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Circular Economy: A Study on Portuguese Fashion Brands

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Master in Management

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Resumo

Nas últimas décadas, tem havido um debate significativo sobre o tema da sustentabilidade. A sociedade está cada vez mais consciente dos danos ambientais, o que levou a apelos às empresas para que abordem o seu impacto.

A indústria têxtil e da moda, em particular, tem sido fortemente criticada pelas suas práticas altamente poluentes. Embora tenham sido feitos alguns progressos, o ritmo da mudança na indústria fica aquém das medidas urgentes necessárias para travar os danos ambientais que a mesma causa. Dada a importância deste tema, esta dissertação pretende abordar esta questão examinando a adoção de práticas de economia circular e sustentável na indústria da moda portuguesa.

O principal objetivo desta dissertação é compreender como as empresas em Portugal estão a implementar aspetos de sustentabilidade e economia circular nos seus modelos de negócio, ao mesmo tempo explorando os impulsores, barreiras, desafios e oportunidades que encontram.

Para tal, o estudo adota uma abordagem de estudo de casos múltiplos, envolvendo entrevistas semiestruturadas com fundadores de cinco empresas de moda portuguesas conhecidas pelo seu compromisso com a sustentabilidade. As empresas representam diversos segmentos do setor, incluindo vestuário, acessórios e calçado. A dissertação conclui propondo um modelo para orientar as empresas de moda, na implementação eficaz de práticas sustentáveis e de economia circular para facilitar a transição para uma indústria da moda mais circular em Portugal.

Palavras-chave: Indústria da moda, Sustentabilidade, Economia Circular, Modelos de Negócio Circulares.

Sistema de classificação JEL: Q56 e Q01

Abstract

Over the past few decades, there has been significant debate on the topic of sustainability, and society has become increasingly aware of environmental damage, prompting calls for companies to address their impact.

The textile and clothing industry, in particular, has come under heavily criticism for its highly polluting practices. Although some progress has been made, the pace of change within the industry falls behind the urgent action needed to stop has the environmental damage it causes. Given the importance of this topic, this dissertation aims to address this issue by examining the adoption of sustainable and circular economy (CE) practices in the Portuguese fashion industry.

The main purpose of this dissertation is to understand how companies in Portugal are implementing aspects of sustainability and CE within their business models, while exploring the drivers, barriers, challenges, and opportunities they encounter.

To achieve this, the study adopts a multiple case study approach, involving semi-structured interviews with founders from five Portuguese fashion companies known for their commitment to sustainability. The companies represent various segments within the industry, including clothing, accessories, and footwear. The dissertation concludes by proposing a phased model to guide fashion companies, in effectively implementing sustainable and CE practices to facilitate the transition towards a more circular fashion industry in Portugal.

Key words: Fashion Industry, Sustainability, Circular Economy, Circular business models.

JEL classification codes: Q56 and Q01

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List of Abbreviations

CE – Circular Economy

TBL – Triple Bottom Line

GSCM - Green Supply Chain Management

C2C - Cradle to Cradle

PaaS - Product-as-a-service

CSF - Connected Smart Factory

IoT – Internet of Things

RFID - Radio-Frequency Identification

BCT - Blockchain Technology

QR - Quick Response

GDP - Gross Domestic Product

SMEs - Small and Medium-sized Enterprises

DIY - Do It Yourself

VAT - Value Added Tax

CO2 - Carbon Dioxide

PESTEL - Political, Economic, Social, Technological, Environmental, and Legal

Chapter 1: Introduction

1.1 Context

Over the last decades, there has been much debate on the topic of sustainability. The continual deterioration of the environment and its negative outcomes have brought even more concern to this issue, and people have started to take notice of the industrial sectors that pollute the planet the most, such as those related to energy, transport, agriculture, food retail, and fashion.

The fashion industry itself is among the highest polluting and resource-intensive industries due to its great energy and water consumption, high carbon emissions, and use of chemicals that impact the environment (Provin et al., 2021). The industry's manufacturing process generates high amounts of waste that are hardly ever recycled or correctly disposed of. Moreover, raw material plantations, fabric manufacturing and landfill disposal of post-consumer fashion items are all guilty of generating significant environmental footprints (Shirvanimoghaddam et al., 2020). Furthermore, the boost in fashion items consumption and its consequent mass production demand have only aggravated the industry's threat to the planet's future (Esposito et al., 2018).

In this scenario, the Circular Economy (CE) model emerges as a new system that proposes closing the loop from production to consumption to preserve as many resources as possible and reduce the high absorption of finite resources. The CE system differs from the traditional linear model – and can be seen as a solution for significant environmental challenges prompted by the fashion industry, such as pollution, depletion of non-renewable sources, emission of greenhouse gasses, and the usage of massive amounts of water and energy. CE also encourages the creation of new and innovative business models.

In the fashion industry, adopting CE practices not only entails environmental preservation and the generation of as little waste as possible but also prioritizes equal rights for all people involved. Additionally, it enables the creation of more durable and usable fashion items made from renewable resources and destined to be recycled (Ellen MacArthur Foundation [EMF], 2017).

The implementation of the CE model in fashion businesses has been an object of study in several countries; however, challenges within this industry urge for applied case study research in different geographic contexts (Brydges, 2021). Considering that, the present dissertation has

opted to investigate how CE practices have been implemented in the Portuguese fashion industry. The research context is the Portuguese fashion industry.

1.2 Research Problem and Purpose

Compared to the linear economy system, the CE model offers significant and positive economic changes to the fashion industry. It calls for innovative thinking that enables the development of new ways to produce clothes intended to be recycled, rented and resold (Warwas et al., 2021). CE consists of an economic approach that allows the fashion industry to embrace sustainable development strategies with the purpose of avoiding environmental and social harm (Huynh, 2021). Despite CE's inherent challenges and considering that genuine sustainable production is still a long way from today's industrial reality, the theory behind this innovative economic model promises positive changes in the fashion industry (Kopnina, 2021).

Practices like recycling in manufacturing are initial steps some fashion companies are taking towards sustainability. However, these efforts are minimal and insufficient to embrace the full essence of CE, which requires innovative processes throughout the supply chain (Vasiljevic-Shikaleska et al., 2017). The fashion industry is progressing slowly toward an industrial paradigm that embraces circularity (Colucci & Vecchi, 2021), but uncertainty remains about whether brands are actively transforming their linear supply chains into circular ones (Brydges, 2021). While literature on CE implementation is extensive, the pace of academic research stays behind the urgent environmental issues posed by the fashion industry's linear model (Huynh, 2021).

To address the issue at hand and shorten the gap between theory and practice, the present dissertation aims to investigate a handful of companies in the fashion industry that have implemented CE principles in their businesses and put sustainable actions into practice. This study intends to contribute to the growing literature on the topic by exploring the interconnection between sustainability and the CE model, particularly focusing on examples from the fashion industry context due to this sector's negative environmental impacts.

1.3 Research Questions

The research questions have been defined considering the objectives that this research aims to achieve. Considering this, the following research questions will be explored:

RQ1: How are fashion brands engaging with sustainable and CE principles in their business models and across supply chains?

RQ2: What are the drivers and barriers to the integration of a sustainability and CE model?

RQ3: How are fashion companies incorporating sustainable and CE practices within the context of Industry 4.0's technological advancements, facing challenges and opportunities?

1.4 Research Objectives

In light of this dissertation's purpose of analyzing the implementation of sustainable practices and CE principles within the Portuguese fashion industry, the three defined research objectives are as follows:

(i) Understand how fashion companies in the Portuguese textile industry combine aspects of sustainability to create companies that operate sustainably in the broadest sense;

(ii) Identify the challenges companies face in integrating sustainable practices into their businesses and implementing a CE model; and

(iii) Create a possible model/guideline to support fashion companies in effectively implementing CE.

To attain these goals, it will be necessary to:

1) Define the concepts of sustainability and CE and identify its practices based on existing literature; 2) Differentiate existing circular fashion business models and practices through the existing literature; 3) Illustrate how circular practices are being adopted by Portuguese fashion companies; 4) Analyze the main drivers and barriers of implementing CE and compare them to the findings in the literature; 5) Appraise if 4.0 technologies could act as enablers of the CE; 6) Evaluate how Portuguese fashion companies are positioned in the adoption of Industry 4.0 technologies.

1.5 Research Methodology

To accomplish the research objectives, namely, to address the identified research questions, several steps were taken, as outlined below:

- A literature review was conducted to assess the current fashion industry and its relationship with sustainability, the CE and the impact that specific management approaches may have on the environment and social sustainability;
- Qualitative research methodologies, particularly semi-structured interviews and case study research, were followed to explore the current evolution and trends in using CE in the fashion industry. The goal is to find evidence of how Portuguese fashion companies are adopting CE practices in their supply chains, including the main drivers, barriers, and best practices for sustainable operations.
- In the obtained results, an analysis was conducted on each company's implementation of CE practices throughout the product lifecycle. The main objective is to understand and analyze how each company adopts circular and sustainable practices across supply chains. A Word Cloud was created for textual analysis of commonly mentioned terms from the interviews, and a PESTEL analysis evaluated external factors that could impact the companies.

1.6 Thesis Structure

The present study is divided into three sections: 1) literature review, 2) research methodology and 3) obtained results, findings and conclusions.

This dissertation is made up of six chapters. The first one contains an introduction to the work to be carried out, including contextualization and definition of the research problem, clarification of conceptualizing and defining the research problem and clarifying its importance and relevance—statement of the research questions, objectives and dissertation structure. The second chapter is reserved for reviewing the relevant bibliography. Introduction to the main concepts: fashion industry and its relationship with sustainability; the CE; CE in the fashion industry.

The conceptual model forms the third chapter, and the fourth specifies the research methodology. The fifth chapter presents the interview results and discusses them. The sixth chapter is reserved for conclusions where the recommendations model is presented, as well as limitations and suggestions for future work.

Chapter 2: Literature Review

2.1 Business in the Fashion Industry

It is widely known that urgent actions are required to create a sustainable future. Companies, alongside government and consumers, must put all efforts into making production processes, business models, and consumption patterns more sustainable (Turunen & Halme, 2021).

Much criticism has been directed towards the fashion industry due to its unsustainable practices, which lead to heavy environmental burdens and social harm. The industry's present-day predominant business model, namely fast fashion, is characterized by rapid production of garments driven by very demanding consumption patterns (Peters et al., 2021). Fast fashion consists of quickly changing trends, very low prices, poor-quality materials, and items often seen as disposable (Sandvik & Stubbs, 2019). According to the Ellen MacArthur Foundation (2017), clothing production volumes have doubled in less than two decades; on the other hand, clothing utilization (i.e., the average number of times an item has been used before disposal) has decreased around 36%.

With this model, companies can both increase sales and minimize costs. This system makes recycling and repairing unnecessary, as clothes frequently end up being discarded after a single use. Sustaining businesses with this model comes at the cost of the environment, of workers, and of society in general – seeing as pollution rates increase, climate change is accelerated, employees are underpaid and face poor working conditions, and so on (Fletcher, 2010; Peters et al., 2021).

Bocken and Short (2021) identify three key unsustainable practices in the fashion industry: 1) Environmental exploitation and waste due to reliance on finite resources and pollution from production; 2) Emphasis on quantity over quality leading to excessive consumption and production of low-quality items; 3) Complex global value chains resulting in environmental impact from global transport, and exploitation of workers in developing countries due to lack of trading transparency.

2.1.1 The Real Price of Fast Fashion: A Choice's Impact

The current fashion supply chain system – production, distribution and use – creates tons of waste and pollution. The fashion industry not only consumes high amounts of water during

cotton cultivation and textile manufacturing – on estimate, around 79 trillion liters per year (Niinimäki et al., 2020) – but also contributes to water pollution from textile treatments and plastic-based textiles. This pollution has led to plastic contamination in oceans, resulting in health implications for wildlife and the food chain (EMF, 2017).

This industry is also responsible for a great amount of greenhouse gases emissions during the manufacturing, distribution and use phase. Cotton cultivation can emit around 3.5 more CO2 in comparison to organic cotton (Niinimäki et al., 2020). To decrease CO2 emissions, synthetic fibers can be substituted by natural ones, but it should be noted that during the use phase, natural fibers will require a bigger energy consumption when washing, drying and ironing. The heavy use of chemicals during manufacturing processes presents another problem, and agrochemicals can cause serious health issues for workers and represent a threat to the environment, such as the decrease in soil biodiversity and fertility (Joy & Peña, 2017; Niinimäki et al., 2020).

The fast fashion system relies on trend replication and low-quality materials to produce inexpensive garments, leading to excessive consumption and disposal. This results in significant textile waste, including pre-consumer waste from production errors and unsold items, which are often incinerated. While incineration recovers some energy, it produces more greenhouse gas emissions and air pollutants compared to reusing and recycling. Post-consumer waste consists of clothes discarded by consumers after use, frequently end up in landfills, incinerated or sent to economically developing nations. Recycling rates are low in comparison to the amount of garment waste generated every year: only 0.5 million tons (around 1%) of total production was recycled for similar quality applications (EMF, 2017); 6.4 million tons were recycled into lower-value applications, and around 1.1 million tons were lost during collection and processing. To tackle this problem, recycling processes must be better embraced, and clothing production and consumption must be reduced (Niinimäki et al., 2020).

2.2 Sustainability Concept

The most formally and widely accepted concept of sustainable development is the one adopted by the United Nations' World Commission on Environment and Development in the 1987 report. The report, titled "Our Common Future," defined sustainable development as growth that meets the current generation's needs without jeopardizing future generations (Turunen & Halme, 2021; World Commission on Environment and Development, 1987).

Ben-Eli (2018) characterized the United Nations' definition of sustainable development as flawed and vague. To solve this issue, the author proposes a new definition. The definition is as follows: "A dynamic equilibrium in the process of interaction between a population and the carrying capacity of its environment such that the population develops to express its full potential without producing irreversible adverse effects on the carrying capacity of the environment upon which it depends" (Ben-Eli, 2018). For this study's purposes, the concept of sustainability will follow Ben-Eli's definition seeing as it rightfully covers the environmental, economic, and social dimensions of sustainable development.

