platform in Europe, counting millions of active users across several countries. Due to the scale and influence of Vinted, this case turns out ideal to be tried with an increased understanding of how consumer-to-consumer transactions have been working within the recommerce space. Vinted's ability to facilitate seamless, decentralized exchanges of second-hand goods highlights the democratization of fashion resale, where individual users play a central role in extending the

lifecycle of products. Vestiaire Collective is chosen because it has been a pioneer in using innovative technologies to bridge the gap between luxury fashion and second-hand commerce. Being one of the first platforms to combine under one umbrella digital verification, authentication, and professional curation of goods, Vestiaire Collective represents one of the highest quality assurance benchmarks within the recommerce market. It has been a model example of "managed recommerce" in the way it is balancing high standards of product quality against the principles of sustainability. Therefore, the collection at Vestiaire Collective allows for an investigation of how technology is changing the basis of consumer trust in the luxury second-hand market. The inclusion of Vestiaire Collective within this study allows for an examination of the intersection of technology, sustainability, and luxury within recommerce. Diesel, owned by OTB Group, has been selected not only for its innovative approach to branded recommerce but also because it is an iconic Italian brand. Including Diesel adds an important geographical dimension, illustrating how Italian fashion brands are embracing sustainability through circular business models. Diesel's in-house recommerce initiative, 'Diesel Second Hand,' showcases how a traditional fashion brand can integrate product recycling and resale into its business strategy, extending the lifecycle of its own merchandise.

4.5.2 Vinted

Vinted is an online marketplace where users are able to buy and sell second-hand products among themselves. Founded in 2008 in Lithuania, the business originated from Milda Mitkute's personal need to clear out her wardrobe full of clothes she no longer wore. To help solve this issue, she collaborated with her friend Justas Janauskas, who developed a website for her to sell her clothes. Today, Vinted is the biggest European marketplace of second-hand clothes, with more than 65 million customers and employs over 1,200 people. Its services operate in 16 countries: Austria, Belgium, Canada, France, Germany, Italy, Lithuania, Luxembourg, Poland, Portugal, Slovakia, Spain, the Netherlands, the Czech Republic, the UK, and the USA. Vinted is particularly present in countries that have a long tradition linked to the second-hand market, such as the Netherlands and part of Central Europe: Germany, Belgium, and France (Palomo-Domínguez, Elías-Zambrano, & Álvarez-Rodríguez, 2023). Nowadays, Vinted Marketplace is the largest C2C second-hand fashion marketplace in Europe, aiming ambitiously to make second-hand shopping the first choice in the world (Vinted, n.d.)



After several years dedicated to broadening its services and increasing site traffic, the Lithuanian platform Vinted has reached a turning point. In 2023, Vinted Group reported revenues of €596.3 million, marking a 61% increase compared to 2022, when it generated €370.2 million. The company's adjusted EBITDA stood at €76.6 million, while net profits amounted to €17.8 million, a significant shift from the €20.4 million net loss recorded in 2022 (Vinted, 2024). Despite a challenging macroeconomic environment, Vinted exceeded its growth expectations during 2023. "We have been deploying capital with a high return on investment for many years, constantly taking into account the financial sustainability of our investments, and so I am pleased that we are able to announce that we are now operating profitably, and that we are posting positive Ebitda for 2023," says CEO Thomas Plantenga. "This is a great testament to the dedication and hard work of our team in making Vinted a success for our members. And it is a solid foundation on which we can continue to build, as we see many opportunities on the horizon" (Guinebault, 2024). Vinted has been able to drive material growth across multiple dimensions—through better market penetration of existing geographies, geographic expansion into Denmark, Finland, and Romania, plus expanded offering into luxury fashion, underpinned by verification services. On top, the firm has further developed its shipping offer via Vinted Go and launched early initiatives to push down further in the value chain via payment services. These strategic moves are enhancing the value proposition for the customers from Vinted and furthering its mission of making second-hand shopping the first choice in the world (Vinted, 2024).

The company has successfully created a platform to empower its users through a lively and expressive community. Its massive appeal is basically due to the ease by which users find interaction, convenience, and personalization from the consumers whose needs are satisfied through second-hand clothing. The platform motivates users to both buy and sell, creating a

dynamic marketplace (Ellen Macarthur Foundation, 2021). It is a typical example of peer-to-peer economy: the platform directly connects buyers with sellers, bypassing any intermediaries and offering better price competitiveness. Users can make bargains on the website, ask questions about items up for sale, and leave feedback so as to earn each other's trust. Vinted also offers buyer protection and a secure way of paying for purchased items (CBM Team, 2024).

