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"From Linear to Circular"
The Transformation of Fashion's Supply Chain into a Value Maximisation Circular Economy

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Faculdade de Arquitetura – Universidade de Lisboa

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ABSTRACT

"How can a product that needs to be sewn, grown, harvested, combed, spun, knitted, cut and stitched, finished, printed, labeled, packaged and transported cost a couple of euros?" (BoF, 2021). This was one of the questions raised by Li Edelkoort, in her 2015, Anti-Fashion Manifesto, when she anticipated the end of "Fashion as we know it". The conventional Linear system of the Fashion and Textiles Industry (FTI) is presented with a variety of environmental, social and economic issues that are becoming subjects of debate. In this study, the concept of Circular Economy is clarified and proposed as an integrated framework that can serve as a guideline that companies can follow in order for the transformation in the industry to happen. This included the categorisation of Circular Product Design Strategies, Circular Business Models and sub-models that were proposed as possible solutions to each stage of the FTI. The fieldwork comprised the development of a questionnaire, giving a general overview of what is already being applied by the Portuguese FTI companies, followed by a case study with an exemplary Portuguese company. This served as a starting point to see if the company influenced or not it supply and value chains to start implementing circular strategies as well. The results obtained indicate that the transition for a Circular Economy is fostered by several factors with legislation and political drive being fundamental for a transformation at scale, since, laws and regulations are fundamental to pursue education, investments and traceability.

KEYWORDS

Circular Economy; Sustainable Business Models; Business Model Innovation; Fashion and Textiles Industry; Circular Design; Circular Business Models

JEL CLASSIFICATION

L670 - Industrial Organization: Other Consumer Nondurables: Clothing, Textiles, Shoes, and Leather Goods; Household Goods; Sports Equipment

Q010 - Sustainable Development

RESUMO

"Como pode um produto que precisa de ser cosido, cultivado, colhido, penteado, fiado, tricotado, cortado e costurado, acabado, impresso, rotulado, embalado e transportado custar poucos euros?" (BoF, 2021). Esta foi uma das questões levantadas por Li Edelkoort, no seu "Anti-Fashion Manifesto", em 2015, quando antecipou o fim da "Moda tal como a conhecemos". O sistema convencional Linear da Indústria da Moda e Têxteis é apresentado em conjunto com questões ambientais, sociais e económicas que se estão a tornar temas de debate. Neste estudo, o conceito de Economia Circular é clarificado e proposto como um sistema integrado que pode servir de orientação que as empresas podem seguir para que a transformação na indústria aconteça. Isto incluiu a categorização de Estratégias de Design de Produtos Circulares, Modelos de Negócio Circulares e sub-modelos que foram propostos como possíveis soluções para cada fase da indústria. O trabalho de campo incluiu a elaboração de um questionário, dando uma visão geral do que já está a ser aplicado pelas empresas portuguesas da indústria, seguido de um caso de estudo com uma empresa portuguesa exemplar. Isto serviu como ponto de partida para ver se a empresa influenciou ou não a cadeias de abastecimento e valor para começar a implementar estratégias circulares. Os resultados obtidos indicam que a transição para uma Economia Circular é fomentada por vários fatores, sendo a legislação e motivação política fundamentais para uma transformação em escala, uma vez que, só com leis e regulamentos é que a educação, investimentos e rastreabilidade podem ser desenvolvidas.

PALAVRAS-CHAVE

Economia Circular; Modelos de Negócio Sustentáveis; Inovação de Modelos de Negócio; Indústria da Moda e Têxteis; Design Circular; Modelos de Negócio Circulares

SISTEMA DE CLASSIFICAÇÃO JEL

L670 - Industrial Organization: Other Consumer Nondurables: Clothing, Textiles, Shoes, and Leather Goods; Household Goods; Sports Equipment

Q010 - Sustainable Development

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ABBREVIATION LIST

B2B	Business-to-Business
AI	Artificial Intelligence
BM	Business Model
BMI	Business Model Innovation
CBM	Circular Business Model
CE	Circular Economy
CLSC	Closed-Loop Supply Chains
CLSCM	Closed-Loop Supply Chains Management
CSR	Corporate Social Responsibility
EfW	Energy from Waste
EMF	Ellen MacArthur Foundation
EU	European Union
FTI	Fashion and Textiles Industry
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GRI	Global Reporting Initiative
IAPMEI	Agência para a Competitividade e Inovação
IE	Industrial Ecology
IM	Industrial Metabolism
INE	Instituto Nacional de Estatística
IoT	Internet of Things
IS	Industrial Symbiosis
ISO	International Standardization Organisation
ISPO	Internationale Fachmesse für Sportartikel und Sportmode
LCA	Life-Cycle Assessment
PSS	Product Service Systems
SDGs	Sustainable Development Goals
TBL	Triple Bottom Line
UN	United Nations
WEF	World Economic Forum

1. INTRODUCTION

1.1 Research Context, Problem Statement and Motivation

Fashion is moved by desire, but without a transformation, this constant longing for novelty might have devastating consequences and, even, compromise the Paris Climate Change Agreement to restrict global warming to 1.5 degrees. The numbers speak for itself: “the global fashion industry produced around 2.1 billion tonnes of Greenhouse Gas (GHG) emissions in 2018, equalling 4% of the global total. From these, around 70% came from upstream activities as materials production, preparation and processing, while the remaining 30% were associated with downstream retail operations, the use-phase and end-of-use activities” (Global Fashion Agenda & McKinsey&Company, 2020, p. 3). The Fashion and Textiles Industry (FTI) satisfies one of people’s basic needs, hence, inevitable for human’s life (Muthu, 2017). Ever since the beginning of History, humans have dressed themselves for protection, comfort and ornament (Barthes, 1998), with clothes representing an important expression of individuality (EMF, 2017). Citing the Ellen MacArthur Foundation (EMF) “the textiles industry is also a significant sector in the global economy, providing employment for hundreds of millions around the world” (2017, p. 3). This is the foundation to state that the FTI is one of the most valuable and profitable activities for the global economy. According to an article of Common Objective (a network for the Fashion Industry), that compiled and analysed data from Euromonitor International, the apparel market in 2018 was worth around $1.34 trillion in retail sales globally per year (2018). These benefits do not offset the major challenges the sector is facing. The Industry’s supply chain dynamics is based on the reduction of the products’ life-cycle, an endless need to ‘refresh’ product ranges and the increased number of fashion seasons (Bhardwaj & Fairhurst, 2010). With an estimated annual volume growth rate of 2.7% in GHG emissions, if no further action is taken over the next decade, (Global Fashion Agenda & McKinsey&Company, 2020), leading to nearly 26% global carbon emissions by 2050 (KPMG, 2018).

Generations have been working, from around the XVIII century, with the Industrial Revolution, to optimize forward supply chains, conducting resources in a linear economy basis of the take-make-dispose model (Braungart et al., 2006; Stahel, 2010). Resources are extracted (take), shaped into products to create value (make), sold, and eventually, after a short period of time, discarded as waste (dispose), into a "grave" - term used by McDonough and Braungart to describe of some kind of landfill or incinerator (2002). This production model led to an impressive job creation, an unprecedent period of population growth and rapid change, together with all the opportunities that came upon it (McDonough & Braungart, 2002). Industries and companies then and now aim at maximum economies of scale, optimizing high throughput levels, and using highly standardized one-way designs (Lüdeke-Freund et al., 2018; Stahel, 2016). This business mindset, along with the rising complexities, interconnectivity and speed of operations, have effects beyond environmental degradation (Moberg &

Simonsen, 2015; Westley et al., 2011). Data from the World Economic Forum (WEF) describes the world resources disappearing at an unprecedented rate, with scarcity becoming a tangible problem, with a record number of natural calamities and temperatures being witnessed, over the past years (2020). "Globally, each 1°C of temperature increase caused by global warming is projected to result in a 20% reduction in renewable water resources and to affect an additional 7% of the population" (World Health Organization, 2018, p. 1). Even if this way of producing was not intended to foster such devastating effects, today's professionals and organisations (the first generation with the knowledge about the impacts) keep perpetuating these paradigms without considering all the attached outcomes (McDonough & Braungart, 2002; Moberg & Simonsen, 2015). Like most industries, the FTI is no exception in applying linear economy systems (Eder-Hansen et al., 2017; Merli et al., 2018). To transform such influential industry will, definitely, be costly, while determining current and future trends and processes. Rethinking existing business models (BMs), products, technologies and processes can represent a key competitive advantage and the opportunity for the industry to remain profitable (Lehmann et al., 2018; Nidumolu et al., 2009). This may involve a major degree of innovation and collaboration to solve the industry's problems and invert its negative contribution to the climate crisis (Eder-Hansen et al., 2017; Jørgensen & Pedersen, 2018).

1.2 Research Gap and Relevance

As a rather new topic, the present study aims to develop the knowledge of the Circular Economy (CE) as an umbrella concept and framework and clarify its relation with adjoining concepts. By analysing the existing research, became apparent the CE field is still considerably fragmented and the similarities and differences amid concepts are not evident (Murray et al., 2017; Ranta et al., 2018). Also, the relation between CE, BM theory and innovation literature is a perceived gap, requiring a more complete conceptualisation, as well as integrated and practical thinking of Circular Economic Business Models, generally shortened to Circular Business Models (CBMs) (Bocken et al., 2019; De Angelis, 2018; Homrich et al., 2018; Jørgensen & Pedersen, 2018). The current literature is generalist, lacking in sector specific concepts and application, particularly in the FTI, and in an European context (Galvão et al., 2018; Homrich et al., 2018; Todeschini et al., 2017). Hence, does not address the specificities, as the drivers and challenges that can influence the transition process to a circular industry, how this transformation occurs in practice and its effects on the performance of companies, supply chains and innovation systems within the FTI (Galvão et al., 2018; Geissdoerfer et al., 2017; Pal et al., 2019). Despite the pressures the FTI is under, to the best of our knowledge, few thorough models were proposed and studied in a concrete and realistic approach. Thus, this thesis aims to reveal new insights into the actual process of building a CE model for the FTI, and simultaneously, cover previous research gaps in which some of the activities of the supply chain were not considered (Bocken et al., 2016). Geisendorf and Pietrulla (2018) disclose product development and customer relationship management as missing.

This implies analysing the current FTI system, rethinking BMs and how value is created, captured and delivered (Osterwalder & Pigneur, 2010), while addressing Sustainability Triple Bottom Line (TBL), in all its dimensions: social, economic and environmental (Bocken et al., 2016; Elkington, 1998; Homrich et al., 2018; Murray et al., 2017). Attention is given to the social aspect of the CE, often overlooked in the literature (Geisendorf & Pietrulla, 2018; Homrich et al., 2018; Murray et al., 2017; Ness, 2008).

The permanent contact with clothes and the concerns raised by a linear model, with high social inequalities, are the arguments sustaining the choice of the FTI as a suitable and far-reaching platform to contribute to a shift and influence society, environment, culture and economy (EMF, 2017). Suppliers, brands and retailers can achieve shared value where market potential, societal demands and policy action converge (KPMG, 2018). This collaborative mindset and supply chain overview will be explored to meet the literature gap and set a possible route for the FTI to stay competitive (Homrich et al., 2018).

1.3 Research Proposal, Question and Objectives

Based on the theme relevance and analysis of previous research gaps, the goal is to comprehend the extent to which the future of the FTI can be circular, the transformations needed to convert the current linear BM to a circular one, and how Portuguese companies can contribute and serve as a guideline to this shift. Thus, to meet its investigation proposal, this work will be developed around the next Research Question (RQ) and Objectives (O), set as a path on how to achieve the proposed on the main question:

RQ: How can the transition process from a Linear System Model to a Circular Business Model unfold, in the context of the FTI?

O1: To clarify and define the concept of Circular Economy and related concepts;

O2: To understand the framework of the conventional linear system of the FTI and identify the processes, as well as the main problems and challenges the Industry faces transitioning to a CE;

O3: To define and explore different CBMs of a CE for the FTI and to infer if innovation, specifically Business Model Innovation, can enable the solutions to the identified problems and challenges;

O4: To identify the strategies and methods that are being used by Portuguese FTI companies to innovate and transform their BMs, to close the loop and achieve a CE in practice.

1.4 Thesis Structure and Outline

As the CE is a still evolving theme containing several principles and their operationalization strategies (Merli et al., 2018), to have an organised approach, this thesis will have a total of five chapters, starting with this first chapter where the problem statement and research questions are presented. The second chapter includes the literature review, where the CE term is defined and linked with related concepts.

The CE is then studied as a model, connected to the need and urge of a circular FTI. The third chapter describes the methodology used to analyse the collected data that allowed for the theoretical-practical approach of the study to be achieved. Chapter four converges the reviewed theory and data collected in the questionnaire and interviews. Finally, the conclusions of this dissertation are presented, as well as its contributions, implications and future research directions under the same topic.

2. LITERATURE REVIEW

2.1 Sustainability and Other Related Concepts

Only recently has the alarm of an environmental problem widespread due to its effect on populations' lives (Jørgensen & Pedersen, 2018; Stern, 2007). Research shows the most vulnerable are disadvantaged groups as lower income populations, relaunching the "environmental and climate justice" discussion (Esposito et al., 2017; Jarrett et al., 1966; Jørgensen & Pedersen, 2018). Contrarily to more than sixty years ago, scientists have now the ability to measure the impact of human's activity on the Planet (Meadows et al., 1972). The urge that business as usual is not an option for a sustainable future led to the appearance of several concepts proposing different solutions that, although independent, share many features in which circularity plays a vital role (Blomsma & Brennan, 2017; Bocken et al., 2014). The concepts presented next can be linked to CE and foster its development, challenging traditional paradigms and consider Sustainability as a crucial design element of the system and not an afterthought (Todeschini et al., 2017).

2.1.1 Sustainability and Sustainable Development

The concept's development is based on whether ongoing continuous growth trends can be "sustained" in the future (W. C. Clark, Crutzen, & Schellnhuber, 2005). Through the years, different discourses have emerged trying to define Sustainability, with the most used description of the concept being connected to Sustainable Development. The latter was presented by the United Nations (UN) in the Report of the World Commission on Environment and Development: Our Common Future (also known as Brundtland Report), as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). Despite this definition being initially more concerned with the ecological impacts of the human activity, it explores the relations amid humans and the global environment, (Brown et al., 1987), being specially concise and powerful (Johnston et al., 2007). Sustainable Development then began to be seen as synonymous of Sustainability (Johnston et al., 2007). The idea of "development" can easily be mistaken with infinite growth, however, here is framed as sustainable growth. To fully define Sustainability as an independent concept, is crucial to

focus on the “sustainable” aspect. (Andersen, 2006; Gladwin et al., 1995; Johnston et al., 2007) According to Pearson the core idea of Sustainability is that “current decisions should not damage prospects for maintaining or improving living standards in the future" (Pearson, 1985 apud Brown et al., 1987). Despite the several definitions both terms have in common the time dimension, addressing the future consequences of present activities, with the intergenerational and continuity thinking stressed every time (Brown et al., 1987). Sustainability can be framed as an integral part, and a precondition of Sustainable Development (Sauvé et al., 2016). The latter is seen as “a timeline” where Sustainability is applied as principles, approaches, strategies and policies (Glavič & Lukman, 2007).

Over the years, the Sustainability concept provided a broad framing, being institutionalized into the agendas of organisations, yet it was predominantly linked to an Ecology context (Geissdoerfer et al., 2017). With the growing concern for issues like poverty, the term started to be framed as the balanced and systemic integration of prior isolated initiatives, so that its implementation was not compromised (Geissdoerfer et al., 2017; Giovannoni & Fabietti, 2013). These intra- and intergenerational dimensions would later be referred as the three pillars of Sustainability: social, economic and environmental, commonly known as The 3P’s - People, Profit, and Planet (Elkington, 2017; Geissdoerfer et al., 2017). In 1994, Elkington uses the Triple Bottom Line (TBL) as a new expression to convert the concept into an integrated framework (Elkington, 2017). The environmental pillar arises as the core that influences the others. Integrated Sustainability is born, implying the management of the inherent tensions between economic prosperity, environmental quality and social justice, in balanced extents, along with the cultural and technological ones (Stahel, 2010). All elements are interconnected, interdependent, and partially in conflict (Jeurissen, 2000; Stahel, 2010).

If in the 1960s and 1970s, organisations acted by reaction when confronted with environmental or social externalities manufactured by them, the implementation of sustainable practices is now supported by a regulatory push. Organisations started, not only complying with the law, but being more predisposed to integrate Corporate Social Responsibility (CSR) practices and act proactively. Plus, they realised that working towards the proposed SDGs, presented for the new millennium, can help find ways to deal with unexpected events and crises, as well as to identify paths to a sustained future for humans to live within the Earth’s boundaries. (Giovannoni & Fabietti, 2013; Moberg & Simonsen, 2015; Rockström, 2017). This led to the application of integrated Sustainability in their core activities, reinforced with the evolving measurement and reporting systems (Giovannoni & Fabietti, 2013; Jørgensen & Pedersen, 2018; Lüdeke-Freund, 2010). These systems include the Global Reporting Initiative (GRI), the FutureFit framework, the Sustainability Accounting Standards Board (Jørgensen & Pedersen, 2018) and the International Integrated Reporting Council (Giovannoni & Fabietti, 2013; Unruh, 2016). Since organized monitoring systems are more common, easier to access and able to cover more sectors and areas of activity, sustainable practices are also more implemented. Sustainability is shaping the competitive landscape and set to be a requirement to achieve competitive advantage, which means rethinking BMs (Bocken et al., 2014; Nidumolu et al., 2009). Still, its actual implementation is

threatened by its frequent separation from business strategies (Giovannoni & Fabietti, 2013). A sustainable mindset can lead to alternatives to current ways of doing business, as well as understanding how companies can meet customers' needs differently (Bocken et al., 2014). Sustainability strategies embedded in the innovation of BMs are slowly becoming leading elements that can link technological innovations, organisational aspects and market positions (Lüdeke-Freund, 2010).

2.1.2 Industrial Ecology and Industrial Symbiosis

Industrial Ecology (IE) represents, an interdisciplinary research field (Erkman, 1997; Hond, 2000) that proposes handling environmental issues, not at the end-of-the-pipe, but to offer an upstream analysis instead (Cohen-Rosenthal, 2000; O'Rourke et al., 1996). These industries built upon ecologically benign production processes, clean resources, technologies and new products are set to achieve compatibility between the industrial and natural metabolism (Huber, 2000). The concept had been applied long before the expression emerged on the literature, which happened around the 1970's (Erkman, 1997). While in the Western world, this idea remained mainly theoretical, Japan had already incorporated the IE as a long-term and large-scale strategy on the 1960's (Erkman, 1997). IE gathers two contradictory words: "industry" and "ecology", that when combined, confer a new working outlook on Sustainable Development and system boundaries (Erkman, 1997; Hond, 2000). The 1990's turning point was when the publication of an article by Frosch and Gallopoulos was made (1989). The authors recognized that the traditional industrial model of taking raw materials to fabricate products and then generate waste, should be transformed into a more integrated system (Frosch & Gallopoulos, 1989). IE should optimize the use of energy and materials, by designing processes where waste from manufacturing process could be used again. The IE goal is to attain an ideal state, resembling Nature most, and minimize pollution and waste of manufacturing processes (Bocken et al., 2016).