2.2.1 Triple Bottom Line

Sustainable development is a holistic approach to achieving a human-ecosystem equilibrium, which is the goal of sustainability (Fung et al., 2021). The Triple Bottom Line (TBL) framework developed by Elkington in 1998 – one of the most known and used frameworks to operationalize sustainable development (Garcia-Torres et al., 2019) – consists of three areas: environment, social and economic (Fung et al., 2019).

According to Elkington (1998), the three pillars are connected to each other and should not be separated. Society is dependent on the economy, the economy on the environment, and in turn, the ecosystem's health represents the ultimate bottom line (Elkington, 1998).

Companies can use the TBL framework as a reference to create sustainable goals and measurements to develop the economy, support social welfare and protect the ecosystem (Fung et al., 2019). The economic pillar focuses on how business organizations impact the global economy (Elkington, 1998). The economic growth of companies is highly related to the economic system. If companies can set up sustainable profit measures, future generations will benefit from a healthy, growing economy (Fung et al., 2019).

2.2.2 Managing Sustainability in the Fashion Business

Managing sustainability within the fashion industry can lead to difficulties and tensions for companies when balancing sustainable practices with the commercialization of their products. Nevertheless, following sustainable practices is of great importance to the fashion industry, given its highly polluting linear supply chains. To implement sustainable product management, companies should be able to find a balance between short-term and long-term profit. Production, distribution, and disposal phases of their products' life cycle create great pressure

on Earth's finite natural resources; nonetheless, it is possible to mitigate these impacts by implementing sustainable strategies in all supply chain phases (Goworek et al., 2020).

Companies should concentrate on creating quality designs and on choosing raw materials that generate less environmental impact—for instance, the creation of fabric from recycled plastic materials has been a great innovation in recent years (Wren, 2022). When producing long-lasting clothes, brands can gain customers' loyalty by offering guarantees or even durability indicators on clothing labels.

To attain an industry that produces less environmental pressure, fashion companies must improve their sustainable supply chain management strategy by reconceiving their operations. Companies should aim to diminish the indirect impact of upstream and downstream activities. Should the industry widely adopt this strategy, it will significantly help reduce its environmental impacts (Wren, 2022).

2.3 Supply Chain Sustainability in the Fashion Industry

Following the overall increase in public attention towards sustainability, industries now face the challenge of redesigning the structure of the traditional supply chain and of developing manufacturing and production processes that take into consideration environmental and social concerns (Beamon, 1999). Notwithstanding, the fashion supply chain is rather complex, in as much as it involves different and interconnected steps and decisions; thus, companies must be able to identify demands in sustainable fashion and take appropriate measures for the use of resources throughout the whole supply chain (Fung et al., 2019).

The fashion supply chain is notable for its global spread and involvement in multiple industries, from agriculture and petrochemicals to manufacturing and retail. Fast fashion's rise has pushed brands to outsource production to low-labor-cost countries, reducing manufacturing in developed nations and complicating the traceability of materials. This shift contributes to environmental issues due to long-distance shipping and disposal of post-consumer waste in developing countries. Fast fashion also worsens environmental and social problems in such countries, such as pollution and unsustainable practices, worsening the industry's ecological impact (Niinimäki et al., 2020).

2.3.1 Supply Chains in the Fashion Industry

According to (Beamon, 1999), the traditional supply chain is defined by a linear path which includes all activities associated with resource extraction, product manufacturing and distribution to the final consumer.

The textile and clothing supply chain includes all processes from sourcing raw materials to making clothing available to consumers. Multiple companies collaborate globally to offer the right product to consumers at the right time and place, with the right quality and quantity.

Industry has historically followed a linear model, where resources are acquired from nature, processed, and distributed to consumers. After use, products are typically discarded, incinerated, or recycled. While recycling regulations help with waste management, products are not designed for biodegradation or remanufacturing. The issue is in the linear process itself – also known as "cradle-to-grave" – seeing as it expects products to turn into waste at the end of their life cycles, as they are disposed of after a single use (Sarkis et al., 2011).

Like other industries, the fashion industry follows an almost full linear model (Figure 2.1) comprising three different stages in the supply chain: (1) take – collection of raw materials; (2) make – production processes; and (3) waste – disposal of clothing after being worn (Brydges, 2021).

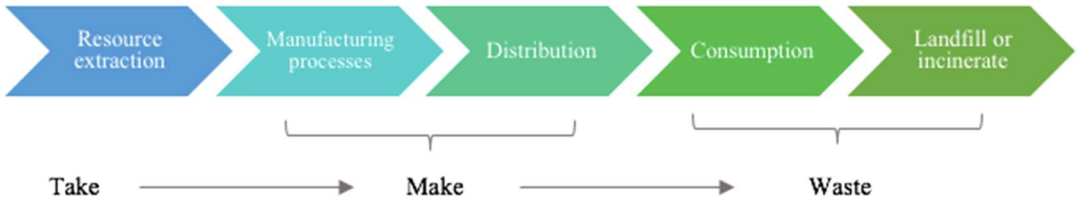


Figure 2.1: The linear economy model (Source: Ellen MacArthur Foundation, 2017; Brydges, 2021)

Traditional supply chain management focuses on optimizing activities, such as purchasing raw materials and turning distribution as efficiently as possible. Supply chain management plays an important role when it comes to business performance. However, this linear model is creating a significant pressure on the environment. Thus, there is an urgent call to change how the current system is operating (Beamon, 1999).

2.3.2 Incorporating Sustainability in Fashion Industry's Supply Chain

Green supply chain management (GSCM) aims to reduce pollution by integrating sustainable practices at various stages of the supply chain, including product manufacturing and design (Ying & Li-jun, 2012), supplier affiliations and organizational purchasing decisions (Woodside & Fine, 2019). GSCM not only helps in reducing environmental pollution but also enhances competitiveness and efficiency through better resource utilization, leading to economic advantages (Ying & Li-jun, 2012).

The fashion supply chain often involves different stakeholders (i.e. retailers, designers, manufacturers, distributors and consumers) and several processes connected to each other. Due to this complexity, cooperation between members is essential if the goal is to achieve a sustainable supply chain (Fung et al., 2019). Fashion supply chains should incorporate sustainability, considering not only environmental but social issues as well (Macchion et al., 2017).

In addition, green design should be applied during all stages of a product lifecycle, namely sourcing, production, distribution, and consumption. Companies need to consider resource consumption and sustainability concerns during the different stages, allowing them to prevent pollution from the source, preserve resources and reduce energy usage (Ying & Li-jun, 2012).

- Take Stage

Green procurement entails the use of green materials such as recyclable, recycled (Macchion et al., 2017), bio-degradable and reused materials. These materials should also be of low energy consumption throughout its production and should be environmentally friendly (i.e. create little or no pollution) (Ying & Li-jun, 2012).

Moreover, the focal company might have to apply supplier examinations to ensure environmental practices are being applied (Macchion et al., 2017).

- Make Stage

The high environmental impact created by manufacturing processes urges the development of new production technologies that help achieve the the "net zero emissions" goal (Macchion et al., 2017) and adopt systems to create less waste. Production processes should also be harmless to the workforce (Ying & Li-jun, 2012).

In search of lower production costs, several fashion companies move their production sites to countries with low labor costs, which are frequently distant from where the main organization is located. This, paired with worldwide shipping services (which most companies offer),

substantially increases impact on the environment. An alternative to this issue could be adopting low-carbon emission transportation to reduce atmospheric CO2 output (Macchion et al., 2017).

Ying and Li-jun (2012) state that choosing green packaging – namely from reusable, degradable, and recycled materials – is important as well.

-Waste stage

Green recycling or reverse logistics (Ying & Li-jun, 2012), is a highly potent scheme for the fashion industry (Macchion et al., 2017). Companies should contemplate different recycling approaches and adopt the best one in accordance with their chosen raw materials and produced merchandise, aiming to maximize value with minimum costs (Ying & Li-jun, 2012).

2.4 Fashion Changes Under a TBL Approach

In the past decade, clothing production increased exponentially. This rise can be attributed to fast fashion, which is characterized by low-cost garments and quicker turnaround styles (Fung et al., 2019). Clothes are bought in high frequency and quantity as they are produced to last little, promoting replacement (Shirvanimoghaddam et al., 2020).

- Environmental Pressure

The rapid growth of human populations creates a massive demand for natural resources. If this continues, future generations will have to face the problem of natural resource scarcity. For the last two decades, the fashion industry has experienced rapid growth, which in turn led to an increase in agricultural production. There is a need to plan agricultural productivity to avoid environmental impact (Fung et al., 2019).

Indeed, the clothing manufacturing process is incredibly wasteful and polluting, leaving a heavy environmental footprint derived from cultivation, fabric manufacturing and landfill disposal after consumer use (Shirvanimoghaddam et al., 2020).

The fashion industry is also one of the largest industries in terms of water consumption and pollution. The production of natural fibers is high and not only requires much water, but insecticides and preservatives are also used, resulting in a decrease in soil fertility. To overcome these issues, fashion companies should rethink their business models and supply chains. Minimizing their ecological footprint will allow them to protect the ecosystem and the planet's environment (Fung et al., 2019).

- Social Pressure

The textile industry also faces other issues related to occupational health and social problems. The use of hazardous chemicals in the dyeing process, fiber dust, noise and other repetitive processes can cause health issues for the workers (Shirvanimoghaddam et al., 2020). Clothing production usually only requires semi-skilled workers, leading companies to move to less economically developed countries, thus creating high employability and contributing towards social development (Kumar et al., 2017).

However, the low payment rate, lack of basic facilities, and child labor are ethical issues the fashion industry still faces. Ensuring labor equality and performing a fair business benefit the community and society. If companies trade fairly with their stakeholders, it will, in turn, allow them to pay their workers the right wages and provide a proper working environment (Fung et al., 2019). Companies can also implement tracing systems to control organizations in other tiers to ensure they are applying the right work conditions (Macchion et al., 2017).

- Economic Pressure

In 2018, only around 60% of purchased clothes were used, while the rest were never worn before disposal. The fast growth rate of population will lead to even more clothes being purchased and disposed of. Fashion businesses, such as fast fashion, lead to the rise of pollution and waste. Companies should, therefore, pay attention to new business models and strategies instead of only focusing on business growth (Fung et al., 2019).

2.5 Circular Economy Concept and Definition

The linear system is the most adopted form for supply chains around the globe. This open-ended system creates huge amounts of waste and is heavy on natural resources use. The linear economy is destroying the environment, therefore ruining the concept of sustainability (Fung et al., 2019). Boulding (1966) and Stahel and Reday (1981) propose a new concept to solve this issue: the closed-loop economy. This concept suggested how the end-of-life materials (previously seen as wastes) should be incorporated again in the production cycle. The closed-loop economy was the foundation of the CE (Fung et al., 2019). The Cradle to Cradle (C2C) system is a similar concept suggested by McDonough and Braungart (2002) that defends there is no such thing as waste, as all end-of-life resources would be incorporated in the

manufacturing system again. Both C2C and CE promote and defend the concept of resource preservation/ recycling and circulation (Fung et al., 2019).

The CE is a topic of academic interest as it is an innovative economic model associated with government policy, businesses and even consumers. The design, structure and objectives are restorative and regenerative. Products, components, and materials are designed to add, recreate and preserve value at all times. This economic model is therefore disruptive as it calls for a change in the present model and demands for the various aspects of production and consumption across the entire chain to be reevaluated. The CE definition covers different perspectives, from restorative waste control to problems that relate to design thinking and an efficiency approach toward consumption and production (Esposito et al., 2018).

CE can be defined as "a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops" (Geissdoerfer et al., 2017).Companies can apply the CE through different methods such as long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, recycling (Geissdoerfer et al., 2017), and reselling (Sandvik & Stubbs, 2019).

2.5.1 Circular Economy Principles and Activities

Despite sharing similarities, the concepts of sustainability and CE are not interchangeable (Geissdoerfer et al., 2017). The concept of sustainability can be adapted to different contexts and objectives, while CE focuses on gains for the environment and economic players that implement the system (Colucci & Vecchi, 2021).

CE is a new economy model that aims to overcome the linear industrial economy based on the "take-make-dispose" extractive model. The shift from an open-ended linear resource consumption model to a closed-loop production system will allow resources to have longer use and reuse as they are kept in loops, gaining value for a more extended period (Colucci & Vecchi, 2020).

A CE is based on the following principles: 1) design out waste and pollution: the model is designed to keep out the negative impacts of economic activity, such as the pollution of air, water and land; 2) keep products and materials in use: activities should be designed for durability, reuse, remanufacturing and recycling to keep products, components, and materials circulating in the economy; and 3) regenerate natural systems: avoids the use of non-renewable resources and enhances renewable ones instead (Esposito et al., 2018). The CE framework

(Figure 2.2) intends to work in closed loops in as many areas as possible, from production to consumption processes, allowing to decouple industries from natural resources and energy use, thus achieving sustainable growth (Vasiljevic-Shikaleska et al., 2017). These loops are associated with activities that go in line with the CE mentioned above principles: the products should be designed with durability and lifetime longevity in mind; reuse: preservation of the products' value such as incorporating byproducts and wastes into other stages of the product lifecycle; remanufacturing: product recovery, to an as-new condition at the end of its life; reduce the use of raw materials and energy inputs through production efficiency, leading to resource preservation and recycling: treat materials and turn them suitable for reuse (Colucci & Vecchi, 2020; Vasiljevic-Shikaleska et al., 2017).