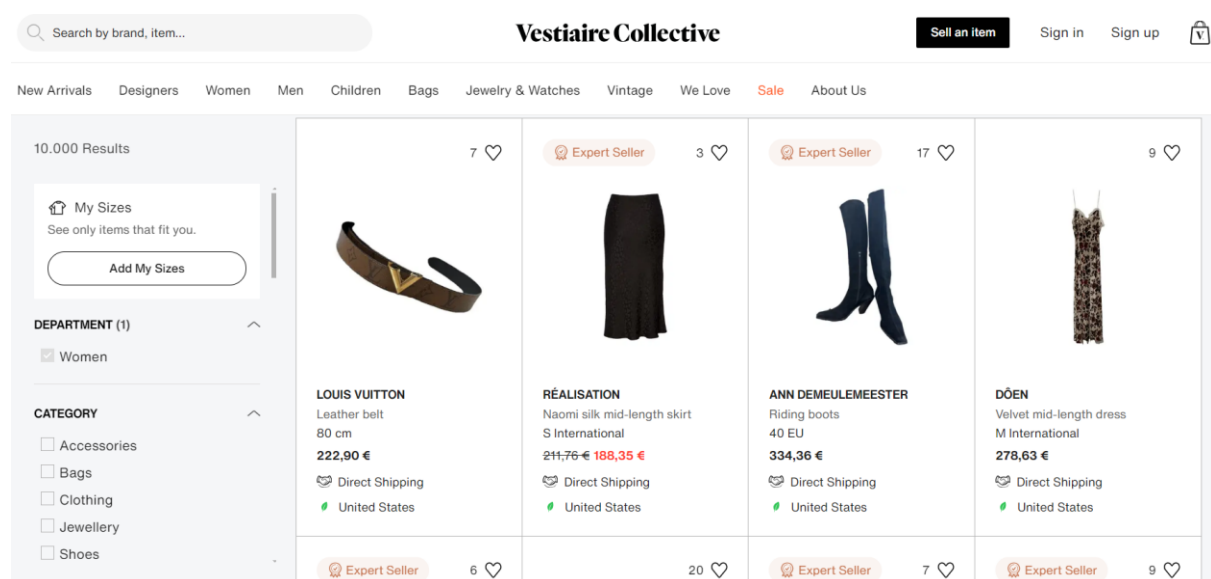
Vinted's success offers several benefits: it has made the buying and selling of second-hand clothing both popular and convenient, while increasing accessibility. The company also makes people more aware of sustainable fashion, showcasing some potential of the Baltic region. At the same time-what makes Vinted different from any other trading platform? According to Janauskas, among the most important reasons is that Vinted is really social. More than just an e-commerce site, Vinted operates like a social network: people don't go there only to buy something but also to kill time, browsing through it, making it a sort of "treasure hunt." Moreover, while other companies are able to deal with a broader array of products, Vinted works only with clothes and fashion. This makes it a bit more focused and less overwhelming for its users (Hegedűs, 2023). Additionally, the company has a strong interest in sustainability as highlighted in Vinted's official websites: "We want to show you just how great second-hand can be. Sell the clothes that have more to give. Shop for items you won't find in stores. Vinted is open to everyone who believes that good clothes should live long" (Vinted, n.d.). Working with Vaayu, a software that tracks carbon emissions for retail brands, Vinted estimated that its marketplace prevented 678,691 tonnes of CO₂ equivalent emissions between 1st January - 31st December 2023. This offsets approximately 256,207 round flights from London to Los Angeles. By sum, Vinted has saved 678,691 tonnes of CO₂ emissions since the beginning of operation (Vinted x Vaayu, 2023). There is also growing difficulty in justifying, on ethical grounds, the buying of new clothes at a time when the world is already overstocked with consumer goods. Results from this report show that 39% of the transactions on Vinted's platform have replaced the need to purchase new items (Kale, 2024). As Thomas Plantega, the Chief Executive Officer at Vinted confirmed, fashion is something that has a huge destructive impact on the environment, and therefore, the mission of the company is really based on a belief that second-hand selling and buying is one of the most important ways to decrease this harm. For a peer-to-peer marketplace like Vinted, this mission involves two critical aspects: encouraging users to choose second-hand instead of new products to avoid the emissions that will be linked with new production, and help people learn the value of what they already own (Mercuri, 2024).

Vinted's business model relies on user choice, favoring the consumers who would rather prolong the product life cycle than follow the insatiable consume-and-dispose pattern. These usually are sustainability-conscious consumers who find in Vinted the extension of traditional reuse practices that are usually confined to passing items along to family and friends, or donating to charities. Thus, in this respect, Vinted becomes not only a place where eco-conscious consumption is possible but also an opportunity for users to save money or even generate income in the process (Palomo-Domínguez, Elías-Zambrano, & Álvarez-Rodríguez, 2023). Vinted's approach has been agile and innovative enough to keep up with changes in the market. For instance, back in 2019, McKinsey & Company's annual report stated that the market for second-hand clothes could grow bigger than that for fast fashion in the next decade, driven by an increased demand for customers of sustainable consumption and possible price savings (McKinsey & Company, 2019). Four years later, McKinsey's "State of Fashion 2023" report came out and said that sustainability was still "the biggest opportunity" for the fashion industry, ranked higher than high market agility and brand differentiation through customer experience (McKinsey & Company, 2023). Convincing consumers to prioritize second-hand items over new products remains a significant challenge, yet the environmental and ethical benefits make this shift both promising and impactful, with Vinted serving as a prime example of this potential transformation.