The evolution of IE expanded to a study field containing different concepts and interrelated study areas, such as: Industrial Metabolism (IM), Industrial Symbiosis (IS) and Eco-Industrial Parks. (Li, 2018; O'Rourke et al., 1996; Tibbs, 1992) IM as originally defined by Ayres is "the set of materials- and energy-transformation processes that convert raw materials into finished materials and final forms of energy" (1994, p. 18). This is essential to IE and its final goal of material flows reintegration through closing loops (Anderberg, 1998; Erkman, 1997; Hond, 2000). The IE possibilities of linkages between entities, networks and material flows can be described as symbioses (Chertow, 2000; Cohen-Rosenthal, 2000), which include loop closing and energy cascades (J. Ehrenfeld & Gertler, 1997; J. R. Ehrenfeld, 1994). In opposition to what was anticipated the geographic proximity is not a limiting factor (Chertow, 2000; J. Ehrenfeld & Gertler, 1997; Hond, 2000; Li, 2018; Mallawaarachchi et al., 2020). IS proposes a complete industrial system, challenging traditionally separated industries to interact and create a cooperative network to achieve competitive advantage by physical exchange of materials, energy, water, and/or by-products, as well as services and infrastructures (Baldassarre et al., 2019; Chertow, 2000;

Mallawaarachchi et al., 2020). Eight years after Frosch and Gallopoulos' article, the most concrete realizations of IE and IS emerged: the Eco-Industrial Parks or Industrial Eco-parks (Baldassarre et al., 2019; Chertow, 2000; Erkman, 1997; Yuan et al., 2006). These industrial clusters explore, within and across different companies, the development of high levels of nearly closed-loop material exchanges and efficiency of energy cascading, where waste or by-products of one company are used as resources by another company (Erkman, 1997; Li, 2018; Lifset & Graedel, 2019). The Kalundborg Park, in Denmark was the first fully created and studied example of a symbiotic industrial organisation (Ayres & Ayres, 2002; Chertow, 2000; J. Ehrenfeld & Gertler, 1997; Erkman, 1997; Tibbs, 1992). The operations management pass to a closed-loop depiction, where design for the environment is essential to the management of the industrial system (Anderberg, 1998; Li, 2018).

The IE implementation and its different methodologies (IM, IS and Eco-Industrial Parks), moves beyond the firm level foundations by broadening the focus to inter-firm and intersectoral cooperation (Cohen-Rosenthal, 2000; Loiseau et al., 2016). While IE is pointed as one of the foundation environmental management systems of CE, accessing the idea of a cyclical system with multiple loops (Cohen-Rosenthal, 2000), it ignores other close system processes (as maintenance, repair, reuse).

2.1.3 Nature-Inspired Design Strategies: Biomimicry and Cradle-to-Cradle[1]

The current system is characterized by being cheaper to replace a broken product, than to repair the original (McDonough & Braungart, 2002). Most products are designed with a shorter lifespan, a so-called "built-in obsolescence" (McDonough & Braungart, 2002) or "planned obsolescence" (Boulding, 1966), which benefits companies as it promotes a faster consumption of goods and resources (Bakker et al., 2014; Boulding, 1966). Lifespan is defined as "the period from product acquisition to discarding of the product by the final owner; this period includes any repair, refurbishment or remanufacturing, as well as periods of storage when the product is not in use (also called 'dead storage' or 'hibernation')" (Bakker et al., 2014, p. 11). This depicts the need for a shift, based on the design phase (of products and systems), and not an end-of-the-line problem mending (McDonough et al., 2003). Hence, the Life-Cycle Assessment (LCA), plays an essential role in reverting this trend. It analyses all the resources needed for the production, manufacturing, distribution and usage (introduction, growth, maturity, and decline stage) and its impact on the environment, society and economy (Lindkvist & Baumann, 2013; Loiseau et al., 2016). Yet only recently have the social and economic aspects of the TBL been included on the evaluation. Due to its general usage, it became recognized and disseminated by the International Standardization Organisation (ISO) (Curran, 2013). What started as a comparison tool for the product's environmental "greenness" has grown into a standardized and comprehensive view of products, process alteration or even selection of potential trade-offs (Curran, 2013; Sauvé et al., 2016). Given results

[1] Cradle to Cradle® and C2C® are registered trademarks held by EPEA Internationale Umweltforschung GmbH and McDonough Braungart Design Chemistry, LLC.

provide data to choose which attributes and design strategies are the most adequate to the need and usage the product will be fulfilling. One strategy to include environmental sustainability in the product design process is Eco-design or Design for the Environment (De Pauw et al., 2014; Glavič & Lukman, 2007). Some design strategies not only consider the products' impacts on the environment, but are also inspired by the "biological metabolism". (De Pauw et al., 2014; McDonough et al., 2003) Coined as "Nature-Inspired Design Strategies" by de Pauw and her colleagues, these are defined as "design strategies that base a significant proportion of their theory on 'learning from Nature' and regard Nature as the paradigm of sustainability" (2010, p. 4). The same authors point Biomimicry, Cradle-to-Cradle (C2C) and Natural Capitalism - approach that seems to include the first two – as the strategies that aim at "redesign as Nature does" (De Pauw et al., 2010, 2014; L. H. Lovins, 2008).

Biomimicry originates from the link of two Greek words: 'bios', life, and 'mimikos', imitation (De Pauw et al., 2010), and according to the Biomimicry Institute, the fundamental idea is that Nature knows what works and what lasts, so humans can use that knowledge and apply it to solve problems, create designs and technologies that are sustainable (2015). As in Nature, if "waste" is still created, it should be as safe and beneficial for the system, a value-producing resource, not an end-of-the-pipe output that ends up in a grave (Geisendorf & Pietrulla, 2018; L. H. Lovins, 2008; McDonough et al., 2003; McDonough & Braungart, 2002). It was, in fact, over the elimination of the waste concept, the two main supporters of C2C started working: for McDonough and Braungart, "waste equals food" (2002, p. 15).

The term C2C suggests an evolution of the expression "from cradle to grave" pointed as the main problem of the present industrial system and the overall linear business thinking (De Pauw et al., 2010; McDonough et al., 2003). The use of the word "Cradle", a synonym of "crib" and "origin", echoes the idea of circularity and loop closing. The expression introduced by Stahel, in the 1970's, and popularized by McDonough & Braungart in 2002, focuses on a product life-cycle perspective, mainly on the design phase (Stahel and Reday, 1976 apud Kalmykova, Sadagopan, & Rosado, 2018; Lovins, 2008). As the design will affect production, but also the following stages and life-cycle of the product, the components of a product should be redesigned for circular recovery. Consequently, negative effects are minimized, efficiency is increased and an optimization of the positive impacts from the process is possible. (De Pauw et al., 2013; Geisendorf & Pietrulla, 2018; Jørgensen & Pedersen, 2018) According to McDonough & Braungart, the C2C strategy is to be effective instead of efficient (2002). Efficiency means "creating more with less", and has revealed increased performance, conversely, it is also the strategy applied during the Industrial Revolution that led to today's scenario (De Pauw et al., 2010). Effectiveness, as a C2C base, goes beyond "not being the worst option available", but to contribute with positive side effects, to cast light and serve a larger purpose (McDonough et al., 2003; McDonough & Braungart, 2002; Toxopeus et al., 2015). Although this idea is not limited to materials, it begins with them. Yet, Products are mostly made from a mixture of materials, which difficult its dismantlement. This derives, from the so called "monstrous hybrids" problem, in which the separation of composite materials is still not fully possible or because it is more expensive and pollutant than to make a new

product. So, both authors, divided the Planet metabolisms into two fundamental cycles: the biological and the technical. The biological metabolism cycle incorporates materials made of biological nutrients. The materials lost during the production, use and end phase of the product's useful life, that cannot be recaptured can then return to the biological cycle, be composted and eaten by microorganisms or other animals. (Bocken et al., 2014; McDonough & Braungart, 2002) This works as an open-loop cycle, as long as these waste streams and emissions are benign and create positive value for the environment (Bocken et al., 2014). The technical metabolism cycle, instead, is made out of materials that do not appear naturally (Jørgensen & Pedersen, 2018). This is a closed-loop cycle, where the resources circulate without harming the biological one. C2C implies a new model for producing (considering the cycles), consuming (products, and products as services, offering collaborative consumption models as renting or sharing) and, finally, composting, recycling or recovering products, based on their components, so that the cycle begins again (Bocken et al., 2014; McDonough & Braungart, 2002). C2C represents an important source of information to build the CE literature, as it introduces an ambitious circular approach to product design (Bocken et al., 2016).

2.1.4 Closed-Loop System Thinking: Reverse Logistics and Closed-Loop Supply Chains

Close loop system management emerges as an evolution of a collection of previously named disciplines (Geisendorf & Pietrulla, 2018; Geissdoerfer et al., 2017; Hond, 2000; Lifset & Graedel, 2019). Just as the former, this model takes inspiration on Nature's circular system with "design to-redesign" thinking (Murray et al., 2017), while also, being rooted in the idea of waste as a resource (Frosch & Gallopoulos, 1989; Li, 2018; Stahel, 1981) or even as a product (Tibbs, 1992). Most researchers and industrial ecologists think society has failed to come up with an approach that recovers resources; yet, evidence exists that, in earlier times, resource recovery was applied and more widespread. (Desrochers, 2000; Guide et al., 2003) In opposition to the present linear supply chains based on Forward Logistics, Reverse Logistics arises (Dekker et al., 2004; Guide et al., 2003). Reverse Logistics, requires meticulous planning and control as it intends to be an integrated approach, to optimize resource flows, an alternative that suggests a movement from end-user to recovery or to a new user (Dekker et al., 2004; Guide et al., 2003). The coordination of both Forward and Reverse Logistics is embodied by the Closed-Loop Supply Chains (CLSC) concept (Dekker et al., 2004; Guide et al., 2003; Paras et al., 2019; Wells & Seitz, 2005). Guide and van Wassenhove, the creators of the concept, attach a business concept to it: Closed-Loop Supply Chains Management (CLSCM). The authors define it as "the design, control, and operation of a system to maximize value creation over the entire life-cycle of a product with dynamic recovery of value from different types and volumes of returns over time". The recovery of value can be made "by reusing the entire product, and/or some of its modules, components, and parts". (2009, p. 10). This requires great knowledge of materials, together with immaterial flows, but also cross-company and -sector contact and collaboration (Ayres & Ayres, 2002; Guide et al., 2003; Lüdeke-Freund et al., 2018).

CLSC intends to retain the highest value at the material level (Franco, 2019; Geissdoerfer et al., 2017; Lüdeke-Freund et al., 2018; Paras et al., 2019; Saavedra et al., 2018). This is achieved with cascading mechanisms (Braungart et al., 2006). Cascading revolves around the transformation of materials across different value streams (including separate biological or technical reverse cycles), and for different use options; materials never leave the system, they just break the loop, to integrate a new one, until "scraped" from the system (Geisendorf & Pietrulla, 2018; Paras et al., 2019). The CLSC model promotes a collaborative dynamic system across industries, cities and communities (EMF, 2015; Lowe & Evans, 1995) and, according to Stahel, helps reducing nations' emissions up to 70% (2016). CLSC and the CE, have the common goal to make changes at the micro-level (individual organisations, communities and consumers), meso-level (industries, Eco-Industrial Parks, networks, supply and value chain) and macro-level (cities, regions, nations, world) (Franco, 2019; Ghisellini et al., 2015). The next section shows how CLSC is interlinked to the CE.

2.2 Circular Economy

2.2.1 Historical Context

The principles of the CE, as a closed system, were first referred in 1966, when Boulding differentiated between open and close systems, but the concept has only recently gained attention (Carson, 1962; Commoner, 1971; Fuller, 1969). After Boulding's proposition, other notions were added, particularly by Meadows and colleagues, with the natural resource limits along with its availability and finitude for human activities (1972). This idea was also explored by Stahel and Reday on concepts interconnected to CE (as the Performance Economy) in studies from 1976 and 1982, which promoted integrated sustainable solutions focusing on the conceptualization of the economy into loops. These describe industrial strategies for waste prevention, regional job creation, resource efficiency, and dematerialisation of the industrial economy. (EMF, 2013b; Geissdoerfer et al., 2017) Despite later contributions, the CE term was only referred for the first time in 1990 (Pearce & Turner, 1990). The authors drew a circular model framework with the interlinkages between the environment and economic activities, mainly through the resource-products-pollution relationships (Andersen, 2006; Winans et al., 2017). From this period to, around, 2013, despite the diverse terminology, most theories focused on dealing with the use of resources by extending the use phase and delaying or preventing landfilling. This relates to slowing the loop, a solution to decelerate resource consumption and an essential factor for closing the loop. The CE core idea starts to arise, with the 3R's as the main principles (reduce, reuse, recycle) and strategies as product longevity, redesign, repair, refurbishment, upgradeability, recover and remanufacturing (Blomsma & Brennan, 2017; Winans et al., 2017).

2.2.2 Not a Waste Management Framework

As a society, we constantly operate under the thought that what we do not see does not exist, as waste is moved out of sight into landfills (Hickel, 2020). This induces people to live under a short-sighted perspective (Fuller, 1969). The CE is resource oriented, yet, it is not a waste management framework, neither a Recycling synonym. In fact, recycling is a narrow answer to reintegrate resources in the system, and often more expensive than if other strategies are pursued first (Ghisellini et al., 2015; Stahel, 2016). The CE proposes the generation of cash-flows based on what was before perceived as waste (Geissdoerfer et al., 2017; Lieder & Rashid, 2016). By redefining waste, terms as wealth, growth and consumption will also be reframed (Fuller, 1969). The goal is to shift from a resource scarce economy, to an economy based on resource rich solutions and innovations (Lieder & Rashid, 2016).

2.2.3 CE as an Umbrella Concept

The CE as an umbrella concept frames and binds together several approaches that were unable to solve the stated problem in an integral way (Blomsma & Brennan, 2017). An umbrella concept, as defined by Hirsch and Levin (1999) is based on Meyer inputs. Meyer states that some subjects are composed by fluid boundaries, ultimately making the debate a permanent issue, creating an enduring pluralistic dialogue amid many academic disciplines, methodologies and perspectives, to answer a set of applied research questions (1991). The CE term uses these schools of thought as strategies and tools that can be aggregated to shape a more articulate, clear and pragmatic term (Blomsma & Brennan, 2017). *Table 1 (Appendix A)* discloses the interconnected before explored disciplines' definitions, and the core takeaways from each that are present and redefined under the CE. Every new concept builds over the preceding one, until the CE as a multidisciplinary framework is proposed (Lieder & Rashid, 2016).

2.2.4 CE as More Than a Concept: The Connection to Business Model Theory

The CE, as described by some researchers, is not only an umbrella concept, but it also develops to be a major BM aggregating the other concepts, as strategies for companies to pursue value creation, value capture and value delivery (Geisendorf & Pietrulla, 2018; Osterwalder & Pigneur, 2010). BMs can help increase future preparation, while foster innovation, as a competitive advantage source (Amit & Zott, 2001; Mitchell & Coles, 2003). Innovation reveals to be essential to succeed in a dynamic and uncertain environment, and happens as new BMs represent new approaches on how firms do business (Sánchez & Ricart, 2010). While innovation of BMs is also a new phenomenon, it is defying the well-delineated boundaries of the "traditional BMs" (Foss & Saebi, 2017). With this, the Business Model Innovation (BMI) field is born (Zott et al., 2011, p. 1032). BMI can be defined in terms of changing components and/or the architecture of the BM, as a continuous reaction and adaptation to changes in the environment,

and where the degree of innovation is a source of value creation for the firm, its suppliers, partners, and customers (Amit & Zott, 2001; Demil & Lecocq, 2010; Foss & Saebi, 2017; Spiess-Knafl et al., 2015). It is considered to be one of the "least used and most powerful ways to create sustainable profit growth, economic development and new 'markets' and 'industries'" (Osterwalder & Pigneur, 2010, p. 261). And is influenced, not only by low-income markets circumstances (with the emergence of business opportunities at "the bottom of the pyramid"), but by a bigger range of sustainable development constraints and its consequences (Demil & Lecocq, 2010; Foss & Saebi, 2017). These challenges include the climate crisis, along with factors as: regulatory pressures, political desires and changes in socio-economic and technological landscapes (De Angelis, 2016).

2.2.5 Sustainable Business Model Innovation: the Space for CE

The need for new and sustainable ways businesses can challenge the traditional and basic assumptions of how to create and capture value, a precondition for Sustainable Development, conveys BMI to be a key tool and strategy working for the construction of a greater Sustainable Business Model Innovation (De Angelis, 2016; Jørgensen & Pedersen, 2018). Some researchers set Sustainability as one of the antecedents of BMI, the element that often triggers the need for corporate and system transformation (Bocken et al., 2015; Foss & Saebi, 2017; Murray et al., 2017). The appearance and focus on Sustainable Business Model Innovation, or as conventionalised Sustainable Business Models, is justified by the fact that, by embedding Sustainability in the BM, the innovation factor is necessarily present, as it obliges the revision of the way companies do business (Jørgensen & Pedersen, 2018; Kiron et al., 2013; Murray et al., 2017). Sustainable Business Model Innovation is, thus, necessary, so that BMs become both profitable and sustainable, by adding more value than what they take (Bocken et al., 2014, 2015; Foss & Saebi, 2017; Jørgensen & Pedersen, 2018).

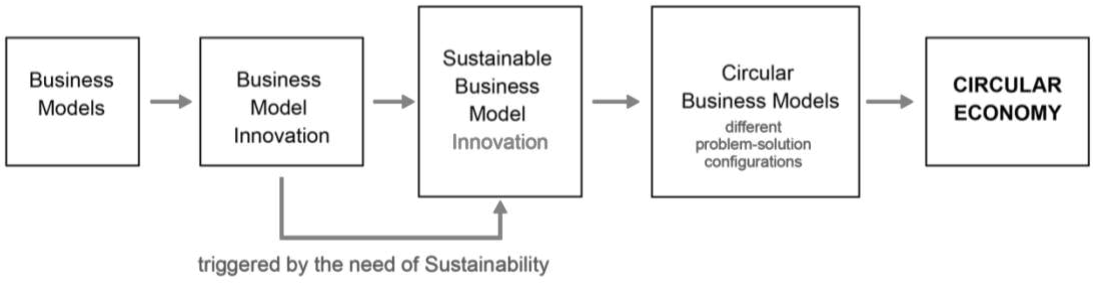

Figure 2.2.5.1 - *The Role of Innovation as an Enabler of CBMs and of a CE (Source: Author)*

Sustainable Business Models (Innovation) can be defined as BM designs in which attending to social and environmental externalities are an integral part of the company's way of creating, delivering, and capturing value (Jørgensen & Pedersen, 2018). Despite this definition, the question of how managers can innovate their BMs toward greater Sustainability, in practice, is still unclear (Foss & Saebi, 2017), With the exception of the Circular Business Model (CBM) approach, that even so has not had the needed

attention inside the sustainable BMs and CE academic literature (Lüdeke-Freund et al., 2018). The CBM returns to "creating wealth by making things last" (Stahel, 2016, p. 436), that together with closing the loop can make these new BMs compete with the existing linear ones. (Reichel et al., 2016; Renswoude et al., 2015; van Beers et al., 2014)

2.2.6 Defining Circular Business Models

The CE concept and the ways companies do business by operating a CBM have been identified with a broad terminology that is not yet consensual. None of the designations had time to be recognized by the academic and business world as the most relevant. *Table 2 (Appendix B)* contains the different designations of the problem-solution combinations to reach a CE, based on existent publications analysis (Lüdeke-Freund et al., 2018). As seen in the table, different terminologies are used to describe the CE. Yet, it is possible to delineate a clear pattern in the use of certain words. To note that "approach" and "framework" have nineteen occurrences each, however, "approach" will be excluded due to its dubious meaning and usage. With this, it is set the use of the terms "framework" and "models/sub-models" when referring to the CE and its different sub-terms respectively, as they are the most referred terminology. The CE principles, contrarily to the concept's other designations, are referred using the EMF proposals. The principles (from the three C2C principles), the EMF points as the core guide for superior economic outcomes in a CE, are: 1) Preserve and enhance natural capital controlling finite stocks and balancing renewable resource flows; 2) Optimise resource yields by circulating products, components, and materials in use at the highest utility at all times in both technical and biological cycles; 3) Foster system effectiveness by revealing and designing out negative externalities, as water, air, soil, and noise pollution; climate change; toxins; congestion; and negative health effects related to resource use; 4) Think in systems (2013a, pp. 22–23). Adding to these is 5) Think in cascades, as waste is food and restorative loops is the central idea (EMF, 2013a; Esposito et al., 2018).