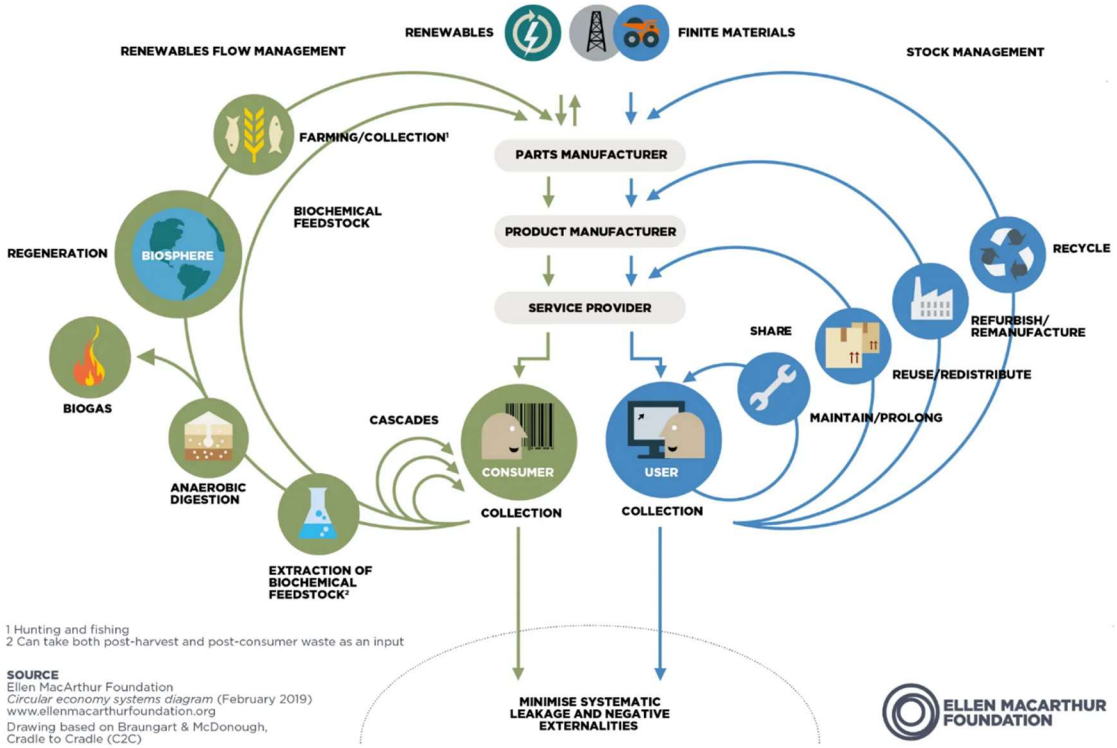


Figure 2.2: CE System Diagram (Source: Ellen MacArthur Foundation, 2017)

The CE principles and activities will affect how companies make a profit. Therefore, changing from a linear to a CE will require companies to adjust or change their existing business models (Colucci & Vecchi, 2020).

2.5.2 CE vs Fashion Industry

The mere recycling of materials is not enough by itself. Many other practices should not be overlooked. There is a need to develop and adopt innovative business models that help fashion companies transform business practices into circular ones (Huynh, 2021).

There are several possibilities for reducing the textile waste stream in different stages of the product lifecycle (i.e. resource extraction, manufacturing, consumption and post-consumer). This also offers opportunities for reducing this industry's negative environmental, social and economic impacts. In the manufacturing stage, the "rethink" strategy can be applied (e.g., making products fully biodegradable and using renewable resources) and "reducing" (such as energy consumption, natural resources, and materials). In the consumption phase it is possible to "reuse" (e.g. swap, borrow), and "repurpose" (e.g. use discarded product or its parts for another purpose). Finally, in the post-consumption stage, it is possible to "recycle" (like fiber, fabric and polymer recycling), "repair" (such as reselling products after restoring them) and recover (energy recovery from incineration) (Shirvanimoghaddam et al., 2020).

Fashion companies need to work alongside consumers. Brydges (2021), states there is little environmental benefit when the products are being consumed with a fast fashion mentality (i.e. buying and disposing after little use). Companies need to develop products and services that lead consumers to make sustainable choices and in turn, consumers must be willing to favor these products or services (Turunen & Halme, 2021).

2.6 Business Innovation and Circularity

The dominant economic model is highly inefficient, destructive, fragmented and creates tons of waste. However, through redesign and reconfiguration the industrial model could bring enduring and regenerative advantages (Ben-Eli, 2018). Given this unsustainable linear model, Esposito et al. (2018) highlights the importance of the creation and adoption of innovative business models (Vasiljevic-Shikaleska et al., 2017).

Vasiljevic-Shikaleska et al. (2017) distinguish circular business models into three main categories according to the different stages of the product lifecycle:

The Circular Innovation Model focuses on integrating circular approaches in different stages of the value chain, with action on product and process design and supply level. Materials and products should be designed as durable as possible, focusing on reuse, recycling, and use

of renewable energy and recyclable or biodegradable materials (Vasiljevic-Shikaleska et al., 2017).

The Circular Use Model focuses on the consumption phase, with business models focusing on value optimization. This includes sharing platforms, product-as-a-service (PaaS), lifetime extension models, and tracing facility models. This model offers pay-for-use services, leasing, rentals, and performance agreements (Esposito et al., 2018).

The Circular Output Model focuses on the recovery and recycling of by-products and waste streams to maximize revenue potential. Reverse logistics transforms waste into reusable resources using technologies like IoT (Esposito et al., 2018). Other activities include restoring used products (refurbishing) and fixing products (repair).

By building business models around CE principles, companies can increase profits while reducing material use through component recovery and remanufacturing (Esposito et al., 2018). Equally, some of these business models such as sharing platform and PaaS can extend the product lifecycle while still being able to offer newness to consumers (Colucci & Vecchi, 2020).

2.6.1. Challenges and Opportunities

As mentioned before, fashion supply chains can be extremely complex and fragmented involving different stakeholders, varying from internal stakeholders (such as brand managers/owners, designers, and employees) and external stakeholders (e.g., government and consumers). Despite some of the industry's efforts to embrace CE practices, this supply chain complexity represents additional difficulty in creating circular fashion (Ki et al., 2020).

The study of (Abdelmeguid et al., 2022) categorizes the challenges of introducing CE in the fashion industry into two subsections: hard aspects and soft aspects [human-related aspects such as organization culture, as described by Bertassini et al. (2021)].

- Hard Aspects:

Business Innovation: The challenges here relate to the complexity of implementing CE activities (Abdelmeguid et al., 2022).

Regulatory pressure: The lack of government regulations is a challenge during the transition to a CE business model and impacts significantly on how companies operate (Kumar et al., 2021). Abdelmeguid et al. (2022) highlight that small and medium-sized enterprises

(SMEs), in particular, require government assistance when transitioning to a CE business model.

Stakeholder pressures: Stakeholder pressures can delay the adoption of CE practices, Effective communication within the organization, with other organizations, and with consumers is crucial (Abdelmeguid et al., 2022). However, companies can transform this pressure into opportunity by collaborating with other companies, such as implementing take-back schemes.

- Soft aspects:

Green human capital: This challenge is associated with the lack of human resources knowledge in CE practices.

Green structural capital: relates to organizational values, which can be challenging if a brand's culture is not sustainability and CE oriented (Kumar et al., 2017; Abdelmeguid et al., 2022).

2.6.2 Drivers and Barriers

Despite the adversities, there are also factors which motivate the industry to adopt CE practices. Ki et al. (2020) identified through their study a set of fashion drivers for the implementation of CE in relation to the internal and external stakeholders.

Internal drivers, motivated by internal stakeholders, comprehend business opportunities (such as creating new businesses) and price competitiveness. For the external drivers, costumer’s awareness and governmental policies and rules were identified as the primary motivational factors. The drivers motivated by both internal and external stakeholders were environmental concerns (such as the importance of protecting the environment against the industry’s ecological footprint), health concerns (e.g., use of toxic chemicals), and technological improvement (such as the development of more resource-efficient production technology).

Regarding CE barriers that fashion companies face, they can also be classified based on internal and external stakeholders. For the internal stakeholders, management barriers such as lack of cooperative management can be identified, which include lack of management support or consistency. For external barriers, the lack of consumer awareness (e.g., not knowing how to dispose of old clothes correctly) and the lack of government-supportive laws and policies were identified. For internal and external barriers, it was identified, the lack of technological

innovation derived from the necessity of significant investments and the rapid shifts in the fashion industry, knowledge barriers such as the lack of skills related to the CE and economic barriers, which include investment cost with the implementation of CE (Ki et al., 2020; Ly & Tan, 2021).

2.7 Industry 4.0 and Sustainability

2.7.1 Industry 4.0 enabling circularity for the fashion industry

The transition of traditional economy models to a CE can be quite complex. Some circular business models, such as service-based, sharing consumption, take-back and second-hand models, present CE solutions for the fashion industry. However, digital innovations, in particular, present great potential for fashion business models (Huynh, 2021).

Industry 4.0 aims to create a communication system between production equipment and products within a connected smart factory (CSF), defined as "a hyper-connected network-based integrated manufacturing system that promotes the monitoring and autonomous control of all processes" (Nascimento et al., 2019). Blockchain technology (BCT), is transformative for fashion supply chains as it improves operational efficiency and productivity (Nascimento et al., 2019). This approach facilitates effective demand forecasting, reduces overproduction, and minimizes fraud while also enabling the selection of sustainable suppliers. Additionally, blockchain enables the verification of product information, supporting recycling and reuse efforts, contributing to textile waste reduction (Wang et al., 2020).

However, Industry 4.0 technologies have challenges like the need for specialized skills and high capital costs. Despite this, smart production systems can support business sustainability and positively impact sustainability performance (Nascimento et al., 2019).

2.7.2 The Importance of Traceability

Companies have understood the importance of sharing information with consumers about their sustainable practices. However, in some cases companies look at sustainability as a marketing tool. Without it, companies might be accused of "greenwashing" (i.e. making a product appear more sustainable than it really is). Traceability helps communicate various product information to customers such as environmental and social impact, raw materials, component history, and logistics data, building consumer trust in product sustainability (Kumar et al., 2017).

Traceability can be defined as “the ability to trace the history, application and location of that which is under consideration, and for products this can include the origin of materials and parts, the processing history and the distribution and location of the product after delivery.” (International Organization for Standardization, 2011). This tool enables transparent information tracking back to the original source using a unique traceability number with the use of labels like RFID tags and QR bar codes, to provide clear information (Kumar et al., 2017). For companies, collecting information from other parts of the supply chain is crucial for making credible sustainability claims.

Despite the advantages, implementing traceability can be costly and challenging. The investment needed might be too high for smaller companies, and there are also issues with technological complexity and consumer privacy (Kumar et al., 2021).

2.8 Literature Review Main Outcomes

The fashion industry linear supply chain system is heavily polluting and creates enormous environmental pressure due to its resource intensive processes and materials. Fast fashion in particular, relies on trends and low-quality garments, incentivizing overconsumption and quick disposal of garments after little use, creating great amounts of waste.

Despite the growing sustainability awareness, the industry remains unchanged. This resource intensive model calls for a change to redesign the supply chain, to integrate environmental and social practices.

CE surges as an alternative economic model, that allows resources to have longer use as they are kept in loops from production to consumption. Activities such as reuse, remanufacturing and recycling offer incredible benefits to the fashion industry, minimizing consumption and waste. Additionally, new business models such as Circular Innovation Model, Circular Use Model and Circular Output Model provide great opportunities to this industry.

Implementing sustainable and CE practices can be challenging. Companies, and in particular SME’s, face several adversities such as financial barriers and lack of consumer awareness. However, opportunities can also arise, such as collaborating with other companies, to implement take-back schemes.

Furthermore, Industry 4.0 technologies like blockchain present amazing potential for the fashion industry. This approach helps to reduce overproduction, enables the verification of

product information, supporting recycling and reuse efforts, contributing to textile waste reduction.

Chapter 3: Conceptual Framework

A conceptual framework is a structure the author believes can best explain the natural progression of the phenomenon to be studied. It represents the researcher's idea of how the research problem should be explored and describes the relationship between the main concepts of the study, showing how ideas can relate to each other (Adom & Hussein, 2018). Also, a research framework is the key step from formulating the research objective to the set of research questions.

As referred to in section 1.3, the main objectives of the research are:

1. to know how the fashion-related companies in the Portuguese clothing industry are combining the aspects related to sustainability to create businesses that operate sustainably in the broader sense;
2. to identify the challenges faced by the companies to incorporate sustainable production practices towards a CE; and
3. create a possible model to provide support for fashion companies in the effective CE implementation.

This study will assess the factors that influence the sustainable choices made by Portuguese fashion-related companies. It will also focus on how these companies' business models follow CE principles.

As duly described in Chapter 4, the study will use semi-structured interviews with different stakeholders (retailers and fashion experts). Therefore, this research is characterized by evaluative and descriptive research forms. Scientific literature will be used to identify key concepts and create an analytical model.

Table 3.1 represents the research perspective sources. The first column refers to the key concepts used in this study, while the second column presents the main theories used to address the subject of this study.

Table 3.1: Sources of Research Perspective

Key Concepts	Theories	References
Sustainable Fashion Companies	Sustainability Theory	(Brydges, 2021); (Ying & Li-jun, 2012); (Macchion et al., 2017)
Circular Economy	Circular Economy Theory	(Geissdoerfer et al., 2017); (Fung et al., 2019); (Colucci & Vecchi, 2020)

With this in mind and revisiting the research questions (Section 1.4) the present conceptual model (Figure 3.1) was created based on the literature review.