4.5.3 Vestiaire Collective

Like other consumer goods producers, luxury brands have to experience the everyday struggle for their competitiveness by trying to satisfy the increasingly changed customers' expectations. According to Kapferer sustainability is what is needed today to make the competitive advantage of the luxury industry (Kunz, May, & Schmidt, 2020). The growth in various governments, non-governmental organizations, consumers, and the media puts more pressure on luxury companies to reduce the negative footprint of the supply chains of their businesses. This pressure is starting to undermine the perceived value of luxury brands, with some consumers even boycotting them. Conventionally, there has always been a lack of affinity between luxury and sustainability, in fact the concepts often operate in a contradictory perspective. About a decade ago, the concept of pairing luxury and sustainability was somewhat oxymoronic: for many people, luxury meant richness, exclusivity, and status, while sustainability meant living in a much more modest manner, conserving resources for a finite earthly life (Ranfagni & Ozuem, 2022). However, new technologies have played a vital role in marrying luxury and sustainability, and thus far, were really instrumental in changing the face of the fashion industry. Especially, digital recommerce platforms have eased both buying

and selling pre-owned luxury products, hence elongating the lives of the product and making fashion more circular. In this way, new technologies not only support sustainability but also redefine the very concept of luxury in the 21st century. A prime example is Vestiaire Collective-an online marketplace for pre-owned luxury fashion (Vestiaire Collective, 2024). The company is committed to changing the face of the fashion industry by promoting the alternative circular fashion movement that offers the overproducing, overconsuming, and waste issues of the industry a different direction. Empower this movement through tools, inspiration, and features needed to drive that change, Vestiaire Collective enables its users to both buy and sell unique, second-hand pieces from one another's wardrobes. Of course, what really sets the platform apart is a very engaged community, together with a highly exclusive, sought-after selection of over three million items (Vestiaire Collective, 2024).



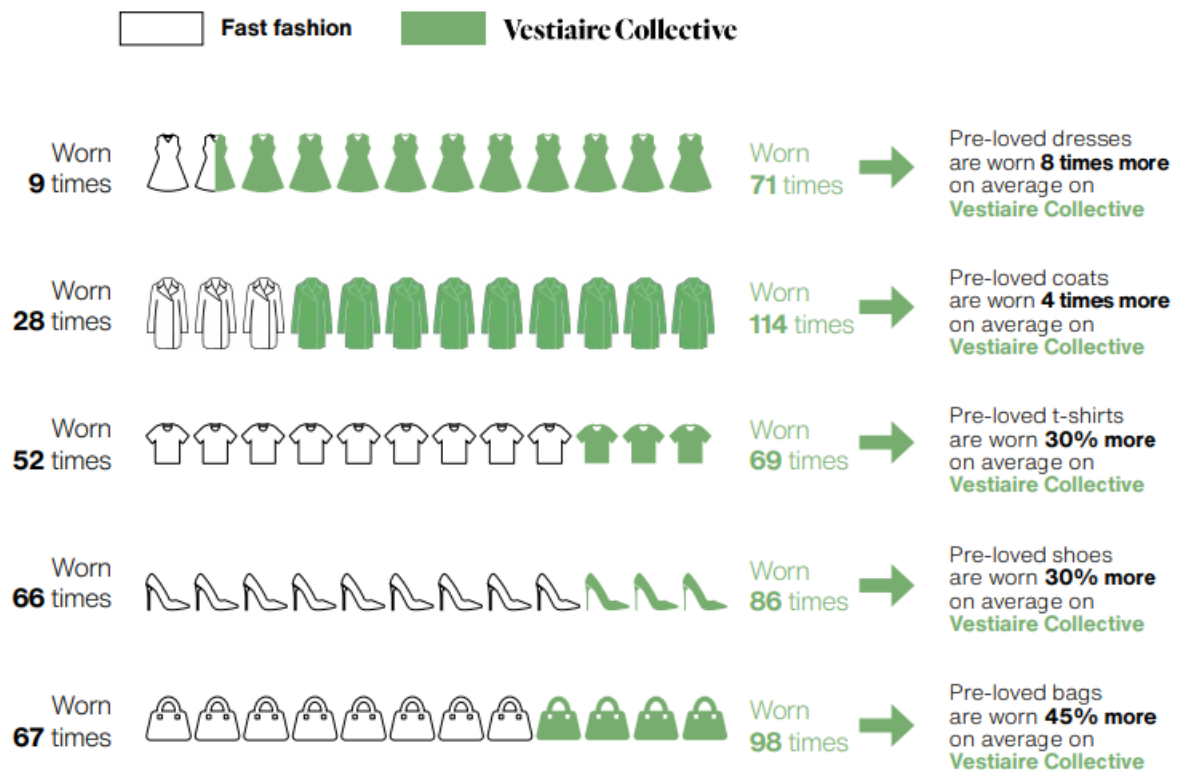
Vestiaire Collective adopts the managed recommerce model by actively managing every step of the resale process and ensuring a high level of control and quality to meet the expectations of consumers in the second-hand luxury market. It digitally verifies by scrupulously screening every posting before publishing it on the site. Through a blend of artificial intelligence and human knowledge, suspicious items are filtered out, and only compliant products can be purchased. Moreover, Vestiaire Collective does authentication and quality control where an item goes through a physical check by the experts at their hubs: these experts check key details like materials, finishes, serial numbers, and state amongst others to ensure the actual product is just like being listed (Vestiaire Collective, 2024).