2.2.7 Circular Product Design Strategies

Succinctly, BMs, and more specifically CBMs are different problem-solution combinations, that incorporate design strategies, that, together frame the CE framework as a system. The design strategies contribute to the CE to be achieved. Provided that there is no consensus on the terminologies which set up the CE, the same does not happen with the above-mentioned strategies. These Circular Product Design Strategies (Bocken et al., 2016; Lüdeke-Freund et al., 2018) or typologies (De Angelis, 2016; Hollander et al., 2017) are built around the resource cycles (narrowing, slowing and closing resource loops) and, together, can lead to more sustainable BMs (Jørgensen & Pedersen, 2018). These cycles include: narrowing (resource efficiency is increased by using fewer resources per product, as lightweight materials and efficient energy and manufacturing), slowing (extending the life of products, that are

designed from the start to be maintained, reused, repaired, refurbished and remanufactured, before their end-of-life; a preventive approach) and closing resource loops (the loop between post-use and production is closed, the goal is to avoid waste since the resources are kept within the economy, even when a product has reached its end-of-life). (Bakker et al., 2014; Baldassarre et al., 2019; Bocken et al., 2014, 2016; Franco, 2019; Geissdoerfer et al., 2017; Lüdeke-Freund et al., 2018) The strategies can be grouped into four big typologies depicted in *Table 3 (Appendix C)*. These are as much about the ideation of the product as they are about the customer relationship management activities (Geisendorf & Pietrulla, 2018). It is, at this level, that these strategies can align producer and user goals, and by this, shape the coming CBMs (Geisendorf & Pietrulla, 2018; Yong & Doberstein, 2008).

2.2.8 The Final CE Definition as a Framework Composed by Different CBMs

The CE uniqueness derives from several interconnected ideas that materialize under CBMs. In a nutshell, distinct CBMs are simply based on different configurations of:

- The five CE principles and extended R's (Refuse, Rethink, Reduce, Reuse, Repurpose, Resell, Repair, Remanufacture, Recycle, Recover, Recommend, Regulate, Reverse and Regeneration of Nature as the ultimate positive goal of the CE);
- The three resource cycles (narrowing, slowing and closing resource loops);
- Circular Product Design Strategies;
- Sustainable Business Model Innovation or BMI for Sustainability;
- The TBL approach presence.

The CBMs, resulting from these five spheres, and their sub-models are presented in the next list, while its respective definitions and literature references are disclosed in detail in *Table 4 (Appendix D)*.

1) *Dematerialised Services:* Physical to virtual/digital; Subscription-based Rental;

2) *Access and Performance Models or Product Service Systems (PSS) / Product as a Service / Servitization:* Pay per use/Pay per service unit; Performance-based contracting; Leasing/Lending; Renting; Sharing (including Sharing Platforms); Swapping/ Bartering/ Pooling/ Gifting/ Borrowing.

3) *Produce on Demand:* Customer Vote (Design); Design and Produce to Order; 3D Printing.

4) *Take-Back Management & Next-Life Sales:* Second-hand (including Second-hand Platforms); Buy-back, Refurbish & Resell; Remanufacturing & Product Transformation.

5) *Repair & Maintenance: Extend Product Value:* Product-Life Extension & Value Recovery; Gap-Exploiter Model.

6) *Classic Long-Life Model:* High Levels of Warranties & implicit associated services of Maintenance and Repair; Encourage Sufficiency; Progressive Purchase.

7) *Pure Circles or Create Value from Waste:* Circular Sourcing; Industrial Symbiosis; Eco-Industrial Parks.
8) *Waste Management: Waste as a Resource*: Waste Handling and Processing; Waste/ Resource Redistribution; Cascading and Repurposing; Recycling & Waste Management: Downcycling; Recycling & Waste Management: Upcycling.
9) *Dealing with Residuals:* Organic Feedstock; Biomass Conversion; Anaerobic Digestion; Composting; Fertilizer Production; Bio-based Materials; Energy from Waste or Waste-to-Energy.
10) *System Scraping*

In the interest of the CE framework, some CBMs and sub-models should be preferred over others, as they do not have the same level of positive outcomes. The models and sub-models can be combined and complement each other to work in several cascading levels to form a global CE framework where interactions occur at the macro-, meso- and micro-level (Ghisellini et al., 2015). After one process or sub-model applied, the material can enter a new one, and maintain its value while kept longer in the system. In addition, the value conservation (across cascades or loops) is extended to the labour, capital and energy (that has to come from ethical, natural and renewable sources). (Blomsma & Brennan, 2017; Hollander et al., 2017; Kalmykova et al., 2018) According to the EMF, "the circular economy explicitly acknowledges the importance of the relationship between various forms of natural capital and the flows that come from and return to them" (2015, p. 47). The CE is pushing organisations to conceive "disruptive technology and business models that are based on longevity, renewability, reuse, repair, upgrade, refurbishment, servitization, capacity sharing and dematerialization" (Esposito et al., 2017, p. 9) This implies shifting from manufacture- to service-based BMs, leading to access and performance and collaborative consumption being preferred over exclusive product ownership (Bocken et al., 2016; Franco, 2019; Geissdoerfer et al., 2017; Lüdeke-Freund et al., 2018; Merli et al., 2018; Moreno et al., 2016). The first CBM and sub-models on the list, being pure service offerings, do not require the purchase of a physical product and, thus, less resources are used. This allows for the reduction of products' fixed costs, that would normally call for storage, maintenance, repair, etc. (Stahel, 2016). As we move down, the level of ownership increases, as does the need for resources and materials. Finally, models are presented that use the waste of the first, as resources to create value and reintegrate it into the system, until it is scraped, once no more cascades are available.

Bocken and her colleagues state, that, while positive, these solutions are often small scale, which limits its potential (2014). To sum these CBMs have the urge to apply scale-up strategies. This requires work and change in the social and cultural mindset with re-thinking partnerships and collaborative models, as triggers of both top-down and bottom-up motivations and actions (Lieder & Rashid, 2016). At this point, and if the five spheres of a CE are embedded in the CBMs, approaches highly related to the LCA concept, as "product passport" and extended producer responsibility arise and are

disseminated. Product passport is a system providing information about the components and materials a product contains, and how they can be disassembled and recycled at the end of the product's useful life (Amed et al., 2022; European Commission, 2013 apud Lieder & Rashid, 2016). In turn, extended producer responsibility, which should be the base of all CBMs (Bocken et al., 2014; Esposito et al., 2017), enables that, at the point of sale, the liability for risks, impacts and waste the product generated since the source of its raw materials, until the end of its future useful life, is kept in the producer's hand and not the consumer's (Stahel, 2016). This promotes transparency in supply and value chains and leads to collaborative and integrative approaches of BMs (Lieder & Rashid, 2016). This trend is supported by the rising tendency to demand more information on environmental, social and economic actions not only by regulations change but, increasingly by consumers (Bocken et al., 2014).

The CE framework with all its CBM's (*Table 4, Appendix D*) is the link between economics and the environment. By providing benefits to both spheres, the result is wider social welfare; the CE offers prospects of new sources of wealth, along with innovative, skilled employment opportunities (EMF, 2013b; Ghisellini et al., 2015; Lieder & Rashid, 2016; Stahel, 2016; Wells & Seitz, 2005). By improving resource use efficiency, wellbeing across geographies and generations will show (Ghisellini et al., 2015; Ness, 2008). Due to the literature production and direct application on organisations, the CE gained its public agenda space, and so, different and complementary definitions emerged. (Bonciu, 2014; Lüdeke-Freund et al., 2018) In 2013, one of the major contributors to the discussion of the concept, the EMF, described the CE as "an industrial economy that is restorative or regenerative by intention and design" (2013a, p. 7). After this, the European Commission has been releasing information aiming to make CE a reality within the Union, and be a tool to reach the SDGs by 2030 (European Commission, 2015).

All in all, CE has the ambition and proposes the tools for a continued economic Sustainable Development by replacing production and unmeasured growth with sufficiency (Stahel, 2016; Yong & Doberstein, 2008), and to decouple growth from natural resource depletion, environmental and social degradation (Liu et al., 2009). The final goal is to have an integrated and optimized sustainable way of doing business (Feng et al., 2007; Ghisellini et al., 2015; Lieder & Rashid, 2016; Murray et al., 2017; Yong & Doberstein, 2008). To conclude, the aim should be, as stated, not only not harming the ecosystem, but contributing to its regeneration as well (Lacy et al., 2020). Ergo, the CE will not materialise if only one player changes practices and complies with the framework. Only by connecting all organisations, that form our economy, will the current system and the future be redesigned (EMF, 2012; Lacy et al., 2020).

2.2.9 The CE Framework as a Plan for the European Future

Europe is equipped with the conditions and stimulus packages that allow for a complete CE transition. As flawlessly put by Laurent Auguste, Senior EVP Innovation & Markets of Veolia, in the EMF 2015 report: "Europe offers the perfect ground for a circular economy to truly take shape and for launching

disruptive models." (2015, p. 6) Hence why, the CE is receiving increasing attention on the European sphere, with a roadmap is outlined since 2019 with the European Green Deal. The Commission admits the adoption of a CE needs to be accelerated, widespread, uniform and include all Member States. (European Commission, 2019) Different studies were made on the impacts of a transition to a CE. One of the most relevant predicts the CE can lead to an European GDP increase of as much as 7%, by 2030, relative to the current development scenario, with a decrease of GHG emissions up to 48% by the same date. A 83% reduction of GHG emissions is foreseen, alongside a 12% increase in GDP, by 2050 (EMF, 2015). Minimizing the EU environmental pressures, would positively contribute to the global future, reduce the high and rising resource dependence, product imports, and be vital as other regions develop and international competition for resources increases (Reichel et al., 2016).

2.3 A Circular Economic Approach to the Fashion and Textiles Industry

2.3.1 The Conventional Linear System of the Fashion and Textiles Industry

The FTI is pointed out as the second most-polluting right after the oil industry (Vecchi, 2020). This happens as the majority of the textile system operates with linear wasteful processes (Eder-Hansen et al., 2017; EMF, 2017). Not surprisingly, it has been one of the most criticized industries, with increasing pressure from customers, that have a "rising trust deficit" on brands' allegations on transparency and sustainability (Amed et al., 2018). And if, in 1997, consumers considered style and fit in detriment of environmental aspects when making purchasing decisions (Butler and Francis, 1997 apud Jung & Jin, 2014) presently, the scenario has changed, with consumers from younger generations. If companies are not aware of how they can change their processes in order to minimize their impacts, the future of the Industry, due to lack of transparency and the increased scarcity and rising prices of raw materials may be compromised (Eder-Hansen et al., 2017; Global Fashion Agenda, 2019).

The FTI is supported by substantial volumes of non-renewable resources, extracted to produce clothes and accessories often used by customers for only a short period of time, due to an unprecedent consumption level and radical reduction in the items life-cycle (EMF, 2017). Since the 1990's, the increasing market demand has been challenging the dynamics of the Industry with the intensification of mass production, increase in number of fashion seasons and modified structural characteristics in the supply chain (Bhardwaj & Fairhurst, 2010). This marks the emergence of what is called Fast Fashion, being ZARA, the brand from Inditex group, the pioneer of the model. And, despite the recent and rising consciousness awakening for the environmental and social consequences of such consumption pace, most consumers still demand speed and trend newness, as the Industry increases its offers of low-cost clothing (Kant Hvass & Pedersen, 2019). Fast Fashion, as Fletcher states is designed to be cheap, easy, and rapid to produce; it draws on low-cost materials and labor, short lead times, and efficient large volume production" (2010, p. 260). The Fast Fashion industry is both a consumer- and supplier-driven approach, implying rapid responsiveness techniques, as just-in-time, quick response and agile supply

chains (Bhardwaj & Fairhurst, 2010). This is even accelerated with the recent appearance of Ultra-Fast Fashion, with brands as Shein (Bovon, 2020). Any product or market where there is an element of style is normally characterized by low predictability, high impulse purchase, shorter life-cycle products and high volatility of market demand (Fernie & Sparks, 1998). The rising costs of producing goods is pressuring companies down a road of squeezed and falling average per-item prices, higher discount levels, accompanied by resource scarcity and an opposite increasing price trend on raw materials and labour (Eder-Hansen et al., 2017). The cost of materials with cotton serving as an example, since it is the most sourced natural fibre worldwide, its price reached a record in October 2021 (Kay, 2021; Lehmann et al., 2018). In addition, pressure is being placed over fashion companies to meet minimum living salaries and working conditions, and with former underdeveloped and industrialized countries improving their life quality, the countries' gap regarding labour costs, is fading. (Amed et al., 2018)

The development phase is the first stage of the FTI value chain and involves the design and material decisions, which will then affect not only the product's style, sales and use, but also its environmental and social impact, influencing all consequent stages of the supply chain, from resource exploitation to post-use and end-of-life (Global Fashion Agenda, 2019). Frequently, these choices prioritise material costs over accessing the life-cycle (environmental and social) impacts of the garment upfront (Vecchi, 2020). The goal is, most of the times, to make the cheapest garment, with the lowest quality, to sell for the lowest price, so that a few "wears" later the client needs to replace it – all supported and justified by an obsolescence and change of trends and styles. The speed and pressure of the system led to incidents like the Rana Plaza disaster in 2013, in which over 1,000 workers were killed, as a result of an irregular subcontracting system and inspection difficulties (EMF, 2017; Henninger et al., 2019; Parveen, 2014). This marks the moment international attention was drawn to the undignified working conditions of the clothing value chain (EMF, 2017). In addition, a variety of expertise is required from manufacturers, which are unlikely to be good at both pleating and embroidering, denim and leather, for example (Tokatli et al., 2008). Fletcher (2010) states despite high speed not being itself a descriptor of unethical and/or environmentally damaging practices, it has ecological and social effects.

The FTI is an "highly fragmented industry, with thousands of actors involved and one of the most complex global production networks and supply chains" (Eder-Hansen et al., 2017, p. 8). Even with its complexity, transportation (distribution, packaging) is the stage of the supply chain with the smallest footprint, being in line with other industries and benefiting from the logistics implemented globally (Eder-Hansen et al., 2017). In the last 15 years, global clothing production has almost doubled, from 50 billion units per year, in 2000, to approximately 100 billion (EMF, 2017) The same trend was seen in the purchases, but with a decrease on the utilization rate of each garment (Eder-Hansen et al., 2017; EMF, 2017). There is still overproduction, with more and more reports of brands to purposely burn or damage unsold products, so their price does not decrease (Amed et al., 2018). These are direct consequences of Fast Fashion: clothes are no longer looked after and repaired, instead, they are treated as disposables (Eder-Hansen et al., 2017; Jung & Jin, 2014).

Recent studies alerted for the negative impact of the usage phase of apparel items, since most garments include plastic-based fibres (polyester, acrylic, nylon) and a lot of the chemicals used during production are still embedded on the textiles when they are sold. Also, when garments are washed, chemicals and plastic-based fibres that make its composition are released into wastewater or transported on microfibres which end up in Nature, with the FTI being identified as "a major contributor to the issue of plastic entering the ocean" (EMF, 2017, p. 21). Despite some countries, as the EU ones, have regulation forbidding certain pollutants in textiles production, the Union keeps importing from countries with no regulation, while those countries also suffer the social, environmental and health effects of producing it (EMF, 2017). After used, worldwide estimations are 73% of garments are landfilled or incinerated, with all its chemicals leaking into the environment (EMF, 2017). In addition, less than 1% of the material used to produce clothing is recycled into new clothing, and fewer than 15% of clothes are collected for recycling (Global Fashion Agenda, 2018). This percentage rises to 20% if considering clothing for reuse as well (Eder-Hansen et al., 2017). To note that, recycling textiles is most of the times impossible due to the mixed materials and fibres composing the garments – the so called "monstruous hybrids" with natural, synthetic and artificial fibres making up for the attire. Additionally, other elements as metal or plastic zips and buttons (that need to be removed ahead), polyester sewing threads and the use of a vast range of dyes are also included. (Beall, 2020; Global Fashion Agenda, 2018) When Recycling is possible and happens, textiles are normally Downcycled to lower quality products, that are not recyclable at the end of their life. Because what is recycled might not always be recyclable.

On top of the identified FTI linear system, there is an additional invisible supply chain that starts with the donations, neither known nor controlled, but has the dumping of clothes in the Global South countries as a result. This is fed with clothes charity shops cannot donate or sell, and with the filling of the containers, consumers see at the Fast Fashion clothing chains stores. (Benson, 2021; Poerner, 2020). Due to misinformation, disinformation and greenwashing, is not clear what happens to these textiles: if donated, sold, recycled? No data is available and so an additional supply chain, invisible to most peoples' eyes is initiated. The containers full of donated clothes are exported to Global South countries, like Kenya or Ghana, where local people purchase garment bales to resale in big markets (Cartner-Morley, 2021; Kubania, 2015). Kantamanto Market, in Accra, Ghana is the largest second-hand clothing market in West Africa, pointed as, probably the biggest worldwide (Ricketts, 2019). Kantamanto's elders reported to The OR Foundation that, when the second-hand clothing trade started in the 1960's it was considered good business (Ricketts, 2019), while, today's influx of 15 million items unloaded every week, is not manageable. All containers have trash and waste and may even be contaminated with mould or objects like plastic bottles that are not clothes, but which weight is included on the bale's price. Garments as winter coats are not needed, valued or sold, for the climate conditions and necessities are different, are also frequently found in the bales. (Ricketts, 2019; Ricketts & The Slow Factory Foundation, 2021) Following the principles of CE, clothing and textiles should stay in circulation as long as possible, yet this is impossible if overproduction remains in this global equation.