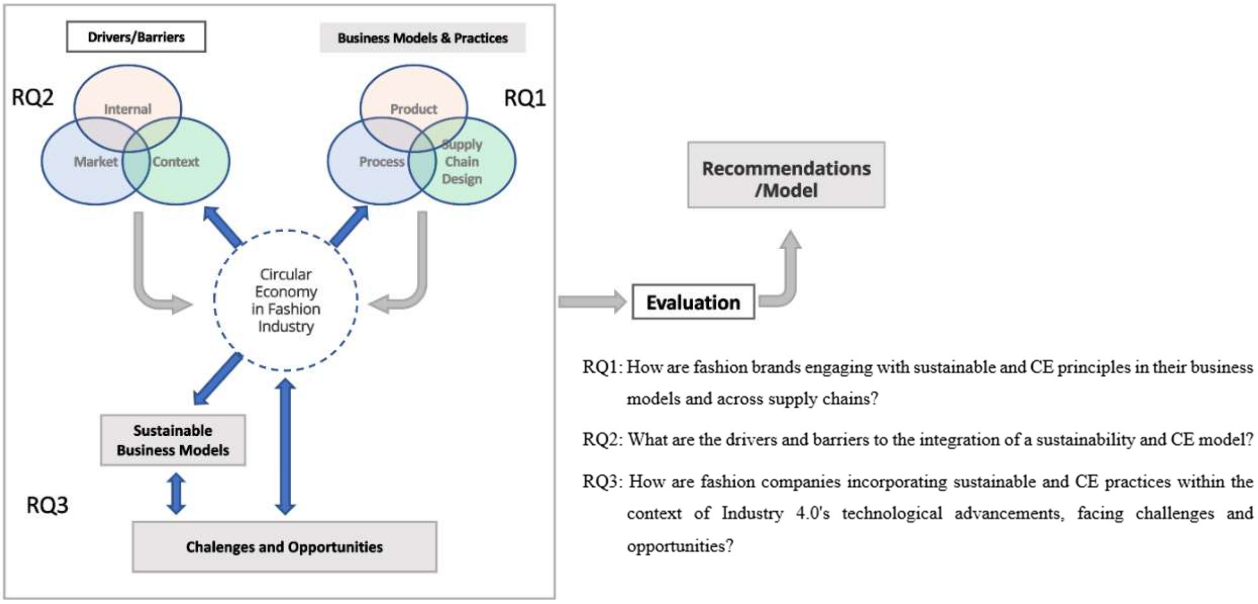


Figure 3.1: Conceptual model

The main aim of this dissertation is to analyze the adoption of the CE in the fashion industry. As such, the concepts detailed in the previous chapter should be connected to allow answering all the Research Questions, enabling the reader to understand the theoretical connection of this dissertation.

In section 2.5, emphasis was given to the importance of the CE as a new production and consumption model, working in closed loops from production to consumption, preserving as many resources as possible. To respond to the challenges the fashion industry creates, companies need to embrace CE practices, which will only be possible by changing their operations, i.e., their supply chain design, production and manufacturing processes and products. These changes will allow resources to be used more extensively and reused as they are kept in loops, gaining value for a longer period.

However, implementing the CE in the fashion industry has motivations and adversities. Moreover, internal or external factors (market and context) can have an influence on these drivers and barriers. Adopting the CE in the fashion industry can bring numerous opportunities. Industry 4.0 technologies support decision-making and boost business, but some challenges remain to be overcome since the implementation of technological innovation is very complex.

Nevertheless, successfully implementing sustainable and circular practices into business operations is crucial for fostering innovative and sustainable business models.

Below, the research questions initially posed in Chapter 1 are revisited. Different propositions were developed based on the insights gained from the literature review. This step helps to establish a link between the base theory of this study and the empirical investigation that will follow. The propositions, based on the literature, serve as informed assumptions that will help the formulation of the interview guide. This approach ensures that the interview questions are relevant to address the specific research objectives.

Regarding RQ1: How are fashion brands engaging with both CE and sustainable principles across supply chains?

- Proposition 1: Companies design their business models around new activities by adapting their processes, products, and supply chain design to achieve sustainable development and circularity.
- Proposition 2: Companies (re)design their business models by adapting their processes and product designs to achieve sustainable development and circularity, but they do not see the need to take specific action in the supply chain.

Regarding RQ2: What are the drivers and barriers to integrating a sustainable and CE model?

- Proposition 3: Societal and environmental concerns are the main drivers to adopting sustainable and CE practices.
- Proposition 4: Gaining a competitive advantage is a driver for adopting sustainable and circular practices.
- Proposition 5: Growing consumer awareness is a driver for adopting sustainable and circular practices.
- Proposition 6: Internal barriers, such as financial barriers, and external barriers, such as social awareness and government policies, are the key inhibiting factors in the implementation of CE practices.

Regarding RQ3: How are fashion companies incorporating sustainable and CE practices within the context of Industry 4.0's technological advancements, facing challenges and opportunities?

- Proposition 7: Fashion companies that implement Industry 4.0 technology into their CE practices can seize numerous opportunities, which in turn allow their business models to reach their full sustainable potential.
- Proposition 8: The technological complexity associated with Industry 4.0 can challenge companies' business models.

Chapter 4: Methodology

The present chapter introduces the methodological elements employed for the investigation, aiming to answer the hypotheses, research questions, and partial objectives. Additionally, it intends to elaborate on the tools used for conducting the analyses.

4.1 Research Context

As already mentioned, this dissertation aims to analyze the adoption of sustainable and CE practices in the fashion industry.

The textile and clothing industry is one of the oldest industries in Portugal. Nowadays, it represents one of the country's biggest and most important business sectors. This industry represents around 18,3% of the Portuguese manufacturing industry and 4% of the GDP, making it an important sector for the economy (Direção-Geral das Atividades Económica [DGAE], 2018).

However, the fashion industry is one of the most polluting and resource-consuming industries. Besides wasting great amounts of energy, its high carbon emissions, water consumption and use of chemicals, this industry also generates high amounts of waste, both during manufacturing but especially post-consumer waste. The mass consumption of fashion items also represents a significant environmental threat. Clothes disposed by consumers after use most times end up in landfills or incinerated. The CE can represent a solution for the enormous environmental challenges created by the fashion industry, such as pollution, the reduction of natural resources consumption, emission of greenhouse gases and the use of massive amounts of water and energy while creating new business model opportunities. Fashion items can be more durable and used, made to be recycled and from renewable resources while minimizing waste as much as possible.

Regarding sustainability and CE, the Portuguese clothing industry stands out for being innovative and environmentally friendly. Some highlights are the creation of textiles from biodegradable materials (such as cork and rose stem) and textiles from manufacturing waste or plastics recovered from the sea (DGAE, 2018).

4.2 Research Design

To understand sustainability and circularity in the fashion industry, it is important to understand why and how organizations adopt certain principles and practices. This can be better investigated through dialogue directly with the people who face these issues. This work is characterized by its exploratory nature, emphasizing an investigative and inquisitive approach. A part of the methodological approach is the use of bibliographical research that was conducted during research:

(i) The literature review defined the scope and theoretical foundation, focusing on the following research areas: Drivers and barriers to the CE in the fashion sector, sustainable business models, fashion supply chains, risk, resilience, capability, and trust. The literature review was conducted using the Scopus and Science Direct databases. Within these databases, terms related to the research subject were employed, including "Circularity in Fashion + Fashion Supply Chain + Risk," "Fashion Supply Chain + Resilience + Capabilities," and "Supply Chain + Sustainable Business Models + CE Drivers in Fashion Sector + CE Barriers in Fashion Sector".

The resulting articles were categorized, and their abstracts were read and analyzed to assess their relevance to the study's theme and objective.

(ii) A semi-structured interview consisting of 11 questions was used to collect primary data. The instrument was applied to a sample of five legal representatives from companies within the fashion and textile sector who responded to the invitation to participate in the research. Subsequently, an extensive explanation of this stage is presented.

The main data source for this dissertation consists of primary data collected through semi-structured interviews with managers of Portuguese fashion brands and secondary data gathered through social media, incorporating internal data (from the communication channels of the studied companies).

The study selected brands via social media and magazines, inviting representatives for interviews. The guide focused on their adoption of sustainable and circular economy principles, discussing challenges, opportunities, and digital innovations. Secondary data from brand websites assessed how Portuguese fashion companies align with sustainable demands and transition to a circular business model.

The interview questions were formulated in accordance with the research questions and propositions, which are comprehensively outlined in Chapter 3. Table 4.1 contains an overview of interview questions, goals, and propositions. A detailed table can be found in Annex A.

Table 4.1: Overview of Interview Questions, Goals, and Proposition Alignments

Interview Question	Research Question	Goal	Position Alignment
1	1	Appraise if the supply chain incorporates sustainability in the manufacturing process (make stage).	Proposition 1 or 2
2	1	Evaluate if sustainability is integrated into the distribution phase (make stage).	Proposition 1 or 2
3	1	Evaluate if sustainability is integrated into the distribution phase (make stage).	Proposition 1 or 2
4	1	Evaluate if sustainability is integrated into the distribution phase (make stage).	Proposition 1 or 2
5	1	Evaluate if sustainability is integrated into the distribution phase (make stage).	Proposition 1 or 2
6	1	Assess sustainability in the consumption phase (waste stage).	Proposition 1 or 2
7	1	Assess sustainability in the end-of-product life phase (waste stage).	Proposition 1 or 2
8	2	Understand the motivations and facilitators driving the adoption of sustainable and circular practices.	Proposition 3, 4, 5
9	2	Understand the challenges and barriers to the adoption of sustainable/circular practices.	Proposition 6
10	3	Determine if companies in Portugal are integrating new technologies into production processes.	Proposition 7 or 8
11	3	Find out if companies are using new traceability methods to ensure transparency in their final product.	Proposition 7 or 8

4.3 Data Collection

Both Primary and Secondary Data were utilized for information collection in this dissertation. Semi-structured interviews were employed to gather primary data, and the analysis was mainly qualitative. This type of exploratory approach is typically used to address questions such as "what" and "why," allowing the interviewees to elaborate on their responses, leading to a rich and detailed dataset (Saunders et al., 2009). Semi-structured interviews follow a predefined set of questions but can be adjusted based on the interviewee's subject. This research uses a qualitative approach with semi-structured interviews as part of a multiple case study strategy.

Secondary Data was gathered through social media, incorporating internal data (from the communication channels of the studied companies) and external data (from social media and news websites).

4.4 Data Handling

The interviews were conducted and recorded with permission for later transcription. Subsequently, the transcripts were coded based on the dominant themes, utilizing content analysis as a research technique. Organizing and categorizing the responses into themes facilitated data reduction, enabling further analysis and theory development (Brydges, 2021). Sensitive excerpts related to the companies were deliberately omitted from the records due to the need for data.

A Word Cloud was created to create a textual analysis of the most common words documented in the interviews. Additionally, a PESTEL analysis was conducted to evaluate the external factors that can impact the companies interviewed.

Chapter 5: Results and Discussion

5.1. Case Study Selection

This dissertation uses a multiple case study approach to analyze the application of CE principles in the fashion industry, aiming to bridge the gap between theoretical frameworks and practical implementation. It examines companies successfully integrating sustainability, exploring their motivators, challenges, and barriers while assessing stakeholder awareness of Industry 4.0's role as an enabler to the successful implementation of CE practices.

To begin with, an extensive review of the existing literature was conducted to understand the relevant topics selected for this study. This exploration facilitated the development of pertinent ideas and concepts. Primary data was gathered through semi-structured interviews. Five case studies were carefully chosen, involving the founders of each company. The companies are either small-sized or startups and were chosen to explore differences in implementing sustainable and CE practices within the same industry, understand their limitations, and gain insights into their specific projects.

The interviewees (Table 5.1) included the CEO and founder of *Vintage for a Cause*, a company dedicated to upcycling clothing and accessories; the co-founder of *Wayz*, a shoe company focused on eco-friendly and recycled materials; the founders of *GreenYouthClothing*, a startup promoting biodiversity and ecosystem protection; and the founder of *Circonstance: From Waste to Useful*, an eco-friendly accessory brand combatting single-use plastic. Lastly, the founder of *BirdWalk*, a company producing sustainable bags, was also interviewed.

Table 5.1: Summary of research participants

Brand	Abbreviation	Position	Industry Segment
Vintage for a Cause	H.A.	Founder	Upcycled Apparel
Wayz	P.M.	Co-founder	Sustainable Footwear
Green Youth Clothing	M. & S.	Founders	Sustainable basic apparel
Circonstance: From Waste to Useful	C.	Founder, Designer	Sustainable Accessories
BirdWalk	S.V.	Founder, Designer	Sustainable Accessories

Finally, secondary data was gathered to complement the primary data from various sources, including the companies' websites and social media channels.

5.2. Data Analysis

According to Chizzotti (2006), content analysis aims to critically comprehend the meaning of communications, exploring both their manifest and latent content, explicit or hidden significations. Deciphering the underlying message is essential. Bardin (1977) defines content analysis as examining communication and inferring knowledge about production or reception conditions using qualitative or quantitative indicators. This research adopts Bardin's (1977) method, which includes the following phases:

a) Pre-analysis: Involves organizing materials in four stages: initial reading for text familiarity, selecting and focusing on key documents, formulating hypotheses and objectives, and referencing indices and indicators from document text extracts.

b) Material exploration: Defines categories, identifies and counts record units, and considers context to clarify the meaning of each unit of record.

c) Treatment of results, inference, and interpretation: Involves condensing information for analysis, followed by inferential interpretation through intuition, reflection, and critical analysis.

The data were analyzed descriptively, and interviewees' verbalized perceptions were reproduced. Bateson (2000) argues that analyzing content without context leads to flawed results, stressing the need to view the system rather than fragment it. Several questions were asked to understand the sustainability and CE activities implemented and the reasoning behind each strategic decision. The focus was on gaining insight into the motivations driving the brand's choices in adopting specific sustainable practices. The grouping of content units extracted from interviews is provided in Annex B, which presents the ensemble of Preliminary Thematic Categories.

5.3. Results and Discussion

As already stressed (section 1.3), The dissertation aims to provide insights into implementing CE and sustainability practices in the Portuguese fashion industry. It will address drivers, barriers, challenges, and opportunities and develop a model to support fashion companies implementing these practices. The results will be discussed in the following sections.