The company offers a product authentication scheme following the T.R.U.S.T. protocol. It begins with the first step, called Track, which involves online monitoring to verify that the item and its listed condition match reality. It is a very important initial step, as it is estimated that in 2023 alone, 450,000 counterfeit items were caught during this period. Later comes the

"Review" stage, which involves checking the documentation associated with the item. The last three steps, "Understand," "Smell," and "Touch," are reserved for close evaluation: "Understand" requires research into the history and origin of the item; "Smell" is crucial to ascertain the materials involved; "Touch" allows the expert to review the texture, weight, and hardware. For Vestiaire Collective, the fight against counterfeiting is fundamental, in fact its motto goes as follows: "Trust can't be bought, it must be earned," which clearly shows how the platform promises to work for customer's trust through severe authentication processes (Abbiadati, 2024). The Consignment service, which is only offered in limited areas, even enables the seller to turn over the entire sales process to Vestiaire Collective—from writing the listing to shipping the item. This greatly limits the operational burden on the seller by giving Vestiaire Collective more control over the sale process. Besides this, professional sellers at Vestiaire Collective have access to personalized tools and a specialized team for support; thus, they are guaranteed a sound infrastructure able to respond to major resellers' needs (Vestiaire Collective, 2024). Vestiaire Collective has further cemented its business model through official partnerships with luxury brands like Gucci and Burberry. These raise the levels of trust and perceived quality by offering pre-authenticated items with fast shipping, critical for a positive customer experience. One of the most symbolic and of importance is Gucci's Preloved program launched in collaboration with Vestiaire Collective, underlining the brand's commitment to preserving its heritage of artisanal excellence. This program allows Gucci customers to return select bags for store credit in exchange for them, and to allow them to resell into a curated page on Vestiaire Collective. Besides extending the lifecycle of iconic Gucci pieces, it is also a chance for their beauty, craftsmanship, and emotional significance to be appreciated by new owners (Bellini, 2023). Boasting fifteen years of experience within the resale industry, Vestiaire Collective finds itself well-placed to offer 'Resale as a Service' to luxury brands and retailers alike. The program initiates long-term partnerships that allow brands to offer pre-owned luxury products to new clients while offering them a high-end, sustainable option in return.

Over the years, Vestiaire Collective has developed a strong commitment to sustainability, and in 2022, it decided to continue its personal campaign for sustainable fashion by imposing a new ban on the sale of 30 fast fashion brands. The list includes a number of very well-recognized names: Abercrombie & Fitch, Gap, H&M, Mango, Uniqlo, Urban Outfitters, and Zara. This measure is not punitive; rather, it was part of a greater project of consumer awareness. Every time users attempt to buy or resell products from these blacklisted brands, a message appears explaining why the brand is banned. Such brands, according to Dounia Wone, Vestiaire Collective's Chief Impact Officer, create overproduction and

overconsumption, which shows severe implications on both social and environmental grounds, particularly within the Global South (Gadeschi, 2023). According to the Vestiaire Collective Impact Report, a second-hand item is worn on average 88 times, which is 76% more than those produced by fast fashion brands.

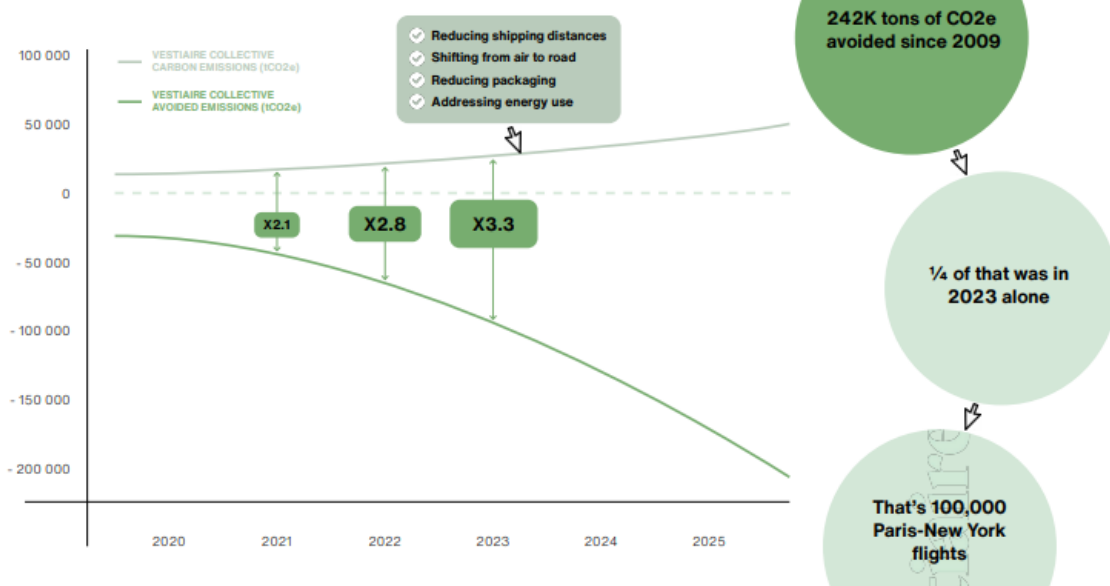


Source: (Vestiaire Collective, 2024)