2.3.2 From Linear to Circular

The truth is: the basis of the system has to change and due to its size and complexity, it will not be possible if planned and executed in a static, independent and fragmented way (EMF, 2017). To achieve a system-level change, long-term commitments need to be made and an unprecedent level of collaboration and alignment on all areas of action must be achieved. All stakeholders need to be involved and each supply chain step must be accessed and redesigned and, as a result, the way the Industry creates and delivers value over its BMs needs to be evaluated as well (Lüdeke-Freund et al., 2018). "Businesses are naturally placed to play a leading role in the transition" (EMF, 2017, p. 29). Additional, but essential for the transition are all levels of economic and non-economic actors: from policy makers and regulators, education and research institutions, other organisations, as industry associations and initiatives, NGOs, international bodies, civil society and the public play important roles (Amed et al., 2021; EMF, 2017).

The road towards a CE will not only affect the way organisations interact with each other, but also their organisational structure (EMF, 2017). For example, new functions and departments may surge, and with it different hierarchical levels and information flows (Ritzén & Sandström, 2017). Thus, how the FTI firms adjust their BMs to the CE, involves considering which processes to adapt, the strategies, the steps and possible partnerships. Businesses urge to have the courage to "self-disrupt" their own identity and the sources of their old success so to undertake these changes and win new customer generations (Amed et al., 2018). For FTI players, being the suppliers, retailers or consumers, the shift to a new paradigm gaining shape, where some of the old rules don't apply, will define who will succeed (Amed et al., 2018; Eder-Hansen et al., 2017). Companies need to take an active stance on social issues while continue to satisfy consumer demands, with the pressure of ultra-transparency and Sustainability. The transition has to start with a switch of mentality and re-adaptation of the vision, mission, and values of each company. The more complex a supply chain, the more challenging and greater the likelihood changes are required to the traditional BM (Bocken et al., 2016). The CE arises as a framework FTI companies of all sizes might adopt to engage with such a radical change and innovation in thinking and doing business (Bocken et al., 2016; Ritzén & Sandström, 2017). Next, is explored which CBMs can be applied into the FTI, how and which problems they can help solving. As there is no common agreement on how to design such system, the supply chain was divided by phases: in each phase proposals are made that, together, contribute to a CE system (Lüdeke-Freund et al., 2018; Planing, 2015).

The first phase of the supply chain to be tackled is the one influencing all the others: design and development. In this phase, LCA and impact assessments should be made, so that the economic activity of the FTI is decoupled from the consumption of finite resources and waste is designed out of the system (EMF, 2017). Hence, Circular Product Design Strategies (*Appendix C, Table 3*) must be applied when designing and developing garments. These strategies can and will only be applied if top management is aligned and committed to approve the necessary changes (Jia et al., 2020). Fashion designers do not work in isolation, so company organisation alignment is crucial (Gwilt & Rissanen, 2011; Jia et al.,

2020). In a practical sense, the first aim should be to produce for durability using less resources (EMF, 2017). If garments are made to be disposable, they cannot be worn for long, resold and even other options as Maintenance, Repair or Recycling are more difficult to pursue. "Decisions made on the design phase are responsible for 80 to 90% of the environmental and economic costs" (Vecchi, 2020, p. 33). Hence, the importance of Circular Product Design Strategies serving as enablers of CBMs.

Design for longevity, based on high quality clothes is not the only factor contributing to slow resource loops and retain product value, proven to be a key selling point (EMF, 2017). The Classic Long-Life Model can be reinforced with attached services of fitting and personalisation, for example, which helps the costumer to create an emotional connection and sense of care (EMF, 2017). Alongside these services, that can be new niche business opportunities, other CBMs that also explore the relationship with the customer include Production on Demand and its sub-models: Customer Vote (Design), Design and Produce to Order or 3D Printing and, in the FTI case, 3D Knitting and 3D Weaving can also be included (EMF, 2017; Vecchi, 2020). These CBMs integrate new technologies which are more personalised, tend to generate less waste and be less resource intensive, while, increase utilization rates and help avoid fast consumption and overconsumption (EMF, 2017; Vecchi, 2020). Production on Demand can help reduce inventory and the need to discard, burn or lower the price to get rid of overproduced stock (Eder-Hansen et al., 2017; EMF, 2017). The listed CBMs and all the upcoming ones should have as a precondition the conception of zero waste pattern designs. Now feasible with smart manufacturing technologies and tools allowing for 3D visualisation and digital prototypes, instead of physical ones (Amed et al., 2021; EMF, 2017; Vecchi, 2020). Such technologies include IoT, AI, big data analytics, Cloud computing as well as 3D printing and designing (Ibn-Mohammed et al., 2021). As to Financial Sustainability, despite the need for specialized machinery, applying such CBMs and Circular Product Design Strategies reduces upfront investment on big batch productions, facilitates prototyping (which becomes faster and cheaper, with no need for physical sample shipping), reduces uncertainty (it is only produced what is ordered), as well as risk mitigation against disruptions (supply chains get smaller and one-product segment can be pursued) (Amed et al., 2021; Eder-Hansen et al., 2017; EMF, 2017; Ibn-Mohammed et al., 2021).

Other Circular Product Design Strategy that can be pursued or combined falls under the Design for Product Life Extension or Value Recovery (*Appendix C, Table 3*). This includes, incorporating design for dis- and reassembly, modular garments, clothes designed to be timeless, multi-purpose, adaptable, and upgradable, for example (EMF, 2017; Gwilt & Rissanen, 2011). By designing products that can adapt to changing user needs, it increases the use frequency and can facilitate repair and maintenance models (as only the damaged component of the garment is replaced) (EMF, 2017). Other design solutions include "garments that can be worn inside out, or that are made up of a fixed base together with removable sections that are offered in multiple colours, would allow one garment to match several outfit combinations" (EMF, 2017, p. 86). This facilitates other upstream activities, as Upgradability, Adaptability, Re-manufacture, Refurbish, Repurpose, Recycling and waste management to be attained.

The maximization of the products' life-cycle can only happen if its materials allow. Thus, the materials phase is intimately connected to the previous one, once the materials choice is a big component of the products design and development journey. Materials are chosen with a mere economic evaluation of the resource, not considering the total impacts (Global Fashion Agenda, 2019). The decisions over which fibre, fabric and additional components and resources to use will affect, not only the price, aesthetics and comfort of a garment, its consequent market acceptability and sales, but the supply chain: its quality, lifespan, social and environmental impacts, and its end-of-life options to re-enter the system in a new cycle of circular sourcing (Vecchi, 2020). So, to reach a CE in the FTI it is urgent to align clothing design, materials and recycling processes (EMF, 2017; Global Fashion Agenda, 2019). This stage is the most complex of the supply chain but, it is where the biggest emissions-savings are (Amed et al., 2021). Improvements in materials, can have immediate impacts without directly interfering in operations (Lehmann et al., 2018). The main problem remains that, often fibres are categorised under "good" (natural fibres are normally in this category) or "bad". However, the subject is much more complex. (Fletcher, 2008; Mistra Future Fashion, 2019) This complexity is often used for greenwashing, as consumers trust they are buying a "sustainable" fibre just because it was marketed as so (as an example, a recycled fibre is not unmistakably less resourceful). Various parameters contribute for the environmental, social, and economic footprint of a fibre, including water usage, land occupation, chemicals to grow crops or produce the fibre, energy, time, dyes, etc. (Gwilt & Rissanen, 2011).

Overall, natural fibres (cotton, linen, hemp, jute, kenaf) are the ones that consume the most water, with cotton, one of the most commonly used fibres taking around 8000 litres of water (an estimated average across the global cotton crop) to produce 1 kg of fibre (Fletcher, 2008; Mistra Future Fashion, 2019). Additionally, wool, silk and leather raise questions over animal welfare and usage of land (the need to grow crops to feed the animals, and the land to keep the animals), but on the other hand "these fibres are durable and have a lower footprint during the use stage of the value chain" (Lehmann et al., 2018, p. 36). Overall, water consumption in the production of manufactured fibres, such as polyester (that takes almost no water), nylon, acrylic is lower than for natural fibres, and if we can stop using pesticides and chemicals to grow natural crops, the same does not happen with manufactured fibres. For these, energy consumption is almost twice the energy needed to make the same amount of cotton and its direct pollutant emissions are higher, as its production is based on processes that use petrochemicals coming directly from oil. (Lehmann et al., 2018) Between natural and synthetic fibres, there are manufactured artificial fibres which main constituent is natural (cellulose or protein based). This category includes the cellulose-based viscose, lyocell (produced from forest management), cupro and modal which can help replacing some of natural fibres, while offering new features, as light weight (Lehmann et al., 2018; Mistra Future Fashion, 2019). The big advantage of natural over non-natural or chemical fibres is at the use and end-of-use phases. While synthetic fibres shed microfibres when in use and washed (EMF, 2017), the same does not happen with natural and artificial cellulose-based fibres, which are renewable, lightweight, strong, mechanically recyclable and are able to decompose naturally

by bacteria when discarded as waste. (Lehmann et al., 2018) The option of circularity and reintegration in a new cycle and under what form, highly depends on the mix of materials made in the design and development phase along with the technology available for that reintegration. Hence, the need for innovation while applying the moto "design to re-design thinking" (Murray et al., 2017, p. 373). Circular Product Design Strategies need to be applied, having the biological and technical cycles in mind (Design for Technical and Design for Biological Cycles - *Appendix C, Table 3*). Technology could also be developed to support Sorting and Recycling processes, by detaching and extracting different fibres from the same structure (EMF, 2017; Global Fashion Agenda, 2019; Lehmann et al., 2018).

The ecological and social impacts of the production of a fabric not rely on the fibre alone, as it highly depends on the implementation of good practices throughout the supply chain as well (Mistra Future Fashion, 2019). Thus, the importance of the connection and traceability of suppliers, in order to create a certified supplier base (Eder-Hansen et al., 2017). Models such as Industrial Symbiosis can reduce the firms' footprints, as with the utilization of closed systems of water that serve several companies on Eco-Industrial Parks. That said, suppliers should engage in active collaboration to tackle environmental and social issues and foster innovation to answer current problems. This may involve looking for certified and fair-trade materials and suppliers, that wage fairly, with no gender or race discrimination, no child labour and animal welfare. For all these to be attained, the true cost of materials, production processes, labour and transportation needs to be reflected on the garments' final prices (EMF, 2017). With potential for automation in some areas, the FTI is generally still very labour intensive, since all clothes need to be sewn together and finished by a seamstress (Amed et al., 2018). Investigation is ongoing with a broad range of opportunities the industry can explore, opening up CBMs possibilities: Dematerialised Services, with Physical to Virtual/Digital products and Subscription-based Rental for fully digitalised garments. A radical idea, not in the far future anymore, is for fashion goods production to be the totally digitalised, with a drastic reduction on resource consumption (Amed et al., 2022).

As previously stated, transportation and distribution is not the most polluting stage of the FTI, still better practices can be applied. By simply reducing the fragmentation of the Industry with closer locations as facilities and production steps, the need for transport is reduced (Eder-Hansen et al., 2017). This phase footprint can be reduced using less polluting transport (as trains instead of planes) and renewable energy powered vehicles, as in line with one of the CE spheres. Space utilization is also key for efficient energy use, so no empty containers or vehicles should be shipped (Eder-Hansen et al., 2017). The "last-mile delivery has the highest per kilometre transport costs and carbon emissions of the whole logistics chain", so reducing or eliminating it, should impact this step (EMF, 2017, p. 81).

After distribution and logistics, it comes the time for the garment to be sold to the final client. Though, instead of a traditional sales BM, fashion companies can turn to Access and Performance or PSS CBMs where there is the possibility for items to be provided as renting, leasing or sharing services (Lehmann et al., 2018). Economic opportunities already exist for many of these models, as Subscription

Models where the client pays per use or a recurrent service fee to have a fixed number of garments on loan for a certain period of time. This can reveal attractive for both sides. The first profits from product exposure, a closer and potentially long-lasting customer relationship based on loyalty and feedback loops, while earning a steady revenue. The customer sees its desires of regular changes of outfit and to follow up the last trend satisfied. (EMF, 2017; Vecchi, 2020) As put by the EMF: "for these customers, short-term rental or subscription models can provide an attractive – and often more cost-effective – alternative to buying new items" (2017, p. 79). Rental, Sharing and Leasing Models can also be directed to fulfil practical needs that change over time (sizes change, maternity wear, baby and children's clothes) and serve one-off occasions and needs without the customer having to make a big investment (special occasion wear, luxury and special sports equipment). (EMF, 2017) For any of these models, logistics optimization is key, as support for all the exchanges between customers, brands, and suppliers.

"More than three in five consumers in a McKinsey survey ran in May 2020 said brands' promotion of Sustainability was an important factor in their purchasing decisions" (Amed et al., 2021, p. 18). Still, there is a behaviour-intention gap between what consumers express as an intent to act and consume more sustainably, and their actual behaviour, normally due to barriers as habits, status-quo bias, price, etc., that need to be overtaken with different interventions, as nudges, exposure to information, individual goal setting incentives, feedback participation actions (Mistra Future Fashion, 2019). This perspective of building a relationship with the consumer, by empowerment and information, will have impacts on those who are expected to use, care for and dispose of the garment in a responsible manner (Gwilt & Rissanen, 2011). Retailers can also close this behaviour-intention gap by implementing Warranties and Services of Maintenance and Repair after sale, by establishing true transparent Take-Back Models for clothes and textiles to turn into new resources and better labelling (EMF, 2017; Ritzén & Sandström, 2017; Vecchi, 2020). Smart labelling with QR-Codes, for example, enables product passports, with detailed information on the origins and conditions in which the garment was produced, the composition, end-of-life collection, take-back systems and recycling processes (Amed et al., 2022). While these are essential to educate customers for new practices, this would also facilitate recyclability and resource recovery by providing material tracking and identification, giving transparent and total disclosure of information (Eder-Hansen et al., 2017; EMF, 2017; Pedersen et al., 2019). The way the consumer cares for and maintains the clothes, as what is done when the garment no longer satisfies the customers' needs, can make or break the system, clothes need adequate washing and storing, so they maintain their integral value (EMF, 2017). At this stage, better labelling of care and washing instructions are essential (EMF, 2017). During this stage, Repair and Maintenance services promoting the extension of the product's life and value, arise as complementary value streams or independent BMs in itself, as garments restyling or consulting models (EMF, 2017). These CBMs can be explored by the company that produces and sells the product or by an independent organisation as a Gap-Exploiter Model, that provides a service to the end-consumer or to the brand that originally sold the item (as a B2B). These services shall be offered to the first customer of the brand and to following owners of the product (which

information can be inserted if smart labelling is used). By prolonging each stage of ownership, the usage rate is increased, lowering the impact of the product and promoting an attachment feeling, increasing the perceived value the user has of the item. (EMF, 2017; Vecchi, 2020).

When the consumer no longer uses the item, other CBMs arise as options to not end the life of the product when it could still be used by another person. Here is where Take-Back Management & Next-Life Sales bigger category of CBMs applies. This category represents models as Second-hand Sales (including Second-hand Platforms) and Buy-back, as the simplest ways to reduce clothing consumption impact. Lifespan of clothes is extended thereby offsetting new production, as "the most sustainable garment of today is already in our wardrobes" (Mistra Future Fashion, 2019, p. 16). Through Reverse Logistics, companies can recover items from direct disposal and continue to derive value from them (Amed et al., 2021). Second-hand and Refurbish and Resell are attractive, widely adopted models, that are expanding their customer segment (EMF, 2017). Though these models can be pursued by independent companies, original brands have advantages, as they are already positioned to capture parts of this market. Selling second-hand alongside new garments would allow them to keep better control of their resale market and even introduce Remanufactured and Transformed Products to the offering, with minimum investment risk. (EMF, 2017) Brands with garment collection schemes, can also take advantage of capturing raw materials to transform it into new products. (Global Fashion Agenda, 2019).

Much remains to be done in the end-of-use phase. As it is highly dependent from what was done before, many of the existent solutions to manage a garment's end-of-life might not even be feasible due to its material composition. Hence why, LCA and Extended Producer Responsibility need to be in place: "companies are obliged to either set up a recycling and waste management system for the clothes they put on the market, or pay a contribution to an organisation that will financially support third parties to manage clothing waste" (EMF, 2017, p. 88). This means, as said afore, that even in the consumer hands, clothes responsibility is on the producer company or companies (Gwilt & Rissanen, 2011). Along with this measure, other directives as an industry-wide end-of-use garment and textile collection to enter the most appropriate and sustainable waste hierarchy end-of-life, cascading option can be applied (Eder-Hansen et al., 2017; EMF, 2017; Mistra Future Fashion, 2019). If products are not composed by material mixes from different origins and use mono-materials, end-of-life processes should be eased. Therefore, if biodegradable fibres (as cotton, cellulose-based fibres, or wool) are used as mono-materials, the garment can integrate the Biological Cycle models of resource management (Organic Feedstock, Biomass Conversion, Anaerobic Digestion, Composting, Fertilizer Production, Bio-based Materials). If these fibres are mixed with non-biodegradable, manufactured fibres, the resulting yarn is no longer biodegradable and needs to be directed to other models of Waste Management as Recycling (chemical and mechanic) (EMF, 2017). This separation can only be successful if the traceability of materials is achieved (EMF, 2017). As the sorting of the fibres is a complex (almost impossible) process, it difficult the application of the most appropriate models for each material type, hence why the Industry turns to Recycling as a preferred method. However, less than 1% of textiles produced for clothing is recycled

into new clothes, with 87% being landfilled or incinerated. Additionally, within recycling processes, most of the material input comes from other industries' products, as PET bottles. Maybe this can explain why most products are Downcycled, that is, cascaded to lower-value applications (EMF, 2017; Global Fashion Agenda, 2019). At this stage is essential the investment on the creation of technology that allows large-scale automated sorting of textiles, would analyse each item, detect fibre types and other components and determine the next steps for further processing (Lehmann et al., 2018; Mistra Future Fashion, 2019). Ideally, all these strategies would be combined, so the advantages of one covers for the deficiencies of the other, as a circular FTI will require a collective effort (Global Fashion Agenda, 2019).

3. METHODOLOGY

3.1 Research Context and Data Collection

The field work aimed to confront the literature review findings with the reality of Portuguese FTI companies, following the EU plans to implement the CE (European Commission, 2014). The overall purpose was to discern the extent to which the identified Sustainability strategies and CBMs are being applied, and how the transformation to a CE materializes, particularly in the FTI context. As the CE is still mainly theoretical, with only a few practical applications documented, the type of research was diversified into a theoretical-practical investigation, showing the framework has been gaining attention in both the academic and business world.