5.3.1 Sustainability as the Main Brand Principle and Motivation

When asked about the primary motivation and factors influencing most of their decisions, all interviewees agreed that sustainability was the main consideration. Companies were often already established from the beginning with sustainability as a foundational principle rather than a secondary objective. The dedication to sustainability is evident in business decisions.

All the companies interviewed acknowledge the fashion industry as one of the most detrimental industries to social welfare, primarily due to its pervasive poor working conditions. Accordingly, P.M states *"Every day we receive proposals in countries where it would certainly be much cheaper to produce shoes rather than producing in Portugal... But in that case Wayz wouldn't exist. It doesn't make sense to us"*.

-Local Production

The companies interviewed emphasized the importance of local production for their brands. They mentioned reasons such as minimizing CO2 emissions, ensuring fair working conditions, supporting Portugal's local economy and family-owned factories.

H. highlighted that all garments are handmade by senior sewers, providing more opportunities for women over 50 and preserving traditional sewing techniques: *"We produce locally in an artisanal way through independent senior seamstresses, ensuring higher quality, smaller quantities, pre-booking on-demand production while maintaining greater control over production management and lower environmental costs".*

-Low-impact Materials

To calculate the footprint of each sneaker, Wayz made a lifecycle assessment of their vegetable leather and vegan shoe selection. It was found that the vegetable-tanned leather collection emits 16,2 kg of CO2 per pair, which reduces 1,6 kg of CO2 (-9%) compared to fast fashion sneakers. The vegan collection emits 6,8 kg of CO2 per pair, reducing 3 kgs of CO2 (-31%). Wayz has offseted 28 tonnes of CO2, corresponding to the pairs produced from 2019 to 2021, to become a carbon-neutral brand. This process has been certified by the United Nations (Wayz, n.d). The use of eco-friendly materials, for instance, can reduce part of the environmental footprint resulting from the production processes. Similar results were found in (Guo et al., 2023).

This type of lifecycle assessment is also important for showing the consumer the direct impact that material choice has on the environment.

5.3.2 Circular Economy Activities

-Longevity and Durability

Longevity and durability, whilst tackled differently by the selected companies, were identified as the fundamental factors behind the implementation of the different sustainability and CE activities – *"I know that the material, the fabric, is very solid and resistant. It's not something you are going to throw away after one year. That was the idea, of course."* – respondent C. indicated. Indeed, one of the main issues of the fashion industry, particularly for fast fashion, is the over-consumption of garments, mainly in an industry where the supply chain is already extremely polluting.

Studies have revealed that clothing longevity – i.e., a product's total life span, which can be achieved through design for durability, maintenance, and re-use of clothing – is one of the most successful ways to reduce the fashion industry's environmental impacts (WRAP, 2012). According to WRAP (2012), if a garment's life span is increased by an additional 3 months of usage, it would result in a 5%-10% drop in carbon emission, water consumption, and waste footprints. With a 9-month usage increment, the reduction of those three environmental impacts would be 20%-30%, which represents a significant sustainable gain. However, these two critical factors will only achieve positive effects when companies work alongside consumers: if fashion items can last longer, fewer clothes need to be bought. Consumers should be aware of the impacts of overconsumption. Therefore, companies should think of ways to educate consumers.

-Repair and Repurposing

Upcycling reduces environmental impact by repurposing deadstock fabrics from other companies. Upcycling deadstock effectively reuses textiles, avoiding potential waste and reducing the consumption of natural resources. Vintage for a Cause offers DIY Kits, free videos with tips on caring for and repairing clothes, and workshops to promote repair and creation. Wayz extends the product's lifespan by offering the option to replace worn outsoles with new ones, and the replaced outsoles are recycled. Circonstance: From Waste to Useful uses fabrics made from 100% post-consumer recycled polyester yarn from plastic collected from the ocean to reduce marine plastic pollution.

-Take-back Programs

Three brands have implemented a take-back system called "Sell 1 Buy 1" in collaboration with White Stamp. Customers fill in a form to sell their garments and receive credit for purchasing new items from partner brands. Verified items are introduced into the second-hand market to maximize its lifecycle. Items that do not meet the criteria are donated.

5.3.3 Barriers

-Financial Limitations

Financial constraints were identified as the main barrier. Brands unanimously acknowledged the difficulty of investing in new practices where the return on investment is not immediate. According to H. "*Big companies have all the resources, but significant structural changes carry a high risk.".*

Furthermore, when a company opts to transition its products to become more sustainable, whether by incorporating new materials or adapting its supply chain, a transition period is necessary. As S.V. shared: *"When we're searching for new suppliers, transitioning to more sustainable production creates a financial strain. It's an ongoing process, and we hope to see the benefits soon.".*

Additionally, the high cost of sustainable materials contributes to an elevated final product price, creating a substantial barrier to adopting additional sustainable and circular practices within the company. As described by C. *"My product is quite expensive - 85 euros, but I couldn't price it any lower. Production costs alone are over 35 euros, not to mention the 23% state taxes. While we understand the environmental benefits, consumers can find similar products for 20 euros at stores like H&M.".*

-Lack of Supportive Governmental Laws

The lack of supportive governmental laws was identified as a barrier to adopting circular practices. For instance, when a secondhand product is sold, the company is still required to pay VAT, even if the tax was already paid during its initial sale.

-Lack of Consumer Interest

Companies recognize the challenge of promoting sustainable products as customers are often unwilling to pay more for sustainable options. Many prioritize fast fashion over sustainable clothing. According to P.M "*people are still not willing to pay more for a sustainable or a product with higher quality. They prefer to continue buying products more often but of lower quality".*

According to some of the brands, there is a segment of consumers willing to pay a higher price, but this willingness is linked to the developmental level of countries, encompassing both economic and educational aspects.

-Working with Sustainable Materials

A notable challenge was the complexity associated with utilizing sustainable materials. Some companies faced limited accessibility to sustainable materials in Portugal and had difficulty

finding suitable factories within the country. According to S.V "*In Portugal there are still no manufacturers for bag textiles with the material and the quality we need, that are 100% recycled (whether that material is cotton or plastic.) That is why we are working with this factory in Spain*".

The cost of sustainable materials is a significant challenge, as they are inherently more expensive than non-sustainable ones. This makes the final product pricier and less accessible to consumers due to affordability constraints. Some brands find it easier to sell products outside of Portugal. There is a trend towards slightly more normalized pricing of sustainable materials, but they remain more expensive than non-sustainable alternatives.

5.3.4 Drivers

-Sustainability (Environmental and Social)

The primary and most significant driver identified in all the interviews was the motivation to create a positive environmental and social impact through their products. All the interviewed brands expressed a shared belief that prioritizing the creation of environmentally friendly products is more important than choosing a different one, even if that could translate into immediate profits. According to C. *"I know we are still so few people doing [sustainable products] and we don't know whether it's going to make a change, but we must do something, even when we are not sure if it's going produce results. To me it's just totally natural to preserve the planet we are living in."*

-Competitive Advantage

Companies agreed that having a sustainable product can provide a competitive advantage. All participants shared the opinion that the only viable path forward is sustainability. According to S.V *"It makes no sense for us to continue to run out of raw materials and not be on this pro-sustainability path. Everything else in our brand is based on design. And in innovation, in the differentiator, in other things. Sustainability must be part of it, it's mandatory."*.

As a resume, figure 5.1 presents a word cloud with the most common words mentioned related to the drivers and barriers.



Figure 5.1: Words Cloud

The brands interviewed integrate sustainability into their operations, aiming to reduce their environmental and societal impacts. This shift, emphasizing "sustainable products" and "sustainable practices," emphasizes that sustainability can serve as a strategic asset, offering a competitive advantage by prioritizing social values such as fair compensation and safe working conditions.

However, adopting sustainable business models presents challenges, primarily financial. The transition requires "large investments" and is often seen as "expensive," making it particularly challenging for SMEs. There are also concerns about the "final price" of sustainable products, which may be higher due to more costly production methods, potentially affecting their market competitiveness. "Fast fashion" is another obstacle, with its low-cost, rapid production model that stands in contrast to the sustainable focus, complicating the shift towards sustainable practices.

5.3.5 The Role of Technology

-Industry 4.0

None of the companies interviewed have integrated any Industry 4.0 technologies into their business models. Instead, they have chosen to stick to traditional manufacturing processes to support family-owned factories and maintain traditional sewing techniques.

Smaller companies seem to find the adoption of Industry 4.0 technologies less suitable. Incorporating such technology may not align with their business model's requirements, especially for businesses emphasizing artisanal production.

-Transparency and Traceability

Transparency should be a crucial factor for all stakeholders to guarantee where the products come from. Respondent M. states, "*Transparency is very important. When you buy, you have to know where it comes from and why it is sustainable*.".

The companies interviewed interpret transparency and traceability differently from the broader literature. They associate transparency with a more conventional perspective and emphasize its significant importance to their brand.

A prevalent response highlighted the advantage of a small supply chain, facilitating effective supplier tracking and clear communication among partners, thereby enabling traceability. Notably, P.M. elaborated on their methods to achieve transparency, emphasizing frequent visits to suppliers' factories for production process oversight *"we know each supplier, we know where the product comes from. We go to the factories, we are in contact with them, to find out what's new. We are also always looking for alternatives. But if you ask me if you track your recycled polyester, if you know where it is collected from, I don't"*.

P.M. further disclosed that the origins of materials are documented in physical technical files. Interestingly, when questioned about the systems used for traceability, all companies clarified that they currently do not utilize any digital systems, emphasizing reliance on traditional, manual methods for tracking their supply chains. According to H.C *"The value chain is short and local. We have facilitated traceability and communication is transparent regarding origin and process."*.

5.3.6 Key Points of the Obtained Results

To enhance the reader's understanding and facilitate the connection between the results and initial research questions, we will restate each question and provide an approximate answer through content analysis, considering the conceptual model previously presented in chapter 3.

RQ1: How are fashion brands engaging with sustainable and CE principles in their business models and across supply chains?

The CE is a new economic model that replaces the traditional linear industrial economy. The closed-loop production system allows resources to be used and reused for longer periods. The companies interviewed demonstrated that they are actively (re)designing their supply chains to close the loop as much as possible from start to finish:

-Supply chain design

1. Local Sourcing: The decision to source locally is driven by several factors, primarily the desire to shorten the supply chain and minimize CO2 emissions associated with shipping. Additionally, companies aim to support the Portuguese textile sector and its traditions, while ensuring fair working conditions. 2. Production: The design thinking process focuses on material efficiency to reduce waste. Companies are exploring ways to reduce waste at this stage, with some already achieving closed-loop production by avoiding virgin materials and using biodegradable materials, pre- and post-consumer plastics, and through practices like repairing and repurposing. 3. Distribution: Companies have opted for low-impact materials for packaging and are working to minimize the environmental impact of shipping by partnering with companies with lower carbon emissions. 4. End of Life: Companies are implementing take-back schemes that promote recycling, upcycling, and reuse. They also encourage sustainable consumption and educate consumers on proper disposal methods. Promoting repair and creation, such as offering DIY Kits and encouraging customers to take an active role in the process.

Table 5.2 contains an overview of the sustainable and CE practices in the supply chain.

-Product

Companies are finding innovative ways to make their products more sustainable through design and material choices. By prioritizing timeless and functional designs they encourage consumers to buy only when necessary, rather than opting for single-use items. Using biodegradable, upcycled, and recycled materials plays a significant role in this effort. These practices mitigate environmental impact by giving new life to materials that might otherwise end up in landfills. Additionally, designing to reduce waste involves creating new products from their own textile waste and contributions from other individuals and brands, to achieve near-zero surplus.

-Process

Companies are transforming traditional linear production into sustainable and circular practices. Regarding the manufacturing process, products are designed for quality, durability and reducing textile waste as much as possible. A good practice identified is offering the option to replace worn outsoles with new ones, which extends the product lifecycle. The replaced outsoles are also recycled. Additionally, having the production close to the main company helps to reduce CO2 emissions.

Table 5.2: Overview of sustainable and CE practices throughout the supply chain.

		Sustainable /CE Principles			
	Supply Chain	**Product life- extension (longevity and durability**	**Reuse**	**Recycle**	**Reduce (Resource Preservation)**
Vintage for a Cause	**1. Raw material origin**	-	Upcycled fabric (deadstock)	-	-
	2. Manufacturing processes	-	Re-Use of textile surpluses for workshops	-	Make-to-order
	3. Distribution	-	Reuse of packages	Biodegradable Packages	Short supply chain
	4. Consumption	-	-	-	No seasonal discounts
	5. End of life	DYI repairing Kits. "Sell 1 Buy 1"	Workshops to promote repairing, free videos and tips	-	Defective garments and samples are sold in urban markets for a lower price
WAYZ	**1. Raw material origin**	-	-	Recycled plastic textile, recycled rubber outsoles	Vegetable-tanned metal free and biodegradable leather; biodegradable insoles made of latex, linen and wood and wool fibers.
	2. Manufacturing processes	Timeless designs	-	-	-
	3. Distribution	-	Re-use of boxes	Recycled cardboard boxes	Short supply chain
	4. Consumption	-	-	-	Discounts only for production surpluses
	5. End of life	"Sell 1 Buy 1"	-	-	-
BirdWalk	**1. Raw material origin**	-	-	Recycled PET plastic	-
	2. Manufacturing processes	Functional design	Pre consumer cotton from production surpluses used for "Taco" bag.	-	-
	3. Distribution	-	Reuse of boxes	Recycled cardboard packaging.	Short supply chain
	4. Consumption	-	-	-	-
	5. End of life	Lifetime warranty policy	-	-	-
Green Youth Clothing	**1. Raw material origin**	High quality cotton (100% organic)	-	Recycled threads used for embroidery	-
	2. Manufacturing processes	Timeless design, embroidery designs.	-	-	Small quantity production
	3. Distribution	-	-	Recycled boxes and labels.	In person exchanges (when possible).
	4. Consumption	-	-	-	5% of T-shirts sold donated to a nature preservation organization
	5. End of life	-	-	-	Unsold stock is donated instead of being sold at a discounted price
Circonstance: From Waste To Useful	**1. Raw material origin**	-	-	Recycled threads, labels, velcro, snaps, and elastics	-
	2. Manufacturing processes	Functional design	-		Make-to-order
	3. Distribution	-	-	Recycled mailer.	Short supply chain; "Carbon neutral" shipping for international sales. Compostable bag.
	4. Consumption	-	-	-	-
	5. End of life	-	-	-	-

RQ2: What are the drivers and barriers to the integration of a sustainability and circular economy model?