Additionally, in 2023, Vestiaire Collective reinforced its commitment to sustainability with New York-based agency Reference through a striking campaign titled "Think First, Buy Second". This campaign was supposed to make people rethink before purchasing fast fashion. The campaign used AI-generated imagery, showing towering piles of discarded textiles sitting atop famous landmarks such as New York's Times Square, Paris' Eiffel Tower, and Rome's Colosseum-representative of the number of clothes wasted each year. Further, the company website housed an online guide complete with practical resources on how to donate your clothes and encourage sustainability, while also offering some suggestions for alternatives to fast fashion (Gadeschi, 2023). According to the estimates, buying second-hand through Vestiaire Collective reduces environmental impact by an estimated 90%. The company reportedly prevents three times the emissions it generates; due to the exponential growth of the company, its undertaking to lower carbon intensity sees it resulting in an increasingly positive climate impact without relying on offsetting measures.

As we're growing, we're also reducing our carbon intensity

Meaning that our net positive impact on the climate is widening, year after year.



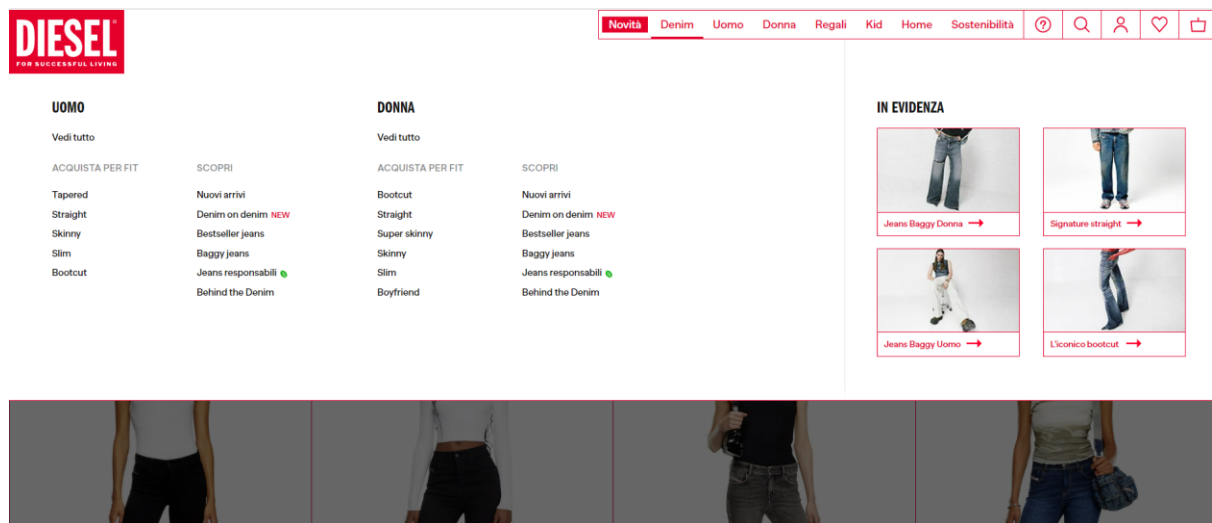
Source: (Vestiaire Collective, 2024)

Yet Vestiaire Collective also recognizes that the change of the fashion industry is not something it can achieve alone. The company keeps pledging an escalation in its efforts in the fight against fast fashion through demands for more controls on brands and textile manufacturers. In the European Union, it is advocating for more accountability within supply chains of fast-fashion retailers on waste management and exportation of textiles to low-income countries. In 2023, Vestiaire Collective called on the European Parliament and industry players to take responsibility for the rising issue of textile waste. It also partnered with Paris Good Fashion to draft a position paper that called for increased transparency and more explicit regulations in regard to the management of end-of-life textiles and waste exportation. The company underlines that this is a shared responsibility; urgent action is required, and not one that consumers can solely lead. The role of key industry players and politicians is now fundamental (Vestiaire Collective, 2024).