The research involved two distinct primary data collection processes: a general questionnaire (*Appendix E*) and an illustrative case study, so to validate and complement the literature review findings. The questionnaire and posterior data collection and aggregation were carried out using Google Forms, and intend to present a general outline of the Portuguese FTI. This was used as a purely descriptive tool, in self-report mode, to assess if so, and which, CBMs and Circular Product Design Strategies are being applied by Portuguese FTI companies, matching the Literature Review (*Appendix C, Table 3; Appendix D, Table 4*). The different methods used aimed to clarify different information, so to assess what has been and is being done for the transition process from a Linear to a CE to happen. A pilot study, as a specific pre-test of the questionnaire was carried, so to solicit feedback and assess the survey design, length and whether the questions were clear and if the information given was relevant and sufficient for the participants to answer objectively (Van Teijlingen & Hundley, 2002). Two companies participated on the pre-test before broadening the survey to the target population. Since the CE requires a system-level change to be attained, the first selection criteria of the sample, included the companies to be from different stages of the FTI value and supply chain, in order to have a broader representation of the transformation processes held. Also to be a Portuguese company, operating in the national market. Companies did not ought to have sustainable and circular economic practices implemented, but the ones that did, were preferred, so information on the transition was provided. Without seeing the selected firms

as strict representants of the Industry, the aim was to collect data on the strategies and models implemented to make the transition. In total, from the 71 firms contacted, 32 companies fulfilled the questionnaire, hence comprising the sample of this part of the study. Accomplished this, particular cases, inside of that general ecosystem could be accurately framed and explored over particular interviews.

Regarding the case study, the process started with an exemplary company chosen for its good practices: TINTEX. The case was written having as supporting documents the company's Sustainability reports from 2019 and 2020 (based on the GRI standard). And also materials present on TINTEX's website, official reports from the Portuguese industrial context, grey literature and press references (which include articles on magazines, newspapers, and fashion platforms, as Jornal T, Knitting Industry, Expresso, Green Purpose) and lastly an interview to the company's Head of Product. From here were drawn TINTEX's main partners and suppliers to continue the interviews in a snowball sampling effect. This method was selected as an attempt to build a full circular model and to understand if the sustainable and circular strategies and models applied by the first company influence or not the others that compose the same value and supply chain. In total eleven companies directly linked to TINTEX as partners (Vintage for a Cause), suppliers (Tearfil and Triwool, through Folte Group), customers (Recit); indirect value chain links (Andrade e Amaro, SKFK, White Stamp, Cru Loja, Katty Xiomara, Rodome & Trevira) and even competitors (Tinamar) arose and were interviewed. The snowball scheme and a more complete visual of the links among the companies is available on *Appendix F, Figures F.1 and F.2*.

This phase held the record of semi-structured interviews to all the companies. Before starting the interviews, all participants agreed either verbally or in writing upon the reading of the informed consent present in the *Appendix G*. The interview scripts can be consulted in *Appendices H, I and J* consist in theory-based open- and close-ended questions, to allow freedom in the exploration of each topic and the rise of new unexplored ideas, but also to offer consistency across the interviews. The interview scripts differ depending on whether the main company, first- or second-level companies are being interviewed. Due to the quantity and complexity of some concepts included in the questions, the script was handed on, when asked, prior to the interview, to the selected companies responsible, along with the arrangement for the place and time of the meetings. The interview with TINTEX was held at the company's facilities, whereas the other interviews were made through written form, online platforms or phone. More information details on the interviews can be found on *Appendix K, Table 5*. The final version of the present work was sent to the interviewed companies, so that they were aware of the direct reference to their names and could oppose to this use before final submission. No company pointed this as a concern.

3.2 Research Design and Data Analysis

Through the collection of secondary data to elaborate the literature review, a conceptual framework was developed to guide the research and analysis of the CE application into the FTI context. This was then

confronted and triangulated with secondary and primary data collected through the contact with Portuguese companies of the sector. For this, were used qualitative and quantitative methods, being the first a complementary approach to the second, aimed at the construction of a case study (Kohlbacher, 2006). The ability to build a questionnaire, the access to specific documents and to conduct interviews allowed for information validation, but also to point data deficiencies and possible ways to mitigate them by collecting information directly from firms operating on the FTI. The general questionnaire data findings were directly extracted in an objective and systematic description of the results. Being a quantitative method, the questionnaire did not account for, for example, distinctive individual cases, but, it provided the general context in which a case study could be framed. (Kohlbacher, 2006)

To aggregate the different sources of data and understand how particular circumstances can influence the processes and changes being created, the chosen research strategy was to build one main case study, with a company already applying circular strategies and CBMs, and to see how it affects or not its value chain stakeholders. As put by Hartley, case study research can provide the contextualization of the theoretical issues being studied (2004). Whereas surveys can be static and limited, case studies are a flexible strategy, normally preferred with "how" or "why" questions, useful to explore and understand new or emerging organisational and managerial processes, taking the company's context into account (Hartley, 2004; Kohlbacher, 2006). Case studies can include varied methods and sources of evidence, normally used in combination, to "deliberately triangulate data and theory (and thereby improve validity)" (Hartley, 2004, p. 324). With the choice of a case study with multiple interveners, contrasts, similarities and patterns across contexts, processes and organisations are made visible, which helps to focus on analytical generalization. The goal is not to make assumptions based on frequency, represent a sample or population, but to generalize based on theoretical propositions. (Hartley, 2004; Kohlbacher, 2006) For the main case study to be built, and its connection with the other companies, both documentary data from the main company and interviews were, first, transcribed and then imported to the qualitative data analysis software MAXQDA, to accelerate and ensure more accuracy to the coding process (*Annex L*). The data analysis process followed is showed in the Research Design diagram (Figure 3.2.1.).

As said, the analysis approach to the collected data, to build the case study, uses concurrently (rather than sequentially), direct quantitative approach, qualitative deductive and inductive approaches. The deductive approach process started with a list of coded categories created in advance. These consisted on formerly studied concepts and models that arose in the literature review, providing a focus on identifying vital information directly linked to the research question, objectives and interview questions (Azungah, 2018). Concerning the inductive approach, it was used so that new concepts, and thus, codes, could emerge, without being constrained by a pre-defined list (Bengtsson, 2016). This was done through the assignment of codes to each paragraph, line and/or segments of text related to the literature review and relevant to the research question (Azungah, 2018; Thomas, 2006). In both deductive and inductive approaches, the data analysis followed content and discourse analysis methods, to describe how

organisations see and implement circular strategies into their BMs. All interviews were conducted in Portuguese, except from one, being the native language of the researcher and the interviewees, and later, the codes and results were translated to English.

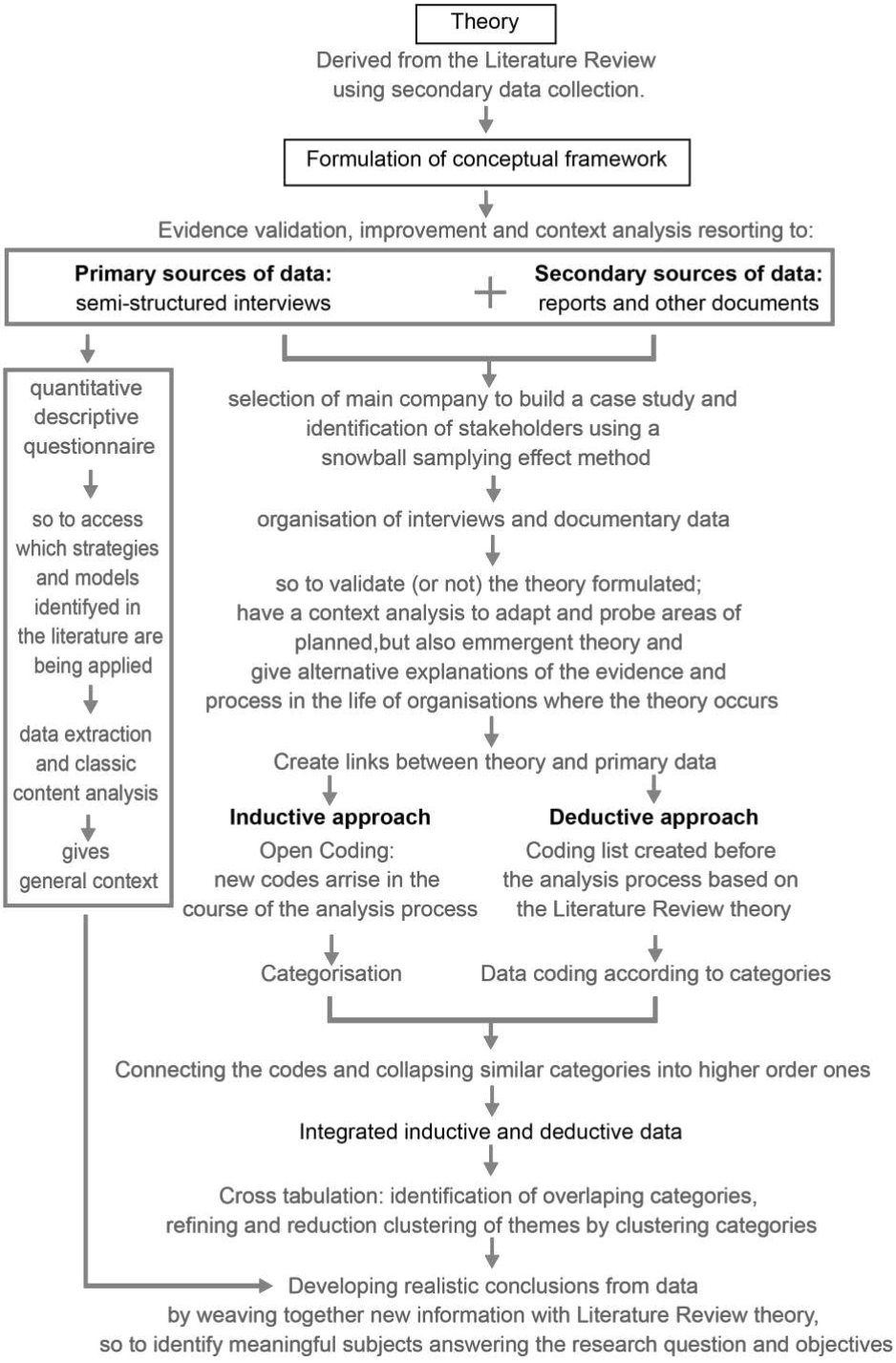

Figure 3.2.1 - *Research Design Diagram based on the Literature*

(Adapted from: Azungah, 2018; Bengtsson, 2016; Hartley, 2004; Kohlbacher, 2006; Thomas, 2006)

The codes from each approach were joined under the same list; rerepeated or redundant codes were merged into bigger categories, producing an integrated inductive and deductive set of data. The last steps entailed the identification of overlapping categories and its reduction into five key themes or topics, from which a narrative was developed based on the links among them, resulting in an in-case and cross-case analysis. Lastly, after the findings analysis, a connection with the initial theory was made and the final conclusions written in Chapter 5.

4. FINDINGS AND DISCUSSION

This chapter is organized into three sections: first the general questionnaire findings with a depiction of the Portuguese FTI; secondly TINTEX Textiles particular case study and lastly, the company's value chain is considered, to see how the practices of the firm influence or not its stakeholders.

4.1 The Portuguese Fashion and Textile Industry Context

4.1.1 Characterisation of the sample

With the FTI having one of the most complex value chains, it arises as one of the most significant sectors of the Portuguese economic and business fabric. The 32 companies that fulfilled the questionnaire allowed to identify the main characteristics of the Portuguese FTI context. The observed results (*Appendix M, Figure M.1*) meet the data from IAPMEI (Agência para a Competitividade e Inovação), where, from the 7.683 companies operating in the Industry, 6.195 are small or medium sized (2022), concentrated in the North Region of the country (*Appendix M, Figure M.2*) and distributed by different sectors of activity, with 50% of the companies investing in Design and Product Development (*Appendix M, Figure M.3*). According to IAPMEI, in 2019, the FTI represented 9% of total Portuguese exportations, accounting for more than five thousand million euros; 18,3% of Manufacturing Industry Employment and 7.683 thousand million euros, corresponding to 7,9% of the Manufacturing Industry turnover (IAPMEI, 2022). To note that these data accounts for the industrial categories of textile manufacture and clothing industry, excluding synthetic fibres. According to the report, the strategy to achieve these results should allow companies to innovate and develop new technologies while strengthening circularity and creating new markets. (IAPMEI, 2022) The present study findings help to understand if this path is being taken and what specific strategies and CBMs explored in the Literature Review are being applied, for the transition of the Industry from Linear to a Circular one to happen. Except from the questions where direct information on the company's size and region was requested, it was possible to choose more than one option, as companies can apply multiple strategies and/or models, meaning the answers number can vary and sometimes exceeded the number of companies in the sample.

4.1.2 Circular Product Design Strategies and Circular Business Models

The findings regarding the application of Circular Product Design Strategies and Circular Business Models are presented on *Appendix M, Figures M.4 to M.17* and described next.

The strategy companies most invest is Design for Long-Life products (*Appendix M, Figure M. 4*). The classic long-life strategy of making durable products is expected to then lead to a different consumer behaviour. The consumer becomes more motivated to take care and keep the products for longer, thus promoting other models as product-life extension (Colucci & Vecchi, 2021). The application of Circular Design Strategies also shows a more responsible view on the end-of-life of products and can lead to a more active evaluation of the products LCA while still in the design and development phase. Concerning Design Strategies for Technical and Biological Cycles (*Appendix M, Figures M.6 and M.7*), the overall values are identical for both cycles, with the exception for the application of the Circular bio-based re-captured materials strategy (56,3% of responses) versus the equivalent category for Technical Cycles: Re-manufacture (via recaptured materials), with 28,1% of responses. If the products are made without mixed materials, they can re-integrate the system through each one of the cycles.

The second part of the questionnaire denoted the application of CBMs and sub-models. The list given on the questionnaire started with models based on offering services which require fewer resources and as we move further down the list, the level of ownership increases, as does the need for resources. Lastly, are displayed models that use waste of the former to create value and reintegrate it back into the system until it is eliminated, as there are no more cascading options available for the reintegration to be done. When analysing the graphs, one of the most obvious results is that digital, less resource intensive models and services that offer access and performance over product ownership are still sporadic and are not established in the Portuguese FTI, representing an opportunity to explore (*Appendix M, Figures M.8 and M.9*). While they require more resources than the antecedent, Produce on Demand Models are well established with only 18,8% of companies declaring not to apply any of the sub-models, and with 3D Printing technologies already being used by 6,3% of companies (*Appendix M, Figure M.10*). Even though companies disclose to Design for Buy-back and Re-use; Design to Refurbish and Resell (either for long-life products and product-life extension) and Design for Re-manufacture (via recaptured components) (*Appendix M, Figure M.4 and M.5*), half of the companies do not to apply any of the Take-Back Management & Next-Life Sales sub-models that would be linked, with only one company applying the Buy-Back, Refurbish and Resell sub-model (*Appendix M, Figure M.11*). In general, companies are applying Circular Product Design Strategies more than CBMs (*Appendix M, Figure M.8 to I.17*). Still this is a good indicator since, as referred in the literature, Circular Design Strategies can lead to more Sustainable Business Models (Jørgensen & Pedersen, 2018). Even though companies design products for longevity (25 out of 32), they do not apply the corresponding model that extends the products' life after the purchase (only 11 disclosed to apply the sub-model Product-Life Extension and Value

Recovery; and only one company reported the sub-model High Levels of Warranties & implicit associated services of Maintenance and Repair - *Appendix M, Figures M12 and M.13*)

The majority of the companies in the sample already works collaboratively via Industrial Symbiosis and Eco-Industrial Parks sub-models (*Appendix M, Figure M.14*). Collaborative models and partnerships create more integrated approaches to BMs, foster transparency, enable knowledge sharing and joint innovation (Lieder & Rashid, 2016). The Circular Sourcing sub-model, also under the Pure Circles or Create Value from Waste Model (*Appendix M, Figure M.14*), selected by 14 companies, discloses good practices while promoting transparency and applying pressure over the stakeholders in contact with these companies. Recycling is still the preferred method, accounting for 24 companies disclosing the sub-model practice (*Appendix M, Figure M.15*). Though, the majority manifested the Upcycling sub-model as the most applied one (with 18 responses against only 6 companies selecting Downcycling). In line with the literature, after pursuing Recycling and Waste Management, the last phases are the ones where more work remains to be done. The end-of-use phase was where the majority of companies declared not applying any of the sub-models. *Appendix M, Figures M.16 and M.17***,** show the Dealing with Residuals Models and The System Scraping Model having 21 and 24 responses, respectively, declaring not to apply any of the sub-models.

4.2 Case Study: TINTEX Textiles

TINTEX Textiles is a dyeing and finishing circular knitwear company, operating in the FTI, producing for the fashion, athleisure, intimate and home textile segments (TINTEX Textiles, 2020). TINTEX was chosen as the main case study, as it operates within the Portuguese FTI, has a known concern for Sustainability issues, being one of the pioneers in the transformation process by applying Circular Product Design Strategies and CBMs or sub-models. TINTEX's commitment can be seen in the company's organisational structure, with exclusive departments for Sustainability, Innovation (with 19% of the employees dedicated to innovation) and Process Management and Development and in its BM (TINTEX Textiles, 2019). Sustainability and innovation are embedded (and recognised) on the company's *modus operandi* since day one. As it can be read in the company's website "Sustainability, innovation and style are the true ingredients of smart collections" (TINTEX Textiles, 2022a). TINTEX was founded in 1998 and after only two years of operation, the company was already making successful technical advances by developing the first superficial finishing technique for TENCEL™ Lyocell (TINTEX Textiles, 2020) with the Austrian partner company Lenzing (Green Purpose, 2021). As noted:

> Lyocell, despite being a man-made fibre at the end of its useful life is biodegradable and before that, its production process is in closed cycle; that is, you have the fibre, and everything like solvents or by-products of its processing are reinserted in the production process of new fibre. (2022)

This enabled new collaborations and led the new founded company from Portugal, to improve techniques and continue to invest in innovation and collaborations. In 2004, the company set Sustainability as the core of the business and started measuring the impacts of its operation (TINTEX Textiles, 2020). This change in priorities made TINTEX, on the next year, to evolve from the traditional service provider to the development of its own fabric collections (TINTEX Textiles, 2019, 2020). Another change reported is related to the communication of the company's products added value:

> When TINTEX started, we worked directly with clothing manufacturers, which limited this attempt to communicate the added value of our products. However, nowadays, this is not the case as we often talk directly to brands. (…) Now what happens is that we talk to the brands and the brands come to the manufacturer and say that they want one of our products. (Interview Tintex, 2022)

With currently more than 5,000 active references in its portfolio (TINTEX Textiles, 2022a), this BM change also had an impact on how the company develops the references. The final product is developed considering the specificities the client wants, which led to not send a large portfolio to the confections, reduced the amount of fabric samples and as the majority of it was not used, optimized the development time for new references, that is more focused and with higher quality (*Interview Tintex*, 2022). TINTEX work is focused on developing and deliver natural alternative fabrics and on enhancing their recyclability, as a way to help the Industry to overcome its environmental consequences (TINTEX Textiles, 2022b). This is supported by the several projects the company has been developing throughout the years with results recognized with several nominations, awards and recognition not only by national but also international institutions, as the Munich fair, ISPO (Internationale Fachmesse für Sportartikel und Sportmode) that has been nominating and awarding TINTEX since 2018 in a broad range of categories. (TINTEX Textiles, 2019, 2022a) The collections are established over five core values: innovation, sustainability, trust, quality and ambition; guided by the combination of design, innovation, R&D investment, sustainability principles and a collaborative attitude (TINTEX Textiles, 2019, 2020). To achieve these targets TINTEX declares to have invested over €26 million to drive material innovation, which covers: high-tech machinery, responsible practices, dyeing and finishing technologies, R&D, ongoing employee enrichment to support research and experimentation to foster future break-throughs (TINTEX Textiles, 2022c). For TINTEX there is no Sustainability without the third pillar "I'm going to start backwards: talking about profits that the company has, otherwise we wouldn't survive" (*Interview Tintex*, 2022). On how the transformation from linear to circular occurs in practice and the effects on TINTEX operations (including investment, costs, profits), processes, supply

chain and innovation systems within the FTI, it was stated the company's main strategy and competitive advantage is to invest the profits into innovation, to anticipate and match the market's future demands.