-Context

The fashion industry is one of the highest polluting and resource-consuming industries. In addition to wasting substantial amounts of energy and generating high carbon emissions, it consumes substantial amounts of water and uses chemicals that destroy the Planet. Occupational health and social issues are significant concerns within this industry.

The interviewed companies prioritize sustainability as a foundational principle over a secondary objective, emphasizing fair working conditions, eco-friendly processes, waste reduction, and innovation. They create textiles from biodegradable materials, repurpose manufacturing waste, and donate a percentage of garment sales to nature conservation organizations.

-Internal

Financial Barrier – This study was done to three SMEs and two start-ups. As previously identified, smaller brands have fewer financial capabilities, which can make the initial adoption of sustainable and CE practices more difficult due to the high costs involved. Investing in new practices is challenging when the return on investment is not immediate. If production needs to pause during a transitioning phase, it can also be challenging. Companies used to work with specific materials and production processes may find change difficult, especially if the new production process is more expensive.

Furthermore, the lack of technological innovation adoption comes from the necessity of significant investments and lack of skilled knowledge. Similar results were obtained from García-Quevedo et al. (2020) and Tura et al. (2019).

Societal and Environmental Driver – The primary and most significant motivation identified in all the interviews was the desire to create a positive environmental and social impact through their products. There is a strong drive to excel and distinguish themselves from other brands in the fashion industry, rooted deeply in their mission and values. The commitment to sustainability and the CE is crucial, especially for start-ups and SMEs, due to significant costs and risks which can adversely affect their brand. Similar results are supported by García-Quevedo et al., (2020).

Competitive advantage – Competitive advantage was also identified as a driver for adopting sustainable and CE practices, however companies did not give great importance to this factor. Despite this, the companies agreed that having a sustainable product can provide a competitive advantage through practices such as product differentiation, innovative designs, and the use of original materials. Similar results are found by Asante et al. (2022).

-Market

A PESTEL analysis (table 5.3) was conducted to facilitate data interpretation for the market. The analysis identifies six key external factors—Political, Economic, Social, Technological, Environmental, and Legal—that can influence companies.

Table 5.3 – PESTEL Analysis on market

Factor	Key Points
Political	• Absence of government policies to support the transition to a Circular Economy (CE) can adversely affect small companies.
Economic	• Economic purchasing power impacts the market demand for sustainable products. • High costs associated with local sourcing and production.
Social	• The lack of consumer awareness (e.g., preferring fast fashion to sustainable fashion, not knowing how to dispose old clothes correctly).
Technological	• High costs related to implementation of new technological processes.
Environmental	• Rising awareness of the environmental damage caused by the fashion industry. • Increasing focus on companies' sustainability policies. • Risk of being accused of greenwashing.
Legal	• High administrative costs associated with starting a business.

External Barriers

The absence of supportive government laws for adopting sustainable and CE policies can affect companies. For example, when a secondhand product is sold, the company is still required to pay VAT, even if the tax was already paid during its initial sale. Legislation and incentives play an important role in accelerating the transition to circularity.

Consumer awareness is a significant factor. The lack of consumer awareness contributes to the preference for low-quality, cheap garments that are used a few times and then thrown away over long-lasting pieces made with environmentally friendly processes and materials. Therefore, brands must develop strategies to motivate customers to engage in circular practices.

Additionally, brands should educate consumers and communicate their circular strategies through their different channels.

The high costs of local sourcing and production make the final product more expensive for consumers. Some of the companies interviewed struggle with the lack of availability of sustainable materials in Portugal. This leads to higher costs for the final product, which in turn makes the product less accessible in the market. Additionally, the high administrative costs associated with starting a new business can be an obstacle for the adoption of sustainable and CE practices, especially for smaller companies that do not have a lot of financial capabilities.

While the adoption of modern technologies can be crucial for the full implementation of CE activities, they require significant investments and are, therefore, challenging to implement.

External Driver

Even though they do not yet make up most consumers, there is a growing awareness of the environmental and social impact of the fashion industry. Some consumers are motivated to support brands that tackle environmental issues. Similar results were found in (D'Adamo et al., 2022).

RQ3: How are fashion companies incorporating sustainable and CE practices within the context of Industry 4.0's technological advancements, facing challenges and opportunities?

-Challenges

Through the case studies it is possible to identify the challenges faced by these small companies in adopting Industry 4.0 technologies. A common factor is the financial restrictions faced by the brands, which make technological investments difficult. For instance, Green Youth Clothing explained that the initial costs of sustainable practices were "brutal". Therefore, spending additional resources for Industry 4.0 may not be possible in the initial phase of the brand. Similarly, BirdWalk had to pause production and invest greatly in the transition to recycled textiles.

The case studies also reveal that the brands value transparency. However, they rely on traditional methods of traceability instead of industry 4.0 technologies. It can be suggested that the complexity and cost of technologies like blockchain, RFID, and QR codes might be inhibiting the adoption of such technologies. For instance, Wayz prioritizes a short, local supply chain which allows periodical checks with suppliers, relying on personal relationships and

physical documentation. Using traditional methods can limit their ability to achieve traceability and therefore, full transparency.

Lastly, these traditional and artisanal production processes might present inherent challenges to integrating certain Industry 4.0 technologies. Vintage for a Cause, which has the objective of preserving traditional Portuguese sewing techniques with the use of upcycled materials, is an example of a business model where adopting advanced technologies of Industry 4.0 might not be suitable or even desirable.

-Opportunities

While the case studies do not provide empirical evidence of Industry 4.0 implementation, the potential opportunities of Industry 4.0 in enhancing circularity are discussed based on the literature review conducted in chapter 2. It can be acknowledged the growing importance of traceability and transparency for the fashion industry. Therefore, adopting technologies like blockchain, despite their initial cost, could allow real traceability, enabling companies to have greater knowledge of their supply chains beyond the close suppliers, allowing the verification of suppliers' sourcing practices. Additionally, this would allow a clear and justified claim of sustainability efforts to consumers.

While these companies already demonstrate practices to reduce waste through design and production processes, access to real-time data on material use, energy consumption, and waste generation could improve efficiency. While requiring an initial investment, this adoption could result in long-term cost savings and resource conservation.

Chapter 6: Conclusions

6.1 Addressing the Research Questions

This dissertation aimed to provide important insights into how fashion brands in Portugal incorporate sustainability and CE principles, the drivers and barriers they face, and the role of Industry 4.0 technologies. Drawing upon the research objectives, key results, and interview data from Chapter 5, for the sake of brevity this conclusion addresses the research questions, considering the propositions outlined in Chapter 3.

RQ1: How are fashion brands engaging with sustainable and CE principles in their business models and across supply chains?

The research revealed that Portuguese fashion companies actively integrate sustainability and CE principles in their business models and supply chains. This is demonstrated through several activities:

- **Local Sourcing:** Prioritizing local sourcing minimizes CO2 emissions from transportation, supports the Portuguese textile industry, and guarantees fair working conditions. This aligns with Proposition 1, which implies companies are adapting their supply chain designs to achieve sustainability and CE.
- **Production:** Focus on waste reduction though efficient use of materials, use of biodegradable materials, and practices like repairing and repurposing contribute to a more circular production process. This aligns with Proposition 1, highlighting the processes' adaptation.
- **Distribution:** Choosing low-impact packaging and partnering with shipping companies with lower carbon emissions therefore creating a more sustainable distribution. This aligns with Proposition 1, highlighting adaptations in supply chain design.
- **End of Life:** Implementing take-back schemes, promoting repair and creation, and encouraging sustainable consumption are practices that extend the product lifecycle. These initiatives support Proposition 1.

However, while companies mostly adapt their processes and product designs, they might not always see a need for particular supply chain modifications. This aligns with Proposition 2.

For instance, Wayz outsources production and relies on its partner's waste management practices.

RQ2: What are the drivers and barriers to the integration of a sustainability and CE model?

The drivers identified are the following:

- **Social and Environmental Concerns (internal):** The main motivation turned out to be the desire to create a positive environmental and social impact. This aligns with Proposition 3, which emphasizes the importance of these concerns in the adoption of sustainable practices.
- **Competitive Advantage (internal):** Companies recognize that sustainable products, innovative designs and materials can lead to a competitive advantage in the market. This supports Proposition 4.
- **Growing Consumer Awareness (external):** The rising awareness of the fashion industry's negative environmental and social impact drives brands to adopt sustainable practices. This supports Proposition 5.

The barriers are identified below:

- **Financial Limitations (internal):** The high cost of sustainable materials and production processes, especially for SMEs, creates a significant barrier. This supports Proposition 6, which highlights financial constraints as key barrier.
- **Lack of Consumer Interest (external):** Preference for fast fashion over sustainable brands is a barrier for the market's full embrace of sustainable practices. This supports Proposition 6.
- **Lack of support of governmental laws:** The lack of supportive government laws for the adoption of sustainable and CE practices can affect companies. This supports Proposition 6.

RQ3: How are fashion companies incorporating sustainable and CE practices within the context of Industry 4.0's technological advancements, facing challenges and opportunities?

The research indicates that despite the potential of Industry 4.0 technologies, none of the companies interviewed have incorporated them into their business models. This suggests a

potential disconnect between theoretical frameworks and practical implementation. Smaller companies, especially those emphasizing artisanal production, might find Industry 4.0 adoption less suitable. Although the literature emphasizes the importance of technologies like blockchain for traceability and transparency, the companies interviewed rely on traditional methods and close relationships with suppliers to achieve these goals. Even if they recognize the importance of transparency, their interpretation may not be the same as the broader literature.

While the fashion companies studied highlight the financial constraints that can hinder the adoption of Industry 4.0 technologies, the potential opportunities for full traceability, data-driven optimisation, and improvements on efficiency remain significant. Overcoming these barriers, potentially through government support, collaboration within the industry, and increased consumer demand for sustainable products, could be crucial for small businesses to take advantage of Industry 4.0's potential in achieving sustainability and circularity. The technological complexity and costs associated with Industry 4.0 are challenging for smaller companies, which supports Proposition 8.

6.2 Recommendation Model for Sustainability and CE Implementation

Based on the research and interviews conducted for this dissertation, the following model (Figure 6.1) is presented to guide fashion companies, particularly start-ups and SMEs, to successfully implement sustainable and CE practices within their business model.

The model was created considering the research questions and objectives outlined in Chapter 1, while addressing the challenges and opportunities identified in the Portuguese fashion industry.

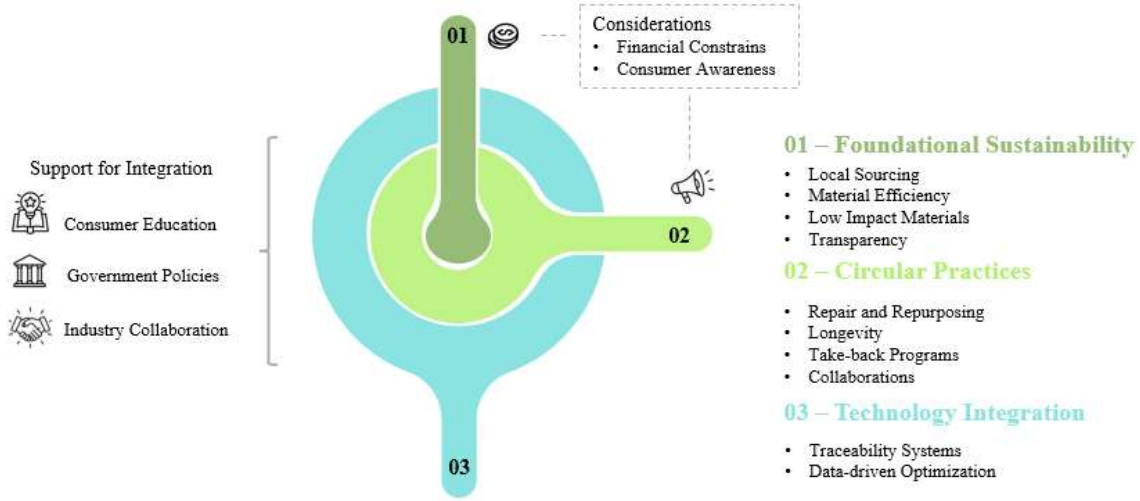


Figure 6.1: Recommendation Model for Sustainability and CE Implementation

Companies should have a strong core foundation of sustainability values, and as the business expands, progressively implement other circular practices.

The recommended stages of implementation are described below:

01 – Foundational Sustainability

- **Local Sourcing:** Prioritize sourcing materials and production locally to minimize transportation emissions, support the local economy, and ensure fair working conditions.
- **Material Efficiency:** Implement design and production processes that mitigate waste and maximize use of material.
- **Low Impact Materials:** Use low-impact materials as much as possible, for the items produced and packaging used, to reduce environmental impact.
- **Transparency:** Clearly communicate the brand's sustainability values and practices to consumers through various channels.

02- Circular Practices

- **Repair and Repurposing:** Offer repair services, promote upcycling, and repurpose production surpluses to extend product life cycles.
- **Longevity:** Focus on creating timeless, durable designs using high-quality materials to extend the product lifecycle.
- **Take-Back Programs:** Implement take-back schemes to enable recycling, upcycling, and reuse of end-of-life products.
- **Collaborations:** Collaborate with organizations that promote CE principles and sustainable practices.