4.5.4 OTB Group & Diesel

Another important company that has a strong interest toward sustainability is Diesel. It is a lifestyle Company that was born in 1978 by Renzo Rosso, well recognized for having taken a leading role in the denim industry. From its origin as an avant-garde treatment of denim to become a premium fashion brand manufacturer, Diesel has been a distinctive alternative to traditional luxury. Its product range today includes apparel, accessories, and numerous

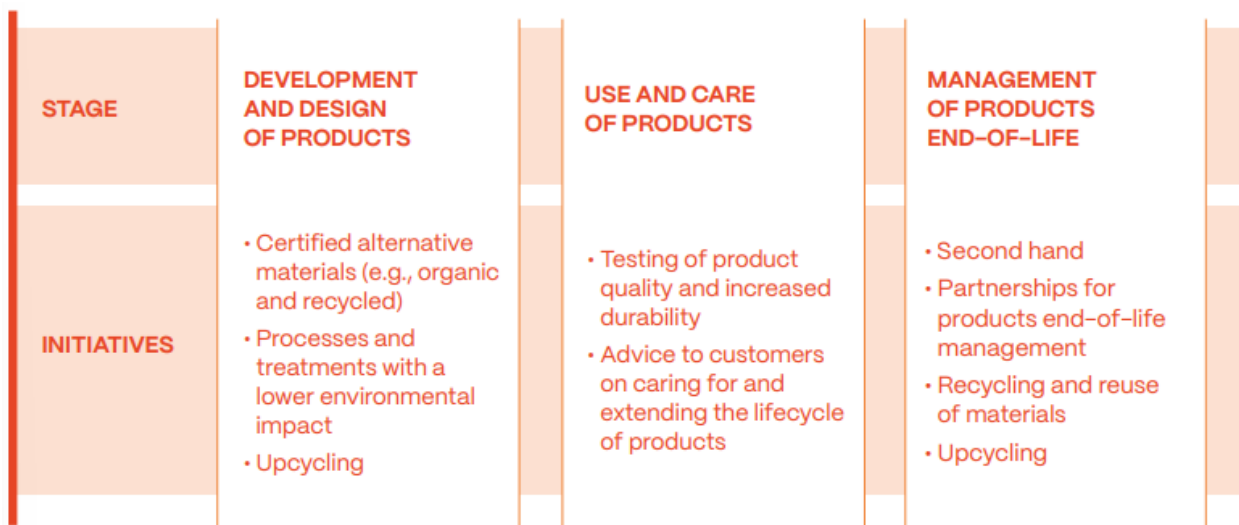
lifestyle collaborations that span from fragrances, watches, and jewelry to home furnishings and even real estate ventures under its Diesel Living division (OTB Group, 2024). Diesel is a core brand of the OTB group, which also operates other premium brands such as Jil Sander, Maison Margiela, Marni, Viktor&Rolf, Staff International, Brave Kid, and Amiri. The name of the group, "Only The Brave", says volumes about its commitment to challenging the status quo in fashion and creating a niche in creativity and style (OTB Group, 2024). Based in the small town of Breganze, home of the OTB group headquarters in Italy's Veneto region, this organization has risen out of obscurity into great heights within the fashion world. In this respect, it announced revenues of 1.9 billion euros with an EBITDA of 348 million at the end of 2023, at 19.6% of its net sales (NordESt Economia, 2024).



Source: (Diesel Homepage, 2024)

According to the commitment of Diesel to sustainability, Andrea Rosso, Sustainability Ambassador of the brand, has mentioned their ambitious aim to reduce environmental impact: "Towards zero is our manifesto dream. In 5 or 10 years, I would love for Diesel to be able to state that we have achieved everything we could achieve in terms of reducing the impact associated with the products we make" (Mahlich, 2024). This vision materializes in Diesel's "For Responsible Living" strategy, which points out the way to ensure continued brand success within a constantly changing world while acting in the best interest of current and future generations. Guided by four main founding principles-to foster alternative ways, protect the environment, embrace individuality, and live with integrity-the strategy is highly proactive. Diesel aims to create a culture of sustainability within the core of this organization, respecting the rights of employees and enhancing their diverse talents. Diversity would act as an enabler of growth that would help in fostering equality whereby workers would realize their full potential with guaranteed safe workplace conditions. It also focuses on responsible products, putting into practice low-impact materials to create innovative ways, teaming up

with its production chain partners to realize sustainable solutions. Moreover, Diesel is committed to guaranteeing respect for high social and environmental standards along the whole supply chain, with particular attention being paid to the traceability of products and the improvement of more responsible practices by suppliers. In response to the ongoing climate crisis, the brand is taking steps to reduce greenhouse gas emissions, decrease water usage, and enhance recycling and reuse efforts within its operations (Diesel, 2024). This last point is part of a greater strategy made by the whole OTB group. As part of the strategic priority of Sustainable product design & circularity, the group is committed to focus on the use of innovative materials with a lower environmental impact than traditional ones, such as organic cotton and recycled fabrics. The production method adopted provides priority for treatments, dyes, and trims that reduce the use of chemical substances and cut water consumption. Furthermore, the group intends to take action in the development of increasingly recyclable and recovered products. The latter focus is also extended to developing initiatives that are actually put into place to extend the life cycle of the products, such as second-hand market circular business models or special garment repair services. The diagram below shows the initiatives related to each phase (OTB Group, 2023):



Following the recommerce model, and in particular in-house branded recommerce model, Diesel in 2021 launched the project “Diesel Second Hand” offering a new version of its denim products, with each model meticulously regenerated, refurbished and made available in selected Italian stores (Milan, Florence and Rome) and online throughout Europe (Miele, 2021). Original Diesel denim garments are collected in select Italian stores, where they undergo a careful evaluation by a team of experts. These garments are then locally refurbished in collaboration with some of Diesel's top suppliers. Once the products have been thoroughly washed, sanitized, and repaired to address minor issues like missing buttons, faulty zippers, or light signs of wear, they are finished with a distinctive “Second Hand” logo (Diesel, 2024).