> TINTEX's policy is always to reinvest. (…) We work with a lot of new technology, but this is only possible because the extra profit we make at the end of the year is always reinvested so that we can continue to respond in this way, continue to be innovative, a company that is recognised for the products it makes has a lot to do with this. (Interview Tintex, 2022)

Some of TINTEX's most recent R&D projects are based on a collaborative mindset between different organisations, as companies, technological and research centres and universities, enabling the development of innovative materials, using cutting-edge technology while reinforcing circularity (Euratex, n.d.). It is not only TINTEX looking for partnerships, on the other side it also happens: "we have never had or created limitations for partnerships, either of the processes before TINTEX or later on, we have always had the openness" (*Interview Tintex*, 2022). It is underlined that being transparent makes others trust the company not only to do business, but to collaborate and develop new solutions:

> We always have our doors open for any of our clients who want to come and visit us and want to see how our processes are done, the audits that take place from specific brands to see if the product they are buying from us complies with their requirements and specifications. (Interview Tintex, 2022)

The company has a privileged spot in the middle of the supply chain, enabling the exploration and investment on the knowledge that exists both downstream and upstream. TINTEX says the acceptance of partnerships is related to the need of finding new solutions and to create new processes, new products: "How can we become better even considering a new thread, a new chemical, a new finish; how will we have the ability to deal with something we have never done before?" (*Interview Tintex*, 2022). From these collaborations resulted some of the company's most recent projects, as STVgoDigital, that, with more than eight partners involved, is working on the digitization of the FTI value chain enabling traceability via the access to the product profile including all its sustainability dimensions; interoperability of supply chains for an integrated view and collaborative services (TINTEX Textiles, 2020). Though, not all partnerships TINTEX has are focused on R&D, others tackle further supply chain aspects, that even with the best planning and innovation are difficult to avoid: waste, through "reusing materials that would not be used for anything else*"* (*Interview Tintex*, 2022). Throughout the interview examples were given touching different stages of the value chain and different pillars of Sustainability:

> We also have another project related to the final product, if it has a defect, for example, in which through a mechanical process we transform it into fibre to make yarn. In other words, there is no waste right from the start and before the product goes to the consumer, we can take this "waste" and reintroduce it back into the process, before it goes to a landfill. (Interview Tintex, 2022)

The goal is to automate, find new solutions and continuous improve the company's use of resources, energy and water consumption, the replacement of some synthetical components for biomaterials with less impact, material value and recovery with the use of residuals resulting from the production processes (TINTEX Textiles, 2019). Just as put by the Head of Product on an online article the main goal of the company is "to be able to design and (re)design all of its products, in an effective way, so that they are coherent with circular design strategies, mainly durability – so that the products last as long as possible aiming to achieve consumers' trust" (Santos & TINTEX Textiles, 2019).

> This has to do precisely with what TINTEX is. We have always been an innovative company, always trying to be at the forefront (both technologically and in terms of products), always aiming to do things better and at first, in order to avoid waste. This encourages us every day, even between the teams in each of the company's sectors there is a lot of know-how sharing. (Interview Tintex, 2022)

The innovation philosophy combined with the collaborative mindset, has led TINTEX to incorporate waste and by-products from other industries into its coating products (TINTEX Textiles, 2020). This resulted into two projects: with Quinta do Soalheiro, where TINTEX reused part of the grape wort, and with Nespresso's coffee grounds (*Interview Tintex*, 2022). Through the years these projects, collaborations and product development, resulted in eight registered brands at the European Community level (TINTEX Textiles, 2019). Despite all the efforts and improvements with the reduction of residuals; waste prevention, recycling, reuse and recovery through intra- and inter-industry collaborations, TINTEX percentage of waste sent to landfill has been increasing, since 2018. Although it is not TINTEX's direct responsibility, and 98% of the discarded waste refers to non-hazardous waste, the company reports to be seeking alternatives for the use of its sludge. (TINTEX Textiles, 2020) The company is not in a hydric-stressed region, although, given the global context, TINTEX started the aWaRe project, a process modification that provides the dyeing is done with recycled water, coming from the reintroduction of the waste water into the production process enabling a 50% reduction in water consumption (TINTEX Textiles, 2019, 2020). After the interview, it was clarified that at this point the water used is treated, but still doesn't re-enter the factory system, but the project aims to put this in practice so to use the water in a close circuit. Other strategies that already allowed for the water

withdrawal reduction are the investment on less water intensive equipment (with upgraded JETS in the dyeing process and a reamer with a new spray process instead of the conventional dyeing bath) (TINTEX Textiles, 2019, 2020). In addition, TINTEX is also committed to improve the quality of the discharged water, hence the adoption of the quality standards and certifications. These help TINTEX evaluate and provide comparable data to assess its water-related impacts and chemical use, as in the case of Bluesign certification. (TINTEX Textiles, 2019, 2020). Apart from the mentioned, TINTEX has more certifications, related to other stages of its activity, that allow for better traceability of the raw materials the company uses, in terms of environmental impacts (water pesticide, chemicals usage), but considering social practices as well (TINTEX Textiles, 2019, 2020).

Along with the water consumption, energy is still the other ultimate environmental impact derived from the company's activity. Concerning energy sources and consumption, TINTEX has made some changes since the first operation days, when in in 2015, the company started transitioning to renewable energy with the installation of solar panels, which in 2020 accounted for 25% of energy use (TINTEX Textiles, 2020). According to the reports, the company has been able to "reduce the total energy consumption as a consequence of the strategy to produce less with higher added value, which not only produces less impacts on the environment", but allows for efficacy on the production and therefore contributes positively to TINTEX's economic performance (TINTEX Textiles, 2019, p. 41). Regarding other energy consumption sources outside the facilities and main company activities, TINTEX has a current fleet of 17 cars and 2 trucks that make the delivery of the fabrics processed in the factory. These started to be replaced to hybrid alternatives. (TINTEX Textiles, 2019) The fact that Portugal has a strong textile cluster, mainly located in the North of the country, where several solutions for the value chain are available, reduces the geographical reach in which companies need to operate to have a finished product, therefore, reducing their environmental impact. In this line TINTEX discloses to allocate 100% of the purchasing budget to source mesh from local suppliers (local considered to be the national territory) (TINTEX Textiles, 2020, p. 63). The company's direct and indirect GHG emissions throughout the years has been decreasing (the difference of total emissions from 2018 and 2020 account for a 16,5% decrease) (TINTEX Textiles, 2020). The measuring and reporting is made according to the GHG Protocol standard and also using the "PME Sustentável" (Sustainable Small Medium Enterprise) tool that adapts the GHG Protocol to the Portuguese reality (TINTEX Textiles, 2020).

For TINTEX, the social pillar of sustainability is attained through an integrated approach that goes beyond the health and safety of the 133 employees, compliance with the regulations in force and training and capabilities development for its workers (TINTEX Textiles, 2020). The company's social responsibility includes its stakeholders as well, promoting transparency, engagement, and long-lasting relationships based on shared principles and values. TINTEX reports to continuously interact with its suppliers and assess them for their social and environmental impacts, if any of the suppliers do not comply with the requirements stipulated by TINTEX the relationship may be terminated (TINTEX Textiles, 2020). One of the strategies the company found to ensure more transparency was to bring in a

single unit all the knitwear production. The company named HATA exists since 2016 and is part of the TINTEX group (HATA, n.d.). HATA, being part of the group is an important partner that allows, for example, for technology to be tested (as AI systems that detect raw material defects and predict production performance) and assures the circular knits the company produces have the same standards TINTEX requires when entering its stage to be finished (TINTEX Textiles, 2020).

TINTEX is committed to the UN's SDGs, by integrating them into the company's strategy. In 2018, TINTEX and other fashion stakeholders worked together during 2018 to create the Fashion Industry Charter for Climate Action incorporated in the UN Climate Change Program. The commitment to the Goals and the Charter was reinforced by a 2019 Letter of Commitment to the UN's General Secretary, António Guterres, signed by the company's CEO, Mário Jorge Silva (Silva & TINTEX Textiles, 2019). Still within the scope of the UN, in 2019, TINTEX announced to be a participant of the United Nations Global Compact initiative, a voluntary leadership platform for the development, implementation and disclosure of responsible business practices (Knitting Industry, 2019).

As innovation fosters and Sustainability pioneers at a time where it was not the norm, and investing during some of the hardest years of the international financial history, TINTEX work proved to be a step forward and an example of transitioning to an Industry that can be more circular (Euratex, n.d.).

> Innovation ends up being one of the very important points of the company. We end up having many projects, whether they are internal or even applications with other partner entities, in which it allows this know-how, especially when you work with people from the same area, or externally, with Universities, with CITEVE - a non-profit entity, but which has this knowledge. (…) This is because there will always be different points of view, there are no wrong answers, that is the truth, and many times in discussions and meetings we end up saying "how come this never crossed my mind?" and there is this kind of input that, being alone or in a closed position, you would not have. In other words, collaborations lead to innovation and problem solving. (Interview Tintex, 2022)

Engagement and collaboration with its stakeholders is an important feature on TINTEX's core strategy (TINTEX Textiles, 2019). This created the need to identify some of those companies who interact with the company and assess if TINTEX's practices influence or not its value chain. When asked to identity the main partner of the company, the following was stated:

> It would be a very long list, and I am really glad that there is this will and agility of the companies themselves, to have this facility and the will to look for us (…). In other words, it's not only us who

believe in our product, but we also have people downstream and upstream who do too. (Interview Tintex, 2022)

4.3 TINTEX Textiles Value Chain Influence

TINTEX served as a departing business already applying strategies and models, being recognised by its peers and organisations for the work with Sustainability and Circularity. From there the goal was to understand how it influences or not the companies around to also transition into a CE. Thus, the snowball effect method was chosen to select the companies to interview, so that a part of the value chain in which the first company operates could be reconstructed. The transition from a Linear to a CE in such big, global and complex industry as the FTI, is difficult to compile. Through the collected data, five topics emerged as key to take into account for the transition to happen: 1) Integrated Sustainability; 2) Circular Economy & CBMs; 3) Innovation and Investments; 4) Legislation, Regulations, Transparency and 5) Partnerships and Collaborations. Along the chapter these themes will be presented and complemented with some citations from the interviews, a broader list of the citations and related topics is transcribed on *Appendix N, Tables 6 to 11*. The themes arose after following the analysis approach described on the Methodology Chapter, and are thereafter explored according to the proposed Research Question and Objectives as well as the formerly presented literature. The literature showed the process from a Linear to a CE will be hard to attain, yet not impossible. The conducted interviews sustained this premise with the following summarising the overall opinions: "There is still a lot to do, and in this respect it can be a little difficult, because we know that the road is still so long, but we are also making small advances, small victories" (*Interview Triwool*, 2022). The interviewed companies know the process is not easy and the strategies undertaken are being applied individually and not structurally, that the Industry is competitive with international companies having the capacity to the same as the Portuguese ones (*Interview Tintex*, 2022). They also defend the Portuguese FTI cluster is prepared to partake the global transition, differentiating itself on the ability to adapt, the execution know-how and the development of novelties. The last decade's investment in the FTI has led Portugal to pass from a purely manufacturer to a label of quality, attested by several interviewees, as TINTEX: "We have many brands, many foreign companies that come to us for the quality of our products; and I'm talking about TINTEX, as surely there will be other Portuguese textile companies that have exactly the same type of demand." (2022).

4.3.1 Integrated Sustainability

Sustainability is recognised in all its dimensions, proving is no longer seen as a flat concept, only linked with its environmental facet. This is a fact reported, directly and indirectly, by all the companies in the study, and supports Geissdoerfer and colleagues, realising the concept has been established in the

agendas of organisations, being “more embedded into the rules that structure social interventions and shape behaviour” (2017). The three pillars of Sustainability are recognised throughout the interviews:

> Everything is thought out in detail, so that it can have the greatest impact on an economic and social level and the least impact on an environmental level. Since, at least, these three pillars must always be in the structure or at the base of everything that is done in the company, because if we miss one it no longer makes sense. (Interview Tintex, 2022)

On the interview with TINTEX, for example, it is even underlined the importance of the cultural (with the values aligned with the strategy, and said to be key for collaborations) and technological dimensions as key aggregators for the true achievement of Integrated Sustainability (Stahel, 2010). While all companies express the importance of Sustainability, some of them do not see it as strategic to their business and, therefore, it is not embedded in their BM. This was stated by service companies, without product development and innovation, thus focusing on matching client’s demands and not developing a product that necessarily has Sustainability as its main characteristic. Yet, it is important to point that these companies comply with the legislations and still have sustainable practices in place. The difference lies on the motivation, rather than being internal, it is driven by external factors as overall industry pressure, regulators, clients, competitors and consumers.

> We are a company, like TINTEX, which is subject to very strong scrutiny by the authorities in regard to environmental protection, we comply with these areas, as TINTEX certainly does. But, let's say, it is not our marketing strategy to emphasise this aspect of Sustainability, it is not our strategy. Our strategy is to provide a good service to our clients, when it is necessary to highlight Sustainability, we highlight it, when it is not, we do what we can and in accordance with what the client requests. (Interview Tinamar, 2022)

Additionally, this is also encouraged by the range of Certifications companies work with, and have to comply to in order to satisfy clients demands, and even the Covid-19 Pandemic is referred by some companies as an accelerator of the recognition and application of such practices. All the companies state that being part of an industry that recognises the importance of Sustainability, influences their own company to search for solutions, and some say it helps for the value added in their activity and products to be perceived. This is aligned with the literature showing that improving Sustainability can prove to be a competitive advantage, inaccessible to businesses not pursuing it (Jørgensen & Pedersen, 2018).

All interviewed companies working directly with TINTEX say its BM, sustainable and circular strategies influence their own. This goes beyond mere transformation or adoption of more sustainable practices, but also with collaboration between companies to create solutions and solve problems, encouraging mutual influence, as the next examples demonstrate:

> We have requests from our customers with challenges in the area of Sustainability and, then yes, the Triwool Group talks to those partners who are better prepared to deal with this type of requests. In this aspect, the challenge may come from TINTEX to us or from us to TINTEX, it ends up being a relationship, a partnership. (Interview Triwool, 2022)

The ones that have an indirect relation report to be influenced as well. Even competitors say that having a company recognised for its good practices, urges them to correspond and offer similar services.:

> I would say that although there is no direct contact, there is always an influence. The fact that TINTEX is directly linked to some of the brands we work with, promotes Sustainability and Circular Economy (…) then when the brand reaches the stage of offering its products and realizing what it is that customers want and realizing the importance of this issue for customers, it becomes much easier for us to also partner with brands because they already come sensitized from behind, namely from the relationship with TINTEX, for example. (Interview White-Stamp, 2022)

4.3.2 Circular Economy & CBMs

Having integrated Sustainability practices is the first transition step and reflects if the company is open to change its BM and include CBMs. Opposed to what happens with Sustainability in which the term is well defined and its three dimensions are understood, the same does not happen with the CE framework. One of the barriers reported for CE and CBMs to be applied is the lack of definition of what the CE really comprises, as rules to follow, so that practices from different companies can be compared:

> Let's say that TINTEX considers itself circular and has a competitor company that also considers itself circular, what does that mean? How do you know that? Ok, they have processes... I think it's great that this is already in place, if the processes are more efficient you have less waste, you are working with innovative yarns, in the part they are natural raw materials: spectacular; you don't make

> mixtures: incredible; you are already starting to respect some of the circular design strategies, but it is by motivation (it is self-motivated and in practice if no one wanted no one would do it). (Interview Tintex, 2022)

The majority of the companies referred Design for long-life Products as the most applied (supporting the questionnaire findings), based on the quality and durability of products, normally, in alliance with other strategies and with a focus on LCA planning, as decisions on the early stages of the value chain will affect all others (Gwilt & Rissanen, 2011; Jia et al., 2020). This is a positive outlook since, according to the literature, designing for durability increases the chances of clothes to have longer lives, be repaired, resold and therefore consume less resources (EMF, 2017). The CE is as much about the ideation of the product as it is about the other strategies and CBMs that follow (EMF, 2013a; Franco, 2019; Geisendorf & Pietrulla, 2018). If Sustainability is the first step to that realization, Circular Product Design Strategies would be the second (Jørgensen & Pedersen, 2018) along with LCA (Bakker et al., 2014). So, using design thinking to optimize product lifespan from a sustainable perspective is at the basis of a CE (Bakker et al., 2014). During the interviews, the LCA practices were reported under distinctive approaches, varying on the company and its core business. For example, it can either be by partner with suppliers that can assure the information on the materials they are buying: "accessing stock that is certified and we know the composition, our upcycling practice, which is our core business, gains more credibility and has more commercial viability, because knowing the composition of fabrics is quite important" (*Interview Vintage for a Cause*, 2022), or when designing the product:

> The garments are made by applying some eco-design concepts, avoiding the use of zippers and other metallic and plastic accessories that disturb the end-of-life of the pieces. We also frequently resort to our internal stock of raw materials to make small repairs to old pieces brought in by customers. (Interview Katty Xiomara, 2022)

The attention given to LCA also marks the two distinct perspectives regarding the materials origin and their end-of-use/life (Fletcher, 2008). On one hand, there is a preference for natural materials:

> When you have a knit or a garment made with a natural fibre, like cotton, for example, it can be reused. Of course we will always have to add some virgin material, but at the limit (…) that fibre, if it is not mixed, it is biodegradable; if you have cotton mixed with polyester, elastane and polyamide,

at first it is not possible to separate it, as if it is mixed it is very complicated and then, at the level of degradation, it will end up in the landfill for many years. (Interview Tintex, 2022)

On the other hand, there are companies that highlight the properties of non-natural materials, as they depend on fewer resources and ease of production, but also recognise the problems caused at their end-of-life and disposal (generally not properly done and controlled):

In terms of the production chain, there is nothing purer than plastic, contrary to what people think. It uses little water, few secondary products, cheap, easy to transform, but unfortunately, the last 5 minutes of its life will define whether plastic is good or bad. (Interview Rodome & Trevira, 2022)

As all the companies interviewed also answered the questionnaire (plus two more: ATB and Sasia Reciclagem that only had availability to answer the questionnaire), they were already included in the sample and succeeding analysis of which Circular Product Design Strategies and CBMs are applied (section 4.1.2). Therefore, that will not be accounted in detail. The most applied models by the interviewed companies are the Classic Long-Life Model, aligned with the correspondent design strategy, and the Recycling and Waste Model. Here the Upcycling sub-model is more popular than the Downcycling, which is also in line with the general questionnaire findings. In general, it is noted the companies already having CBMs in place are the ones that have Sustainability and Innovation (with product development) embedded into their BM and, therefore have control over what they will develop, or have strong partnerships and work with companies that have said features (De Angelis, 2016; Jørgensen & Pedersen, 2018). These partnerships are seen as key when companies want to close the loop, but do not have the capacity to do so in their facilities and tools, leading to the identification of new business opportunities (Kiron et al., 2013). To pursue a CE, several companies resort to partners that help them deal with value chain final stages "The raw materials that are 100% cotton or those composed of two fibres, cotton and polyester, are segregated, are separated and sent to the Valérius group project, Project 360" (*Interview Triwool*, 2022); "We collect discarded garments from our end-customers and send them to KOOPERA, a social enterprise for its selection. Then they sell part of it and whatever cannot be resold is selected for its recycling mainly with RECOVER" (*Interview SKFK*, 2022). These are examples on how CE as an integrated framework, promotes, and will only be possible through collaboration (Esposito et al., 2017; Kiron et al., 2013).