03- Technology Integration

- **Traceability Systems:** Gradually adopt traceability technologies, such as blockchain, to achieve supply chain transparency and communicate product origin and sustainability information to consumers.
- **Data-Driven Optimization:** Use data-driven optimization to monitor and optimize resource consumption, waste generation, and production efficiency.

Additionally, the following aspects should be taken into consideration:

- **Financial Constraints:** Financial limitations are a significant barrier for smaller companies. Therefore, the model suggests an approach in three phases. Starting with

low cost with great impact practices first, then integrate more resource-intensive initiatives as the business expands.

- **Consumer Awareness:** It is important to address the lack of consumer awareness/interest for sustainable fashion. For this reason, the model emphasizes that transparent communication of sustainable CE practices is crucial, to educate consumers and increase market demand for sustainable solutions.

Finally, recommendations for support to implement the model are addressed:

- **Government Policies:** Companies should advocate government policies that incentivize sustainable practices, such as tax breaks for using recycled materials or implementing CE initiatives.
- **Collaboration:** Encourage collaboration among the Portuguese fashion industry to share knowledge, resources, and best practices regarding the implementation of CE.
- **Consumer Education:** Work together on industry-wide initiatives to educate consumers about sustainable and circular fashion.

6.3 Final Remarks

In conclusion, while Portuguese fashion companies demonstrate a strong commitment towards sustainability and CE principles, barriers such as financial limitations and lack of consumer awareness set back full implementation.

Bridging the gap between theoretical advancements in Industry 4.0 technologies and practical application, particularly for smaller brands, presents an important opportunity for future development within the Portuguese fashion industry into a transition for a circular economy. The model previously presented aims to serve as a framework for the necessary transformation within this industry. Advancing sustainably is imperative, and the circular economy business model undoubtedly offers a promising path forward for fashion industry in Portugal and beyond.

6.4 Main Outcomes for Theory and Practice

The integration of sustainability and circularity in the fashion industry has significant importance on theory, practical, and environmental levels.

For theory, this dissertation expands the research on sustainable business models, CE implementation, and the challenges smaller companies face in adopting such practices. The case studies highlighted in Chapter 5 offer empirical evidence of these challenges and opportunities, enabling a deeper understanding of the adversities of transitioning to more sustainable and circular fashion systems.

Practically, the study clarifies the strategic decisions and managerial contribution made by small fashion brands in Portugal, offering insightful information for other businesses seeking to incorporate sustainability and circularity into their operations. These real examples show concrete actions companies can take, such as sourcing locally, using recycled materials and implementing take-back schemes.

To the environment, the dissertation addresses the urgent need to mitigate the fashion industry's ecological impact. The brands studied are actively contributing to waste reduction, and resource depletion, by promoting durable, ethically sourced, and recyclable products. This shows how circularity can help transform the industry into a sustainable one.

6.5 Limitations and Recommendations for Future Work

This dissertation offers important insights regarding the adoption of sustainable and CE practices within the Portuguese fashion industry. However, it is essential to address its limitations.

First of all, the sample size is small and limited. The study focuses on five companies in the Portuguese fashion industry, which does not fully represent the diversity of practices and perspectives within the sector. A larger and more diverse sample size, including different company sizes, business models, and target markets, would provide a richer understanding of the challenges and opportunities associated with implementing sustainability and CE principles.

Second, smaller businesses are the focus. The sample consists of SMEs and start-ups. Examining the methods of more well-known and established brands could reveal different challenges and opportunities, particularly regarding integrating Industry 4.0 technologies.

Last but not least, more study is required to explore how Industry 4.0 technologies can be successfully integrated, particularly by SMEs, to achieve transparency, traceability, and resource optimization within the fashion industry's supply chains. It is critical to understand the

reasons behind companies' lack of full transparency—whether it may come from lack of knowledge, resource limitations, or other underlying factors.

Addressing these limitations and suggested recommendations for future research will contribute to a richer and deeper understanding of the landscape of sustainable and CE practices within the Portuguese fashion industry.

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ANNEXES

Annex A - Research questions and propositions

Interview Question	Research Question	Goal	Proposition	Expected Result
Q1: Do you seek suppliers who adopt sustainable policies in their extraction processes and production methods even if it involves higher costs?	Regarding RQ1: How are fashion brands engaging with CE and sustainable principles across supply chains?	Appraise if the supply chain incorporates sustainability in the resource extraction phase ("take" stage of the linear supply chain)	Proposition 1: Companies design their business models around new activities, by adapting their processes, products, and supply chain design, to achieve sustainable development and circularity. Proposition 2: Companies (re)design their business models by adapting their processes and products design to achieve sustainable development and circularity, but they do not see the need to take specific action in the supply chain.	The expected result of these set of questions is to ultimately understand where the companies apply the sustainable and circular practices across their supply chain – from sourcing to consumption processes. At the same time, the goal is to understand how companies are adapting their business model to achieve sustainability and circularity.
Q2: a) Does durability and longevity play an important role in the material choosing phase? b) What about choosing low impact materials or ones that allow for future reuse, recycling and remanufacturing?	Regarding RQ1: How are fashion brands engaging with CE and sustainable principles across supply chains?	Appraise if the supply chain incorporates sustainability in the manufacturing process phase ("make" stage of the linear supply chain)	Proposition 1: Companies design their business models around new activities, by adapting their processes, products, and supply chain design, to achieve sustainable development and circularity. Proposition 2: Companies (re)design their business models by adapting their processes and products design to achieve sustainable development and circularity, but they do not see the need to take specific action in the supply chain.	The expected result of these set of questions is to ultimately understand where the companies apply the sustainable and circular practices across their supply chain – from sourcing to consumption processes. At the same time, the goal is to understand how companies are adapting their business model to achieve sustainability and circularity.
Q3: What measures do you take to avoid waste and to reuse surpluses?	Regarding RQ1: How are fashion brands engaging with CE and sustainable principles across supply chains?	Appraise if the supply chain incorporates sustainability in the manufacturing process phase ("make" stage of the linear supply chain)	Proposition 1: Companies design their business models around new activities, by adapting their processes, products, and supply chain design, to achieve sustainable development and circularity. Proposition 2: Companies (re)design their business models by adapting their processes and products design to achieve sustainable development and circularity, but they do not see the need to take specific action in the supply chain.	The expected result of these set of questions is to ultimately understand where the companies apply the sustainable and circular practices across their supply chain – from sourcing to consumption processes. At the same time, the goal is to understand how companies are adapting their business model to achieve sustainability and circularity.
Q4: Do you produce locally?	Regarding RQ1: How are fashion brands engaging with CE and sustainable principles across supply chains?	Appraise if the supply chain incorporates sustainability in the manufacturing process phase ("make" stage of the linear supply chain)	Proposition 1: Companies design their business models around new activities, by adapting their processes, products, and supply chain design, to achieve sustainable development and circularity. Proposition 2: Companies (re)design their business models by adapting their processes and products design to achieve sustainable development and circularity, but they do not see the need to take specific action in the supply chain.	The expected result of these set of questions is to ultimately understand where the companies apply the sustainable and circular practices across their supply chain – from sourcing to consumption processes. At the same time, the goal is to understand how companies are adapting their business model to achieve sustainability and circularity.

Q5: Is there concern in the materials used for the packaging of the products?	Regarding RQ1: How are fashion brands engaging with CE and sustainable principles across supply chains?	Appraise if the supply chain incorporates sustainability in the distribution phase ("make" stage of the linear supply chain)	Proposition 1: Companies design their business models around new activities, by adapting their processes, products, and supply chain design, to achieve sustainable development and circularity. Proposition 2: Companies (re)design their business models by adapting their processes and products design to achieve sustainable development and circularity, but they do not see the need to take specific action in the supply chain.	The expected result of these set of questions is to ultimately understand where the companies apply the sustainable and circular practices across their supply chain – from sourcing to consumption processes. At the same time, the goal is to understand how companies are adapting their business model to achieve sustainability and circularity.
Q6: Is it possible for consumers to return purchased and end-of-life products to your stores?	Regarding RQ1: How are fashion brands engaging with CE and sustainable principles across supply chains?	Appraise if the supply chain incorporates sustainability in the consumption phase ("waste" stage of the linear supply chain)	Proposition 1: Companies design their business models around new activities, by adapting their processes, products, and supply chain design, to achieve sustainable development and circularity. Proposition 2: Companies (re)design their business models by adapting their processes and products design to achieve sustainable development and circularity, but they do not see the need to take specific action in the supply chain.	The expected result of these set of questions is to ultimately understand where the companies apply the sustainable and circular practices across their supply chain – from sourcing to consumption processes. At the same time, the goal is to understand how companies are adapting their business model to achieve sustainability and circularity.
Q7: Do you promote sustainable consumption to your **customers**?	Regarding RQ1: How are fashion brands engaging with CE and sustainable principles across supply chains?	Appraise if the supply chain incorporates sustainability in the landfill/end of product life phase ("waste" stage of the linear supply chain)	Proposition 1: Companies design their business models around new activities, by adapting their processes, products, and supply chain design, to achieve sustainable development and circularity. Proposition 2: Companies (re)design their business models by adapting their processes and products design to achieve sustainable development and circularity, but they do not see the need to take specific action in the supply chain.	The expected result of these set of questions is to ultimately understand where the companies apply the sustainable and circular practices across their supply chain – from sourcing to consumption processes. At the same time, the goal is to understand how companies are adapting their business model to achieve sustainability and circularity.
Q8: a) Are customers willing to pay more for sustainable products? b) Do you believe having a business model based on sustainability and CE can lead to a competitive advantage? c) What are your biggest motivations?	Regarding RQ2: What are the drivers and barriers to the integration of a sustainable and CE model?	Understand the biggest motivations/enablers to the adoption of sustainable and circular practices	Proposition 3: Societal and environmental concerns are the main drivers to the adoption of sustainable and CE practices. Proposition 4: Gaining a competitive advantage is a driver for the adoption of sustainable and circular practices. Proposition 5: Gowing consumer awareness is a driver for adopting sustainable and circular practices.	Assess the enablers for the adoption of sustainable and circular activities. Appraise if the enablers found are in accordance to the literature review.
Q9: a) Do you find it more difficult to implement circular and sustainable practices due to the lack of government supportive laws, or the need to have big investments? b) What are the major setbacks that you have faced so far?	Regarding RQ2: What are the drivers and barriers to the integration of a sustainable and CE model?	Understand the biggest challenges and barriers to the adoption of sustainable/circular practices	Proposition 6: Internal barriers, such as financial barriers, and external barriers such as social awareness and government policies are the key inhibiting factors in the implementation of CE practices.	Assess the challenges and barriers for the adoption of sustainable and circular activities. Appraise if the barriers found are in accordance to the literature review.
Q10: a) Do you use any kind of new technology in the design/production process?	Regarding RQ3: To what extent are the fashion companies adopting sustainable and CE practices aware of the industry 4.0?	Understand if companies are using new technologies in their production processes to make the supply chain more efficient	Proposition 7: The fashion companies that implement Industry 4.0 technology into their CE practices are able to cease numerous opportunities that in turn allow their business models to reach their full sustainable potential.	Assess if companies in Portugal are using new technologies to optimize their business model. The goal is to make a comparison to what was found in the literature to understand if companies are up to date with today's trend.

Q11: a) Do you trace your supply chain? b) What kind of systems do you use? c) Is communicating the information of the product important to you?	Regarding RQ3: To what extent are fashion companies adopting sustainable and CE practices aware of the industry 4.0?	Understand if companies are using new traceability to create transparency over the final product	Proposition 8: The technological complexity associated with industry 4.0 can represent a challenge to companies regarding their business models.	Assess the importance that the companies give to transparency. The goal is to understand if companies use traceability in order to achieve transparency and to evaluate the challenges that come with this.

Annex B - Preliminary Thematic Categories.