For previous owners, Diesel will offer a gift card worth up to €35 per item of clothing to be used on all items in the Full Price and Diesel Second Hand collections. In this way, the company aims to incentivize the re-use of its clothes following the new circular economy.

The company is full of initiatives. Just to mention some of them: at the beginning of 2023, Diesel diversified its sustainability development by introducing solar-powered watches with eco-friendly materials. These straps were made from #tide ocean material®, consisting of 100% post-consumer recycled plastic collected upon the coasts, and the case of the watch would be made from a bio-based material sourced from the castor oil plant. Later that year, at Salone del Mobile 2023, Diesel Living launched a range of sustainable textiles, including Getis, fully made from recycled polyester, and Hyle, which comprises 20% of recycled cotton. The REGLOBE pendant lamp was also unveiled by the brand, made from offcuts produced by recycled plastic. Another initiative is that Diesel launched a downcycling program, which collected 3,000 kg of prototype shoes and began the recycling of their rubber soles for materials suitable for athletic tracks and playground surfaces (OTB Group, 2023). Innovation is a strong component of the general strategy at OTB Group, and further confirmation came in October 2021 when it became a founding member of the Aura Blockchain Consortium, with other global luxury giants such as LVMH, Prada Group, and Cartier, a Richemont Group brand. In the same year, OTB introduced its sustainability strategy, "Be Responsible. Be Brave", reaching beyond all the brands and companies that make up the Group. This is underpinned by three core areas: environmental protection, product innovation, and social responsibility (FashionUnited, 2022). Thanks to mentioned initiatives and many others, in 2023 the OTB Group has been able to reduce by 2.3% in Scope 1, Scope 2 market-based and Scope 3 emissions compared to 2022, and to reduce by 19,2% in direct emissions (Scope 1 and Scope 2 market based) compared to 2019 (OTB Group, 2023). The group nowadays continues its commitment towards a greener planet; although, as Andrea Rosso reminds us, "For Responsible Living is a mindset that should be embraced by everyone who crosses the brand, starting with our employees, our suppliers but also all our customers" (Mahlich, 2024).

4.5.5 Results

The following table synthesizes the findings from these case studies, offering a comparative analysis that highlights key variables across each company. By examining their strategies and practices, we can gain valuable insights into how these entities navigate the complexities of sustainability while meeting the evolving demands of the fashion industry.

Criteria	Vinted	Vestiaire Collective	Diesel (OTB Group)
Business Model Variables	Peer-to-peer platform	Managed recommerce	In-house branded recommerce
	Focus on second-hand clothing	Luxury and premium second-hand goods	New versions of regenerated denim products
	User-driven marketplace	Professional and community-driven selling	Direct brand involvement in second hand market
Approach to sustainability	- Promotes sustainable consumption through reuse - Reduces waste by extending product life	- Commitment to luxury sustainability - Ban 30 fast fashion brands to raise awareness - advocates for stricter regulations on textile waste and supply chain transparency - Focus on high-quality authentication and minimal waste	- Emphasis on low-impact materials and circularity (e.g., organic cotton, recycled fabrics) - Focus on responsible supply chain practices and product traceability
Role of technology	- Digital platform enabling social interaction and feedback among users: social technology - Mobile app providing easy access for buying and selling: mobile technology - Verification services for luxury fashion items	- Technology for product authentication and quality control: use AI and human expertise to screen postings and filter out suspicious items - Use of AI for improving user experience and sustainability initiatives (e.g., “Think First, Buy Second”)	- Blockchain technology (Aura Blockchain Consortium) for supply chain transparency - Innovative technologies (e.g., sustainable materials like recycled polyester) - Technology in production processes (e.g., eco-

	- Expanded shipping solutions and payment services through Vinted Go	- Mobile and social platform	- friendly dyes, water reduction methods) - Digital platform for ‘Diesel Second Hand’
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Conclusion

In conclusion, this thesis has explored the intricate relationship between sustainability, technology, with a focus on second-hand clothing industry, underlining the urgent need for a paradigm shift in how businesses operate within the context of a rapidly changing global landscape. The findings emphasize that the difficulties faced by climate change, resource depletion, and social injustice need a shift from traditional linear economic models to more sustainable, circular ones. This transition could be a strategic necessity for companies aiming to prosper in an increasingly environmentally sensitive economy. As discussed in this thesis, sustainability brings numerous benefits to companies such as increased profitability and innovations, improved stakeholder relationships and brand differentiation.