4.3.3 Innovation and Investments

Innovation is an enabler of CBMs and of a CE, key on the transition for an Industry that is not only more sustainable, but profitable and that continuously works in technological advances to solve the problems that will, inevitably surge (Bocken et al., 2014, 2015; Foss & Saebi, 2017; Jørgensen & Pedersen, 2018). With this in mind, the interviews last question had to do with scale when applying circularity, the future of the Industry and if there is enough and adequate technology to pursue that future. Concerning this, almost all interviewees believe the technology needed for a circular future already exists: "at the moment there are already machines for that, but, perhaps they are aimed at a market other than ours, the sustainable one, and also, a large scale, that's not so much the intention of the sustainable and circular market" (*Interview Cru Loja*, 2022);

> The existing technological means are already a great help, but technology is precisely the sector that has the least "right" to accommodate itself, technology must have a thirst for evolution, constantly questioning its ideas and solutions and it should be in the sector of Sustainability that it will have to work more persistently in the coming years. (Interview Katty Xiomara, 2022)

"Technology is there, but it needs regulation and it needs scale to be economically feasible" (*Interview SKFK*, 2022). Although the question focused on technology, the last testimony echoes the opinion shared by almost all interviewees, that the most important factor for the future of the FTI to be circular (and to be so at scale) is legislation.

Regarding innovation and technological advances in the years to come, some companies referred solutions for the existing textile excess, with the Recycling technology being the most mentioned, particularly on the Recycling technology and capacity status "We are at a scale of 100/200 kg, we have to reach the scale of thousands of tons. Only in Portugal we have 200 thousand tons to treat (of post-consumer materials), and this has a brutal scale" (*Interview Recit*, 2022). With companies referring the investment and development urge to solve one of the Industry's main problems. Other technological advances mentioned included 3D Printing, as a possible solution to reduce the excess fabric that is produced by the FTI, that through software could enable virtual rendering and product visualization (Amed et al., 2021; Vecchi, 2020). "3D can also have a very interesting impact on the issue, for example, of returns, I'm not sure, but I believe it's a very significant part of the items carbon footprint, more and more with the growth of online commerce" (*Interview White-Stamp*, 2022).

Technology as a tool for supporting transparency was also pointed as a necessary breakthrough to be made, with White Stamp pointing out the Blockchain as a possible solution for traceability and consumer access to reliable information, with TINTEX also referring that already had projects and

partnerships that promoted traceability, by adding a QR code to each article produced "where you could see the water consumption needed to produce that yarn, the geographical distance,..." (*Interview Tintex*, 2022). Smart labels enable product passports, promoting traceability and transparency (EMF, 2017).

The interviewed companies say Portugal has all to be competitive in the transition, still, is necessary to retain the talent, so the industry can compare to its international peers, "we have knowledge, machinery, excellent professionals and we cannot let go of everything we are good at. Which is what happens, export talent" (*Interview Tintex*, 2022). The talent retention is intimately connected to the investment ability and the work/salary conditions given in the country "we have so many people who know how to do things well, that if there was greater support, better working conditions, better salaries, there would certainly be many more people wanting to work in this area" (*Interview Cru Loja*, 2022). This, inevitably, affects the companies' capacity to innovate and develop original and relevant products, "whether we like it or not, technology, is not often developed in Portugal. We are good at executing, at the development level there are things we are exceptional at, but there is a lot of technology that is imported, that is the truth" (*Interview Tintex*, 2022). Several companies indicate the lack of investment associated with the costs to pursue innovation of more circular processes, materials and equipment to be a barrier, as it means having the economic capacity, to assume the risks and the likelihood these investments will translate in the need to raise prices. "That depends on us approaching a potential economic crisis, and facing a rise in unemployment, people end up buying the cheapest product that tends to be made of synthetic materials. This is a big obstacle for circularity" (*Interview Triwool*, 2022); "although we have brands that are increasingly focused on Sustainability, with the concern of offering a quality product, (…) this is still for a consumer with greater purchasing power" (*Interview Triwool*, 2022). The Portuguese FTI inherited the 2008 crisis survival, the Covid-19 Pandemic and the present inflationary prices rise, making investment and risk management hard to predict, "just imagining a company that has several decades working same way, having to adjust the way of operating, apart from taking time, carries risks, because we don't know exactly what the results of those changes will be and then obviously it also costs a lot of money. So it's not necessarily easy" (*Interview White-Stamp*, 2022).

4.3.4 Legislation, Regulation, Transparency

The majority of the companies see the Industry problems as systemic and so, the transition to a CE has to be made with a structural approach in mind (EMF, 2017). Measures that target education and legislation are defended to be the ones changing the Industry as a whole. As mentioned, when posed with a technology biased question, the simplest answer transversal to all companies was "is often more of a political will, than the actual technological levels" (*Interview Rodome & Trevira*, 2022);

> Now, for that to happen, there has to be a systemic approach, which is accompanied by legislation, by will, by training of the leaders who are at the head of the economic agents who can do something and that has to be, perhaps, rethought with regard to scale, because, if we only replace the process and only replace the materials, but continue to do it at the same pace, with the same principles that we have done until now, we are only changing the product, we are not changing the paradigm. (Interview Vintage for a Cause, 2022).

> Until we create a legislative strategy so that companies can have an idea of the path and what needs to be changed, it will be very difficult for us to move organically towards a more Circular Economy. Because I might be optimising my processes, making more durable products, in the same way that other companies are doing it, but are we making them in the same way? Is the impact you have from the processes exactly the same? You don't know. (Interview Tintex, 2022)

Legislation is also a means to measure and compare what companies are doing in a way that is the same for everyone. Despite reporting systems being more adopted, if organisations do not use the same methodology, the results cannot be directly inferred. The certifications have been occupying this role, but even these labels have strengths and weaknesses. As put by some companies, the standards one label defends are not coherent with the processes from other, with changing parameters that are contradictive "there needs to be regulation so that there are not four or five labels or certifications with each one having its own ideas on Sustainability" (*Interview Tinamar*, 2022). This makes the final consumer not to access reliable information on their purchases, with companies defending that, for information to be clear, processes need regulation. One essential step is the European Climate Pact, and in a broader sense the European Green Deal (European Commission, 2021). Several companies mentioned the Pact, and the role of the EU as crucial for a CE at scale: "And now the European Climate Pact, which I don't know what impact it will have on the activity; I think it will be big, because the textile industry is the second most polluting industry" (*Interview Triwool*, 2022). Legislation will also allow for the market to be more transparent and fairer to the ones that produce according to the regulations and, specifically with the announced Carbon Border Adjustment Mechanism, that will tax imports that are not in conformity with the European laws and ensure that European emission reductions contribute to a global emissions decline (European Commission, 2021, 2022).

In addition there is also the question of education and awareness of society in general, besides political will, which is interconnected, "raising awareness in society depends on political will, nothing else.", with the same interviewee adding further on "So, it's not a problem to build factories to recycle,

the problem is in the collection of plastic. And, that doesn't depend on the factories, it depends on the political power" (*Interview Rodome & Trevira*, 2022). Since closing the loop and the CE highly depend on consumer behaviour to take care of the clothes and to participate in collection schemes; brands together with governments, and other system institutions have the important task to support the shift of consumption patterns and educate consumers on the value of clothing (Global Fashion Agenda, 2019). Thus, is essential that consumers are seen as part of the system with whom collaborations are key for the CE framework to succeed: "Unfortunately no matter how many steps the textile industry tries to take to reduce the impact, in this case I'm going to talk about environmental impact, there is an issue that has to be worked on: legislation and consumer awareness" (*Interview Tintex*, 2022).

4.3.5 Partnerships and Collaborations

When talking about partnerships and collaborations, this is not limited to firms and organisations, as governments or academies, but consumers should be included as well. The "consumer is both at the end and starting point of a circular global economy of material reuse" (Lieder & Rashid, 2016, p. 41), the implementation of a CE means connecting the Industry's smallest player on a micro-level, with individual organisations and consumers, to the meso- and macro-level of cities, regions and nations (Ghisellini et al., 2015). Bocken and colleagues defend is fundamental to have a system-wide view, with innovative approaches to collaboration, while covering education and awareness is key (2014), "because the consumer still doesn't understand the impact of the things he buys" (*Interview Tintex*, 2022).

Consumers worry more and more with these topics, but, frequently they are ill informed, as a result of green washing and buzzwords, driven by an Industry that is still not transparent (not with suppliers and clients, let alone the final consumer). Most of the interviewees referred that along with legislation there is an urgency to raise awareness with reliable information. This has been discussed for years (Amed et al., 2018), but as assumed by the companies most "people don't know, they don't have the knowledge, they don't have to know" (*Interview Tinamar*, 2022). Aware of the reality, some companies undertake this as one of their social roles. For the majority of the companies that indicated equipping consumer with trustworthy information was crucial, they also pointed, as referred previously, that this responsibility has to come from organisational and more specifically from political action. There is still a big information gap, and to reach a CE, the urge for consumer/user education is clear, and technology can be used with that purpose: to boost authentication, transparency and sustainability, through smart labelling containing their "product passports", for example, companies are now able to share product information with both consumers and partners (Amed et al., 2022; Bocken et al., 2014).

> In other words, as soon as we have access to this information and it cannot be manipulated, I think it will probably cost us a lot more to buy from brands that do not have, perhaps, the due respect both

from an environmental and a social point of view, and obviously this will lead to a readjustment of practices. (Interview White-Stamp, 2022)

Just as mentioned with legislation, as the Industry problems are structural, education is proposed as a pillar for a sustained transition, as a means to influence society:

If we manage to introduce this in schools and education: the importance of circularity and how much more sense it makes compared to the alternative, to the linear economy, (…) that will then spill over into everything: into legislation, into business, into those who are creating new businesses, they will always think with that mindset, a more circular one. It's something that may take some time, but while super urgent, maybe if we look at things in the perspective of mankind history, 30 years, perhaps it's not that significant. (Interview White-Stamp, 2022)

Only through a systemic approach and shared responsibility among all stakeholders will the CE be achieved (Ghisellini et al., 2015). Partnerships are essential to raise awareness, promote innovation and bring new perspectives to firms' BMs and their value creation (Lieder & Rashid, 2016). It is also clear, in the interviews, companies influence each other to be more sustainable and apply better practices (certifying materials and processes, developing solutions for a common problem). This comes from the need, companies showed, for their partners' values and practices to be aligned with their own. "I can even say that the focus and the acceptance of these partnerships has a lot to do with this" (with finding new solutions and creating new processes, new products). (*Interview Tintex*, 2022) Some companies even have their BM based on a collaborative mindset. This is the case of Vintage for a Cause that uses deadstock from TINTEX activities for their products and also promotes partnerships with designers providing an experimentation chance in a controlled environment, as well as White Stamp, connected to Vintage for a Cause, that explains their partnership based BM:

Vintage for a Cause is part of an ecosystem of over 40 brands at the moment that have the Sell 1 Buy 1 programme on their website, (…) which allows clients of Vintage for a Cause or any partner of White Stamp that is part of this ecosystem, to offer their clients the possibility of exchanging used items for new ones. (Interview White-Stamp, 2022)

With these three companies, is given an example on building a CE while evolving different players, including the consumer, with the role of collecting and redirecting the product to re-enter the system.

Concerning partnerships with Schools, Universities and Research Centres, companies state that these organisations are much more open to collaborate with the Industry and that a greater concern with this topics is visible, "they are finally focusing on sustainable innovation, one can see this attempt at partnerships, even with small projects and with people that until now would not have crossed the minds of these Universities, who would sooner turn to multinational firms" (*Interview Cru Loja*, 2022).

5. CONCLUSIONS

5.1 Main Conclusions

The present study tried, first, to clarify that the CE framework results from the contribution and evolution of several concepts as: Sustainability, Sustainable Development, Industrial Ecology, Industrial Symbiosis, Biomimicry, C2C, Reverse Logistics and Closed Loop Supply Chains. Other concepts were left aside as they did not show enough relevance for the formation of the CE concept. Every concept adds something so the CE is seen as, first, an umbrella concept and then as a framework to be applied in practice. The process of fostering innovation and including it is essential for the CE to be applied and the transition to happen, as it serves as a vehicle to apply and incorporate Sustainability on the BMs of companies. As, in circular systems value is created in a different way than in linear systems, BMI arises as essential to disrupt traditional (mostly Linear) ways of thinking and to be open to the other elements contributing for a CE in practice. An example involves collaborations, essential in a highly fragmented industry as the FTI is, where no player will change the system (and maybe not even its own BM) alone. Due to recent events as the Covid-19 Pandemic and the climate crisis emergency, there is a changing consumer demand and behaviour for a more transparent FTI. Consumers are starting to not solely be driven by price, but by environmental and social factors when making fashion purchasing decisions. Hence, there is the need, and pressure, for companies to follow this mentality change, propose new ways of consuming fashion and also involve the consumers itself on constructing a better Industry.

The CE uniqueness, as a framework, derives from interconnected ideas that materialize under CBMs, based on different configurations of: a) the five CE principles and extended R's (Refuse, Rethink, Reduce, Reuse, Repurpose, Resell, Repair, Remanufacture, Recycle, Recover, Recommend, Regulate, Reverse and Regeneration of Nature as the ultimate positive goal of the CE; b) the three resource cycles (narrowing, slowing and closing resource loops); c) Circular Product Design Strategies; d) Sustainable Business Model Innovation or BMI for Sustainability and e) the TBL approach presence.

So, to the main Research Question of "*How can the transition process from a Linear System Model to a Circular Business Model unfold, in the context of the FTI?"*, the answer lies on the CBMs proposed as different solutions, that can be adapted to each stage of the FTI supply and value chain and, thus help solving the industry's Sustainability (social, economic, environmental) problems. Hence, the present study follows previous ones, and proposes a categorisation of CBMs and sub-models so new ways of

doing business can be followed. By linking the questionnaires and interviews findings with the compiled literature, is clear that legislation and political drive are vital for a universal and at scale transformation. Only with laws and regulations can other areas as education, investments and traceability be unlocked. The FTI will, inevitably, turn more transparent, with the ones that are not applying sustainable or circular strategies starting to see value on CE and CBMs to orient the transition "From Linear to Circular".

5.1 Academic Implications

The current study intended to develop previous research by meeting some of the identified gaps and focusing on a rather recent topic and apply it to a specific industry. A lot of research has been done regarding Sustainability, but CE is still recent in the literature, and so, recognisably, CBMs and BMI theory are even newer and less explored. Thus, applying these concepts to a specific sector and geography is also a breakthrough in the literature. Having such a strong FTI that has been transforming itself technically in the last years, makes Portugal a pioneer country, the ideal setting to explore the actual process of building a CE for the FTI. Lastly, the sector is opening more to collaborations with the academic world, and so, to promote studies aligned with the transformation the Industry has been going through, enables the establishment of bridges which can open up future research opportunities, either between universities with different areas of study or between universities and organisations. At the same time, with the sector concentrated in the Northern region of the country, it also nurtures interconnections with academic institutions further away from the majority of companies area of activity.

5.2 Managerial Implications

The research aimed at further explore the concepts of sustainability, circularity, innovation and their correlation through BM theory in a more integrated and practical way, so that it can be followed by companies (Bocken et al., 2019; Boons & Lüdeke-Freund, 2013; De Angelis, 2018; Jørgensen & Pedersen, 2018). By exploring the Circular Product Design Strategies, CBMs and sub-models in terms of concept definition and categorisation (De Angelis, 2016) the goal was to provide possibly the first contact of companies with these concepts. Also, by allocating these concepts to specific stages of the supply chain, as alternatives for the current FTI *modus operandi*, companies can evaluate their own activities and follow these propositions as a practical exemplary guide to transition to a more circular industry. This can utterly impact organisations to transform their BMs by fostering sustainable innovation and easily understand which activities and components of the product value chain can be managed differently, to involve partners inside or outside the Industry or to even communicate what they are doing differently. By presenting a specific case of a Portuguese company there is the opportunity that others see TINTEX as an example to follow. The interviews and questionnaires findings, show that, despite having a long way ahead, the Portuguese FTI companies are more open to

innovation, collaborations and a more sustainable future, even if most of them are not applying it holistically. This can be a vital point for companies that are hesitant on pursuing any of these plans and also help demystify that doing better does not imply to transform everything, but to start changing.

5.3 Limitations and Future Research

Every investigation has its limitations that can open up opportunities for future research to continue the work done, explore new perspectives or unconsidered elements. This dissertation's first limitation is the research topic being too broad. The existent literature is too recent and with many concepts and connections amongst them that need clarification. This, aligned with the content and size limitations of the present document structure makes it difficult to study all the topics in the same depth.

Concerning the data collection on the questionnaire and interviews, many of the contacted companies either ignored the invitation to take part of the study, after the most appropriate person to answer could not be reached or, despite the positive feedback to participate, the company did not have the time or did not send the answers. All these contributed for the sample, in both cases, to be small and not representative of the population. Regarding the questionnaire, despite the descriptions given along with the presentation of each CBM and sub-model, due to the space limit and time constraints from the companies when answering, the concepts non-familiarity can lead to the non-accuracy of the disclosed information. Moreover, the interviews' sampling method was the snowball effect, where the results are highly dependent on the given contacts quality, also when there is no response, the contacts cannot be replaced. Still regarding the interviews, as they were carried out directly between the two parties, it is known that respondents may answer according to their ideal intention and not their actual behaviours.

Despite all the limitations, this study provides a starting point for further research, since even though the CE was already explored in the FTI and Europe, to the best of our knowledge, there is scant research on CBMs. Future studies should measure the application of the models and sub-models, while extending the sample size. Also there is the need to differentiate between pre- and post-consumer models, as they have different logistics and stakeholders involved. CBMs were mainly studied under the business and organisations perspective, not considering the consumer, further research is advised to explore consumption models (Colucci & Vecchi, 2021), that can have their own category. The consumer-business interaction (Pedersen et al., 2019), the role of consumers and its openness to help to close the loop and contribute to a CE within the FTI would also be an interesting direction to take on. Lastly, and as the interviewees referred, regulations are key to realise a CE in the FTI, upcoming studies could examine which regulatory measures would have more impact on the construction of a CE future.

6. REFERENCES

Achterberg, E., Hinfelaar, J., & Bocken, N. (2016). Master Circular Business with the Value Hill. In *Circle Economy* (Issue September). White Paper.