Interview Q.	Vintage for a Cause	Wayz	Green Youth Clothing	Birdwalk	Circonstance: From Waste to Useful
Q1: Do you seek suppliers who adopt sustainable policies in their extraction processes and production methods even if it involves higher costs?	**Yes**, the company values alignment with suppliers who share similar sustainability values and policies. They source deadstock fabrics from Tintex Textiles and SKFK and wholesalers. Respondent H.A. states, **(our) mission is to reuse textile waste, which by itself already minimizes the impacts that arise from creating new fabrics, but we still try to use materials that have less impact in the post-consumer phase.**	**Yes**, Wayz exclusively partners with suppliers adhering to strict environmental, health, and social welfare standards. They prioritize quality and collaborate with family-owned businesses offering fair wages and good working conditions.	**Yes**, their main supplier is B&C, a Netherlands-based B2B company committed to sustainable garment production. They chose B&C for their quality and sustainable materials, opting for 100% organic cotton despite the higher cost. Embroidery is outsourced to Portuguese providers who use recycled threads. Respondent M.&S. stated, **"We import sweatshirts and T-shirts only from B&C, a company with a sustainability policy. We prioritize quality guarantees despite the higher cost of organic materials."** Their warehouse also practices sustainability by minimizing plastic bag usage and using recycled cardboard packaging.	**Yes**, Birdwalk has transitioned to using textiles certified by the Global Recycling Standard (GRS), administered by the Textile Exchange. The GRS mandates compliance with rigorous social and environmental criteria, including pre- and post-consumer recycled materials. Birdwalk sources pre-consumer surplus production and post-consumer recycled PET plastic, consistently applying reduction, repurposing, and recycling in their manufacturing process.	**Yes**, initially, finding suppliers offering the desired sustainable materials was a challenge. Their primary supplier is a Spanish factory specializing in recovering marine plastic waste, sending recycled polyester yarn to a Portuguese factory for fabric production. This fabric is used for their main products, including bags and hats. Respondent C. prioritizes actively seeking the most sustainable options or collaborating with local suppliers, emphasizing their commitment to environmental responsibility throughout the supply chain.
Q2: a) Does durability and longevity play an important role in the material choosing phase? b) What about choosing low impact materials or ones that allow for future reuse, recycling and remanufacturing?	a) **Yes**, creating long-lasting pieces is a core principle for Vintage for a Cause. They promote repair and garment creation through DIY kits, free videos with tips on care and repair, and workshops to raise awareness about extending garment lifespan. Respondent H.A. explains, **"Creating pieces with greater longevity is one of the brand's principles. We create DIY KITs to promote the repair and creation of garments; we have free videos and tips that show how to take care of and repair clothing. Additionally, we also have workshops to bring attention to this practice".** b) They upcycle garments from deadstock fabrics, leftovers, and repurposed materials, giving new life to unwanted materials and mitigating environmental damage.	a) **Yes**, Respondent P.M. stresses the importance of durability: **"Durability, to begin with, is a concept that is very important. Before talking about recyclable and biodegradable materials, high-quality material is more important. The difference between a good pair of shoes is how long it will last, and the ability to be repaired as well, extending the lifespan of the product."** They incorporate this concept in the design phase, aiming for timeless, gender-neutral designs, and choosing materials that can be repaired to a like-new condition. b) Wayz incorporates recycled materials, recycled cork, organic cotton, biodegradable leather, recycled plastic textile, which originates from plastic waste. The outsoles are replaceable and made from recycled materials, which allows for the extension of the product's lifespan.	a) **Yes**, Respondent S. highlights the importance of durable, high-quality cotton for longevity: **"We are looking for a quality cotton that, although more expensive, guarantees greater durability and, therefore, greater longevity. We try to create timeless products that don't go out of style, like T-shirts, that withstand a greater number of washes without changing quality, to combat consumption."** b) They prioritize suppliers using 100% organic cotton and water-based paints for dyeing. Embroidery, chosen for its durability, uses recycled thread and simple, universally appealing designs.	a) **Yes**, Birdwalk promotes longevity through functional designs: **"Our products are all based on a very functional design. They are not style pieces, so our customers are people who need a bag to fulfill a function. Through design, we manage to educate people."** They are known for their exceptionally durable bags and are rigorously testing new materials for durability: **"We've always had resistant bags. The brand has been around since 2017, and there are people who have had their bags even before the official opening of the brand – the first ones were made in 2015. I hope that now these certified and more sustainable fabrics with recycled materials will offer longevity."** b) They use cotton from production surpluses, and bag components are made from recycled PET plastic, with ongoing testing to assess durability.	a) **Yes**, Respondent C. emphasizes the importance of high-quality materials for their bags, initially designed for functionality over style. b) They use 100% post-consumer recycled polyester yarn for their fabric. They consciously source additional materials like threads, labels, Velcro, snaps, and elastics to ensure they are either recycled or certified as non-toxic.

Q3: What measures do you take to avoid waste and to reuse surpluses?	Vintage for a Cause implements a "make-to-order" production strategy to prevent excess stock and minimize waste. Surplus textiles are repurposed for labels and accessories, and defective garments or samples are sold at lower prices in urban markets.	Wayz designs its shoes to minimize waste. Currently, they do not recycle production surpluses, as these are managed by their partner suppliers. However, they may change this approach if they take control of production in the future.	Green Youth Clothing produces clothing in small quantities to minimize waste. They donate unsold stock instead of discounting it to discourage unnecessary consumption.	Birdwalk's bag patterns are designed to maximize fabric usage and minimize waste. They aim for near-zero surplus and create a specific bag, "Taco," solely from their textile waste and contributions from others.	Circonstance: From Waste to Useful minimizes fabric waste through its design process and uses a "make-to-order" model to avoid overproduction. Leftover materials are used to teach sewing skills for social integration.
Q4: Do you produce locally?	**Yes**, they source and produce locally to maintain a small supply chain. Their workshop, "From Granny to Trendy," manufactures garments in Portugal, primarily handmade by socially isolated elderly seamstresses. They ensure fair pay and use the workshop to discover new talent and upcycle outfits. This project showcases the value of experience and the importance of reducing human and material waste. Another benefit is preserving traditional Portuguese sewing techniques: **"(the brand) produces locally using traditional sewing techniques to ensure high product quality. The use of senior seamstresses allows for flexibility in production and better-quality control with lower environmental costs."**	**Yes**, sourcing, design, and production are done within 70km of Porto, Portugal. A short supply chain fosters better relationships with partners. They frequently visit suppliers to test designs and materials, enhancing quality. Additionally, this minimizes their ecological footprint: **"We take into account the type of materials we use, where they are produced. We try to make them Portuguese; having a short supply chain is also part of our project."**	While they initially aimed for local production in Portugal, high production costs made it unfeasible. Their primary supplier, B&C, produces in Bangladesh, while embroidery is done locally. Respondent states: **"We initially aimed to produce in Portugal, but high production costs for small companies made it unfeasible."**	**Yes**, Birdwalk's production occurs in Portugal, either at the Mouraria Innovation Center or in collaboration with two partner factories. They prioritize local production to revitalize the Portuguese textile industry, create jobs, generate wealth, and preserve expertise.	The brand prioritizes local production to support the local economy and minimize carbon emissions. They use "carbon neutral" shipping for international orders, even at a higher cost.
Q5: Is there concern in the materials used for the packaging of the products?	**Yes**, they prioritize reusable and biodegradable packaging, striving for the lowest possible environmental impact.	**Yes**, they use recycled cardboard boxes for shipping and reuse them whenever feasible.	**Yes**, they use recycled paper for boxes and labels, issue digital invoices, and encourage in-person exchanges when possible to reduce packaging and shipping impact.	**Yes**, they package items using recycled, plastic-free materials and frequently reuse boxes for product resale.	**Yes**, they prioritize recycled and recyclable packaging, including 100% recycled mailers, compostable bags, and recyclable stickers.

Q6: Is it possible for consumers to return purchased and end-of-life products to your stores?	**Yes**, Vintage for a Cause participates in the "Sell 1 Buy 1" program with White Stamp. This allows customers to sell used garments for credit towards new purchases from partner brands.	**Yes**, Wayz participates in the "Sell 1 Buy 1" program with White Stamp. Wayz is currently developing a program to enable customers to return worn shoes, which will then be reintroduced into the production cycle.	**No**, this has not yet been implemented but it is under consideration for future plans.	**No**, although a formal take-back program is being considered. Currently, the brand offers a lifetime warranty policy on its bags, and they envision using a take-back system in the future.	**No**, as a new project, a take-back system is not yet in place, though the possibility of introducing one in the future is being considered.
Q7: Do you promote sustainable consumption to your customers?	**Yes**, Vintage for a Cause promotes sustainable consumption through various channels, avoiding seasonal discounts and trends to discourage impulsive buying. They provide detailed information on their website about the price breakdown of each garment and its sustainable impact. Vintage for a Cause has created DIY Kits, free videos with tips, and workshops to bring attention to the repair and care of garments.	**Yes**, their product commercialization strategy promotes conscious and sustainable living: **"We aim to promote conscious, sustainable living. We offer discounts sparingly, mainly for production surpluses, imperfect models, or end-of-life products."** Their website features a price breakdown of their sneakers, highlighting water and CO2 savings related to their sustainable impact.	**Yes**, the garments come with washing instructions on the tags. They aim to raise awareness about biodiversity preservation and sustainable choices through their designs, incorporating messages about planet protection. Additionally, 5% of T-shirt sales are donated to IUCN - International Union for Conservation of Nature.	**Yes**, Birdwalk promotes sustainable consumption through its focus on functional design, prioritizing genuine needs over fashion aesthetics.	**Yes**, they actively engage with consumers on Instagram, sharing articles about the fashion industry's environmental impact and raising awareness on days like World Recycling Day (March 18) and World Water Day (March 22). They also offer practical tips for a sustainable lifestyle.
Q.8: a) Are customers willing to pay more for sustainable products? b) Do you believe having a business model based on sustainability and circular economy can lead to a competitive advantage? c) What are your biggest motivations?	a) **Yes**, but Respondent H. notes that this willingness is often linked to the developmental level of a country, considering factors like economic conditions and education. b) **Yes**, the brand prioritizes creating value and impact by reducing waste and addressing inequalities. This focus is reflected in their business model. Respondent H. believes that changing consumer trends is making this type of business increasingly competitive compared to traditional models. c) Vintage for a Cause is a CE brand with a social commitment, aiming to offer affordable, ethical, and sustainable clothing while actively creating a positive social impact.	a) **Yes**, while more people are beginning to value products based on their production methods, many remain hesitant to pay a premium for sustainability or higher quality. Many consumers still prioritize lower prices, even if it means sacrificing quality. b) **Yes**, Respondent P.M. believes that a sustainable business model and a CE can lead to a competitive advantage. They emphasize the importance of continuous innovation and differentiation to maintain this advantage, including innovative solutions for waste management and production materials. c) Wayz's mission is to create long-lasting ethical sneakers with timeless designs. They believe that success can be achieved through means other than rapid growth and immediate profit: **"BE CONSCIOUS, BUY LESS, CHOOSE WELL."**	a) **Yes**, but to a limited extent. While there is a growing awareness of fast fashion's negative impacts, only a small percentage are willing to pay more for sustainable garments. b) **Yes**, but consumers' continued preference for fast fashion presents a challenge to the market's full embrace of sustainable practices. c) Their primary motivation is to preserve animal life and raise awareness about biodiversity protection. They counter fast fashion's detrimental environmental impacts through simple, timeless designs.	a) **Yes**, Respondent S.V. acknowledges that there's room for growth, but believes people generally value sustainable products. b) **Yes**, while sustainability can be a competitive advantage, it was not the primary motivation for the brand: **"Regardless of whether it is competitive or not, it makes no sense for us to continue to run out of raw materials and not be on this pro-sustainability path."** c) Birdwalk emphasizes local production, high-quality materials, and sustainability, prioritizing craft and quality over mass production.	a) **No**, Respondent C. believes only a small percentage of consumers are genuinely concerned about sustainability, suggesting that for many larger companies, it's more of a trend than a genuine commitment: **"It's more of a trend for big corporations to sell sustainable products because people want to feel good about buying them, but the companies don't really care about sustainability."** b) **Maybe**, but it's not clear if this has been achieved yet. c) Growing up with an eco-friendly education, building a brand with sustainability as a core value was the only way forward for Respondent C.

Q.9 a) Do you find it more difficult to implement circular and sustainable practices due to the lack of government supportive laws, or the need to have big investments? b) What are the major setbacks that you have faced so far?	a) **Yes**, SMEs face challenges with insufficient investment and a shortage of qualified personnel, hindering their shift toward circular practices. Larger companies have more resources but are often risk-averse to significant structural changes. Legislation, incentives, and clear taxonomy are vital for a faster transition. b) Smaller companies struggle with the financial burden of sustainability, while larger companies face risks in making structural changes. Insufficient investment and a shortage of qualified staff hinder the transition to circularity. Legislation, incentives, and taxonomy are crucial for a faster transition.	a) **No**, while government support could be a driver, the brand does not see the lack of supportive laws as a barrier. b) They initially faced high production and material costs, leading to a high final product price that limited accessibility to a wider audience. This prompted them to explore international markets and reassess their business strategy due to the limitations of the Portuguese market.	a) **Yes**, Respondent S&M believes governmental support is crucial, especially for smaller companies with limited funding: **"When a company is formed, initial investments can be brutal. It's exceedingly difficult for a start-up or someone with no funds to get past this stage."** b) Bureaucracy and high setup costs, including accounting and taxes, were significant challenges, particularly as a startup without external investors.	The brand encountered challenges finding Portuguese producers for recycled textiles, leading to collaboration with a Spanish factory. The transition to sustainability required significant financial investment, causing a temporary production halt and the search for new suppliers. The lack of local producers for specific sustainable materials and communication complexities with foreign suppliers added to the costs and challenges. Despite these hurdles, they believe the shift is worthwhile.	Initially aiming for complete sustainability, the brand adopted a more balanced approach due to high sustainable material costs. This resulted in higher-than-planned product prices. Obtaining certifications and government assistance was difficult. Additionally, they faced high costs associated with starting the business.
Q.10 Do you use any kind of innovative technology in the design/production process?	No. Production processes are very traditional.	No. Traditional production processes are used. Manufacturing employs manual cutting techniques.	No.	No.	No.
Q.11 a) Do you trace your supply chain? b) Is communicating information about the product important to you?	a) **Yes**, the brand benefits from a small supply chain, making traceability straightforward. They rely on personal knowledge and confirmation from suppliers rather than technology to track product origins. b) Vintage for a Cause promotes transparency by providing information on their website about the price breakdown of each garment and its sustainable impact.	a) **Partially**, Wayz prioritizes a short, local supply chain for oversight and cost control. They use technical files to ensure transparency but acknowledge they may not have complete knowledge of material origins. They focus on quality control, exploring new materials and alternatives, and maintaining direct control over production without heavy reliance on technology. b) **Yes**, they communicate product information on their website to educate customers about the value and reasons behind the higher cost of their shoes compared to conventional footwear. They emphasize their manufacturing process, differentiating themselves from fast fashion brands.	a) **No**, the brand is considering using QR codes for traceability but has not yet implemented the idea due to knowledge and cost challenges. b) **Yes**, Green Youth Clothing recognize the importance of communicating their supply chain transparently to the final consumer.	a) **No**, though they have considered it but haven't implemented it yet. b) **Yes**, they are considering using QR codes to provide information on material origin but have not yet implemented it due to knowledge and cost barriers. They recognize the significance of supply chain transparency.	a) **Partially**, the respondent emphasizes the clarity of the fabric production process due to the short supply chain, even if the entire chain might not be fully traceable. b) **Yes**, they actively engage with consumers on Instagram, sharing sustainability tips, articles about the fashion industry, and plans to incorporate more sustainability information into their products.