The first chapter has established the fact that the adoption of Circular Economy principles by a company is vital to the development of its resilience. It brought into focus scientific consensus about climate change and, because of it, how there is multidimensional injury caused to ecosystems and human societies, emphasizing that during recent decades, degradation of the environment was contributed to considerably by human activities. It is here that the concept of the circular economy has come to be a shining beacon of hope, touting a model that calls for resource reuse, recycling, and waste minimization. As such, going by the principles of Circular Economy, companies are able to lower their environmental footprint while unlocking new avenues of growth and profitability. This idea has been further conceptualized through the Triple Bottom Line approach, which called upon organizations to look at their performances in terms not only of economic parameters but also social and environmental ones. Those companies that will be able to embody these principles into their operational models might enjoy a competitive advantage in the market, which increasingly values ethical and sustainable behavior.

For doing so, emerging technologies may help. For instance, the second chapter delved into the transformative role of digital technologies in facilitating this transition. The rapid advancement of digital tools—ranging from mobile technology and big data analytics to machine-to-machine communication—has revolutionized the way businesses operate. Using these technologies, companies are able to rethink their processes, achieve operational efficiencies, and make greener choices in line with the concept of the circular economy. With social technologies, companies can raise the awareness of consumers about sustainability issues and foster responsible consumption; through advanced recycling businesses, the volume of waste can be reduced, thus lowering pollution and damages to the environment. Finally, through modular design, companies may support the repair and maintenance of their

products, thereby extending their lifetime. Moreover, the integration of digital technologies not only streamlines operations, bringing benefits to companies, but also enhances the overall consumer experience, making sustainable choices more accessible and appealing for clients.

The third chapter focused on the emergence of innovative business models that prioritize sustainability, particularly within the context of the second-hand clothing market. The exploration of six sustainable business models—circular supply chains, recovery and recycling, product life extension, product-as-a-service, sharing economy, and recommerce—demonstrated how companies can repurpose waste into valuable resources while minimizing their environmental impact. What recommerce and sharing economy boom indicate, in particular, is a big cultural step towards responsible consumption, driven by younger generations above all-people who make decisions at the cash register with sustainability in mind. Just take a look, for example, at the market for second-hand clothing. It is an economic opportunity to spur growth and innovation rather than just a reaction against environmental challenges. We analyzed three types of recommerce: peer-to-peer marketplace, which is a consumer-to-consumer model where consumers can sell by themselves clothes they do not use anymore and give them a second life. Then, there is managed recommerce with one big company-like Zalando or Amazon-which provides a specialized service to manage the resale process on behalf of third-party companies. Lastly, the in-house branded recommerce model used by brands who would want to keep full control of the recommerce process. Yet, no matter the model, the purpose of this would all be the same: to reduce waste and elongate the clothes' life by giving them a second chance.

Chapter four provided an in-depth analysis of the second-hand clothing market, examining consumer motivations and the challenges faced by this sector. The findings revealed that younger consumers, particularly Gen Z and Millennials, are leading the charge towards more sustainable purchasing behaviors. Their preferences for second-hand clothing are highly influenced by aspects such as cost-effectiveness, being environmentally conscious, and the urge to own unique fashion items. However, the chapter also highlighted the challenges inherent in the second-hand market, including issues related to product quality, inventory management, and the need for trust and authenticity in transactions. For this reason, technology integration-from blockchain-enabled tracking of product quality to digital identities for garments-could present promising solutions to these problems and, in turn, heighten consumer confidence in such a marketplace through increased transparency.

Throughout this thesis, it has become evident that the intersection of sustainability and technology is not merely a theoretical concept but a practical imperative for businesses today. The twin transitions of circular economy and digital transformation create a fertile ground

where new opportunities are emerging for enterprises to innovate and rewrite value propositions. By embracing sustainable practices and benefiting from technological development, businesses are able to work in a manner that creates shared value with society, while continuing to enjoy economic prosperity. Company case studies such as Vinted, Vestiaire Collective, and Diesel clearly showcase how new business models are thriving in the second-hand market and thus can be an enabler of competitiveness and growth. Most importantly, the results of this research confirm that stakeholder collaboration forms the bedrock on which systemic change can be fostered. Indeed, businesses, consumers, policymakers, and civil society need to come together to create an enabling environment in which sustainable practices can take hold. This collaborative approach will lead to innovation, more transparency, and consumer trust flowing from it, eventually helping clear the path toward a more sustainable and equitable economy.

As we move to the future, it is clear that transition to a circular economy is not only an obligation but rather a direction to resilience, equity, and sustainability of life for all. Companies operating for sustainability help create a healthier environment in which to live and also position themselves as leaders in a rapidly changing marketplace. The results of this study reinforce the common commitment to the proliferation of sustainability best practices, promoting cooperation between stakeholders and systemic change that is symbiotic in the interest of economic and ecological advancement. This thesis serves as a call to action for businesses to recognize the interconnectedness of sustainability and technology, urging them to embrace innovative practices that align with the principles of the circular economy. By doing so, they can not only meet the demands of today's consumers but also contribute to a more sustainable and equitable world. This journey is about much more than compliance or risk management; it is about seizing the opportunities that come through commitment to responsible business practice. As we move forward, let us embrace the potential of the circular economy and digital transformation to create a brighter, more sustainable future for all.

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