Amed, I., Berg, A., Balchandani, A., Andersson, J., Hedrich, S., Young, R., Beltrami, M., Kim, D., & Rölkens, F. (2018). The State of Fashion 2019. In *Business of Fashion; McKinsey & Company*. https://www.mckinsey.com/~/media/McKinsey/Industries/Retail/Our Insights/The State of Fashion 2019 A year of awakening/The-State-of-Fashion-2019-final.ashx

Amed, I., Berg, A., Balchandani, A., Hedrich, S., Jensen, J. E., Straub, M., Rölkens, F., Young, R., Brown, P., Le Merle, L., Crump, H., & Dargan, A. (2022). *The State of Fashion 2022*. Business of Fashion; McKinsey & Company. https://cdn.businessoffashion.com/reports/The_State_of_Fashion_2022.pdf?int_campaign=sof22_02122021&int_content=cta_1&int_medium=article_embed_asset&int_source=onsite_marketing

Amed, I., Berg, A., Balchandani, A., Hedrich, S., Rölkens, F., Young, R., Jensen, J. E., & Peng, A. (2021). The State of Fashion 2021. In *McKinsey & Company*. Business of Fashion; McKinsey & Company. https://www.mckinsey.com/industries/retail/our-insights/state-of-fashion

Amit, R., & Zott, C. (2001). Value Creation in e-business. *Strategic Management Journal*, *22*(6–7), 493–520. https://doi.org/10.1002/smj.187

Anderberg, S. (1998). Industrial Metabolism and the Linkages between Economics, Ethics and the Environment. *Ecological Economics*, *24*, 311–320. https://doi.org/10.1016/S0921-8009(97)00151-1

Andersen, M. S. (2006). An Introductory Note on The Environmental Economics of The Circular Economy. *Sustainability Science and Springer 2006*, 1–8. https://doi.org/10.1007/s11625-006-0013-6

Ayres, R. U. (1994). *Information, Entropy and Progress: A New Evolutionary Paradigm*. American Institute of Physics.

Ayres, R. U., & Ayres, L. W. (2002). A Handbook of Industrial Ecology. In *Green Accounting*. Edward Elgar Publishing, Inc. https://doi.org/10.4324/9781315197715-6

Ayres, R. U., Norberg-Bohm, V., Prince, J., Stigliani, W. M., & Yanowitz, J. (1989). Industrial Metabolism, The Environment, and Application of Materials-Balance Principles for Selected Chemicals. In *IIASA, Laxenburg, Austria*.

Azungah, T. (2018). Qualitative Research: Deductive and Inductive Approaches to Data Analysis. *Qualitative Research Journal*, *18*(4), 383–400. https://doi.org/10.1108/QRJ-D-18-00035

Bakker, C., Wang, F., Huisman, J., & Den Hollander, M. (2014). Products that Go Round: Exploring Product Life Extension through Design. *Journal of Cleaner Production*, *69*, 10–16. https://doi.org/10.1016/j.jclepro.2014.01.028

Baldassarre, B., Schepers, M., Bocken, N., Cuppen, E., Korevaar, G., & Calabretta, G. (2019). Industrial Symbiosis: Towards a Design Process for Eco-Industrial Clusters by Integrating Circular Economy and Industrial Ecology Perspectives. *Journal of Cleaner Production*, *216*, 446–460. https://doi.org/10.1016/j.jclepro.2019.01.091

Barthes, R. (1998). The Language of Fashion. In *Journal VWA in no.25* (2004th ed.). Bloomsbury Publishing Plc.

Beall, A. (2020, July 13). *Why Are Clothes So Hard To Recycle?* BBC Future; BBC Future. https://www.bbc.com/future/article/20200710-why-clothes-are-so-hard-to-recycle

Bengtsson, M. (2016). How to Plan and Perform a Qualitative Study Using Content Analysis. *NursingPlus Open*, *2*(February), 8–14. https://doi.org/10.1016/j.npls.2016.01.001

Benson, S. (2021, November 1). *What Happens To The Clothes Our Charity Shops Can't Sell, and How Can We Make Sure Our Donations Don't End Up Piled High in Waste Dumps?* Glamour Magazine UK; Glamour Magazine UK. https://www.glamourmagazine.co.uk/article/charity-shop-donation-tips

Bhardwaj, V., & Fairhurst, A. (2010). Fast Fashion: Response to Changes in The Fashion Industry. *International Review of Retail, Distribution and Consumer Research*, *20*(1), 165–173. https://doi.org/10.1080/09593960903498300

Bigano, A., Śniegocki, A., & Zotti, J. (2016). Policies For a More Dematerialized EU Economy. Theoretical Underpinnings, Political Context and Expected Feasibility. *Sustainability (Switzerland)*, *8*(8: 717), 1–22. https://doi.org/10.3390/su8080717

Biomimicry Institute. (2015, September 8). *What is Biomimicry?* https://biomimicry.org/what-is-biomimicry/

Blomsma, F., & Brennan, G. (2017). The Emergence of Circular Economy: A New Framing Around Prolonging Resource Productivity. *Journal of Industrial Ecology*, *21*(3), 603–614. https://doi.org/10.1111/jiec.12603

Bocken, N., de Pauw, I., Bakker, C., & van der Grinten, B. (2016). Product Design and Business Model Strategies for a Circular Economy. *Journal of Industrial and Production Engineering*, *33*(5), 308–320. https://doi.org/10.1080/21681015.2016.1172124

Bocken, N., Rana, P., & Short, S. W. (2015). Value Mapping for Sustainable Business Thinking. *Journal of Industrial and Production Engineering*, *32*(1), 67–81. https://doi.org/10.1080/21681015.2014.1000399

Bocken, N., Ritala, P., Albareda, L., & Verburg, R. (2019). Innovation for Sustainability: Business Transformations Towards a Better World. In *Palgrave Studies in Sustainable Business In Association with Future Earth* (1st ed.). Palgrave Macmillan, Cham. https://doi.org/https://doi.org/10.1007/978-3-319-97385-2

Bocken, N., Short, S. W., Rana, P., & Evans, S. (2014). A Literature and Practice Review to Develop Sustainable Business Model Archetypes. *Journal of Cleaner Production*, *65*, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

BoF. (2021, September 24). *Li Edelkoort's 'Anti-Fashion' Manifesto*. Business Of Fashion Podcast; Business of Fashion. https://www.businessoffashion.com/podcasts/sustainability/li-edelkoorts-anti-fashion-manifesto

Bonciu, F. (2014). The European Economy: From a Linear to a Circular Economy. *Romanian Journal of European Affairs*, *14*(4), 78–91. https://www.researchgate.net/publication/289891523_The_European_Economy_From_a_Linear_to_a_Circular_Economy

Boons, F., & Lüdeke-Freund, F. (2013). Business Models for Sustainable Innovation: State-of-the-art and Steps towards a Research Agenda. *Journal of Cleaner Production*, *45*, 9–19. https://doi.org/10.1016/j.jclepro.2012.07.007

Boulding, K. E. (1966). The Economics of The Coming Spaceship Earth. *Environmental Quality in A Growing Economy: Essays from the Sixth RFF Forum*, 1–8. https://doi.org/10.4324/9781315064147

Bovon, G. (2020). *Fast Fashion: The Real Price Of Low-Cost Fashion*. https://www.rtp.pt/programa/tv/p41338

Braungart, M., McDonough, W., & Bollinger, A. (2006). Cradle-to-Cradle Design: Creating Healthy Emissions - A Strategy for Eco-effectiveProduct and System Design. *Journal of Cleaner Production*, *13–14*, 1–12. https://doi.org/10.1016/j.jclepro.2006.08.003

Brown, B. J., Hanson, M. E., Liverman, D. M., & Merideth, R. W. J. (1987). Global Sustainability: Toward Definition. *Environmental Management*, *11*(6), 713–719. https://doi.org/10.1007/BF01867238

Brundtland, G. H. (1987). Our Common Future ('The Brundtland Report'): World Commission on Environment and Development. In *United Nations General Assembly document A/42/427*. https://doi.org/10.9774/gleaf.978-1-907643-44-6_12

Carson, R. (1962). Silent Spring. In *Crest Book*. Fawcett Publications, Inc. https://doi.org/10.1016/0027-5107(77)90059-8

Cartner-Morley, J. (2021, September 20). *'Circular' Fashion: Greenwashing Myth, or Attainable Goal?* The Guardian; The Guardian. https://www.theguardian.com/fashion/2021/sep/20/circular-fashion-greenwashing-myth-or-attainable-goal

Chertow, M. R. (2000). Industrial Symbiosis: Literature and Taxonomy. *Annual Review of Energy and the Environment*, *25*, 313–337. https://doi.org/10.1146/annurev.energy.25.1.313

Clark, W. C., Crutzen, P. J., & Schellnhuber, H. J. (2005). Science for Global Sustainability: Toward a New Paradigm. In *Journal of Policy Analysis and Management* (No. 120; CID Working Paper). https://doi.org/10.1002/pam.4050030177

Cohen-Rosenthal, E. (2000). A Walk on the Human Side of Industrial Ecology. *American Behavioral Scientist*, *44*(October), 245–264.

Colucci, M., & Vecchi, A. (2021). Close The Loop: Evidence on The Implementation of The Circular Economy From The Italian Fashion Industry. *Business Strategy and the Environment*, *30*(2), 856–873. https://doi.org/10.1002/bse.2658

Common Objective. (2018). Mapping the Fashion Industry: Size of the Global Fashion Retail Market. In *Common Objective: CO DATA* (Issue The Retail Market). https://www.commonobjective.co/article/the-size-of-the-global-fashion-retail-market

Commoner, B. (1971). The Closing Circle: Nature, Man and Technology. In *Alfred A. Knopf, Inc.: Vol. 3.1*. Alfred A. Knopf, Inc.

Curran, M. A. (2013). Life Cycle Assessment: A Review of The Methodology and Its Application to Sustainability. *Current Opinion in Chemical Engineering*, *2*(3), 273–277. https://doi.org/10.1016/j.coche.2013.02.002

D'Amato, D., Droste, N., Allen, B., Kettunen, M., Lähtinen, K., Korhonen, J., Leskinen, P., Matthies, B. D., & Toppinen, A. (2017). Green, Circular, Bio Economy: A Comparative Analysis of Sustainability Avenues. *Journal of Cleaner Production*, *168*, 716–734. https://doi.org/10.1016/j.jclepro.2017.09.053

Damen, M. (2012). *A Resources Passport for a Circular Economy* [Utrecht University]. http://igitur-archive.library.uu.nl/student-theses/2012-1121-200521/UUindex.html

De Angelis, R. (2016). A Conceptualisation of Circular Business Models and Explanation of Their Adoption: Evidence From Four In-Depth Case Studies [University of Exeter]. In *University of Exeter, UK*. https://www.infodesign.org.br/infodesign/article/view/355%0Ahttp://www.abergo.org.br/revista/index.php/ae/article/view/731%0Ahttp://www.abergo.org.br/revista/index.php/ae/article/view/269%0Ahttp://www.abergo.org.br/revista/index.php/ae/article/view/106

De Angelis, R. (2018). *Business Models in the Circular Economy: Concepts, Examples and Theory* (1st ed.). Palgrave Pivot, Cham. https://doi.org/https://doi.org/10.1007/978-3-319-75127-6

De Pauw, I., Kandachar, P., Karana, E., Peck, D., & Wever, R. (2010). Nature Inspired Design: Strategies towards Sustainability. *In Knowledge Collaboration & Learning for Sustainable Innovation - ERSCP-EMSU Conference*, *October 25-29*, 1–21. http://repository.tudelft.nl/assets/uuid:98ce3f26-eff8-40f5-82dc-ed92fec7e8f9/352_Pauw.pdf

De Pauw, I., Karana, E., & Kandachar, P. (2013). Cradle to Cradle in Product Development: A Case Study of Closed-Loop Design. *Re-Engineering Manufacturing for Sustainability - Proceedings of the 20th CIRP International Conference on Life Cycle Engineering*, 1–6. https://doi.org/10.1007/978-981-4451-48-2_8

De Pauw, I., Karana, E., Kandachar, P., & Poppelaars, F. (2014). Comparing Biomimicry and Cradle to Cradle with Ecodesign: A Case Study of Student Design Projects. *Journal of Cleaner Production*, *78*, 174–183. https://doi.org/10.1016/j.jclepro.2014.04.077

Dekker, R., Fleischmann, M., Inderfurth, K., & Wassenhove, L. N. Van. (2004). *Reverse Logistics - Quantitative Models for Closed-Loop Supply Chains*. Springer-Verlag. https://doi.org/10.1007/978-3-540-24803-3

Demil, B., & Lecocq, X. (2010). Business Model Evolution: In Search of Dynamic Consistency. *Long Range Planning*, *43*(2–3), 227–246. https://doi.org/10.1016/j.lrp.2010.02.004

Despeisse, M., Baumers, M., Brown, P., Charnley, F., Ford, S. J., Garmulewicz, A., Knowles, S., Minshall, T. H. W., Mortara, L., Reed-Tsochas, F. P., & Rowley, J. (2017). Unlocking Value for a Circular Economy Through 3D Printing: A Research Agenda. *Technological Forecasting and Social Change*, *115*, 75–84. https://doi.org/10.1016/j.techfore.2016.09.021

Desrochers, P. (2000). Market Processes and the Closing of "Industrial Loops": A Historical Reappraisal. *Journal of Industrial Ecology*, *4*(1), 29–43. https://doi.org/10.1162/108819800569276

Direção-Geral das Atividades Económicas. (2018). Indústria Têxtil e Vestuário. In *Sinopse*. https://www.dgae.gov.pt/gestao-de-ficheiros-externos-dgae-ano-2019/sinopse-textil-vestuario-17-04-2019-pdf.aspx

Eder-Hansen, J., Chalmer, C., Tärneberg, S., Tochtermann, T., F. Seara, J., Boger, S., Theelen, G., Schwarz, S., Kristensen, L., & Jäger, K. (2017). Pulse of the Fashion Industry 2017. In *Global*

Fashion Agenda & The Boston Consulting Group. Global Fashion Agenda Boston Consulting Group. http://globalfashionagenda.com/wp-content/uploads/2017/05/Pulse-of-the-Fashion-Industry_2017.pdf
Ehrenfeld, J., & Gertler, N. (1997). Industrial Ecology in Practice: The Evolution of Interdependence at Kalundborg. *Journal of Industrial Ecology*, *1*(1), 67–79.
Ehrenfeld, J. R. (1994). Industrial Ecology : A Strategic Framework for Product Policy and Other Sustainable Practices. *Green Goods: The Second International Conference and Workshop on Product Oriented Policy*, *October 2011*, 1–40.
Elkington, J. (1998). Partnerships from Cannibals with Forks: The Triple Bottom Line of 21st - Century Business. *Environmental Quality Management*, *8*(1), 37–51. https://doi.org/10.1002
Elkington, J. (2017). *Enter the Triple Bottom Line* (pp. 1–16).
EMF. (2012). *Explaining the Circular Economy and How Society Can Re-think Progress | Animated Video Essay*. EMF for Youtube. https://www.youtube.com/watch?v=zCRKvDyyHmI
EMF. (2013a). Towards The Circular Economy: Economic and Business Rationale for an Accelerated Transition. In *The Ellen MacArthur Foundation* (Vol. 1). https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf
EMF. (2013b). Towards the Circular Economy: Opportunities for the Consumer Goods Sector. In *The Ellen MacArthur Foundation* (Vol. 2). https://doi.org/10.1162/108819806775545321
EMF. (2015). Growth Within: A Circular Economy Vision for a Competitive Europe. In *The Ellen MacArthur Foundation*.
EMF. (2017). A New Textiles Economy: Redesigning Fashion's Future. In *The Ellen MacArthur Foundation*. https://www.ellenmacarthurfoundation.org/publications/a-new-textiles-economy-redesigning-fashions-future
Erkman, S. (1997). Industrial Ecology: An Historical View. *Journal of Cleaner Production*, *5*(1–2), 1–10. https://doi.org/10.1016/s0959-6526(97)00003-6
Esposito, M., Tse, T., & Soufani, K. (2017). Is the Circular Economy a New Fast-Expanding Market? *Thunderbird International Business Review*, *59*(1), 9–14. https://doi.org/10.1002/tie.21764
Esposito, M., Tse, T., & Soufani, K. (2018). Introducing a Circular Economy: New Thinking with New Managerial and Policy Implications. *California Management Review*, *60*(3), 5–19. https://doi.org/10.1177/0008125618764691
Euratex. (n.d.). *TIntex Textiles: A Specialist of Responsible Fabrics*. Euratex. Retrieved September 21, 2022, from https://euratex.eu/stories/tintex-textiles-a-specialist-of-responsible-fabrics/
European Commission. (2014). *Towards a Circular Economy: A Zero Waste Programme for Europe*.
European Commission. (2015). Closing the Loop - An EU Action Plan for the Circular Economy. In *COM(2015) 614 final*.
European Commission. (2019). The European Green Deal. In *European Commission*. European Commission. https://eur-lex.europa.eu/resource.html?uri=cellar:b828d165-1c22-11ea-8c1f-01aa75ed71a1.0002.02/DOC_1&format=PDF
European Commission. (2021, July 14). *European Green Deal: Commission proposes transformation of EU economy and society to meet climate ambitions*. European Commission; European Commission. https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3541
European Commission. (2022). *EU Strategy for Sustainable and Circular Textiles*. https://eur-lex.europa.eu/resource.html?uri=cellar:9d2e47d1-b0f3-11ec-83e1-01aa75ed71a1.0001.02/DOC_1&format=PDF
Feng, W. J., Mao, Y. R., Chen, H., & Chen, C. (2007). Study on Development Pattern of Circular Economy in Chemical Industry Parks in China. *Modern Chemical Industry*, *27*(3), 7.
Fernie, J., & Sparks, L. (1998). *Logistics and Retail Management: Insights into Current Practice and Trends from Leading Experts* (2nd ed.). Kogan Page Limited.
Fletcher, K. (2008). *Sustainable Fashion & Textiles_ Design Journeys*. Earthscan. http://library1.nida.ac.th/termpaper6/sd/2554/19755.pdf
Fletcher, K. (2010). Slow Fashion: An Invitation for Systems Change. *Fashion Practice*, *2*(2), 259–266. https://doi.org/10.2752/175693810x12774625387594
Foss, N. J., & Saebi, T. (2017). Fifteen Years of Research on Business Model Innovation: How Far Have We Come, and Where Should We Go? *Journal of Management*, *43*(1), 200–227.

https://doi.org/10.1177/0149206316675927
Franco, M. A. (2019). A System Dynamics Approach to Product Design and Business Model Strategies for the Circular Economy. *Journal of Cleaner Production*, *241*, 1–16. https://doi.org/10.1016/j.jclepro.2019.118327
Frosch, R. A., & Gallopoulos, N. E. (1989). Strategies for Manufacturing: Waste From One Industrial Process Can Serve As The Raw Materials For Another, Thereby Reducing The Impact Of Industry On The Environment. *Scientific American, Inc.*, *261*(3), 1–7. https://doi.org/10.1038/scientificamerican0989-144
Fuller, R. B. (1969). Operating Manual for Spaceship Earth. In J. Snyder (Ed.), *The Top 50 Sustainability Books* (2008th ed.). Lars Müller Publishers. https://doi.org/10.9774/gleaf.978-1-907643-44-6_7
Galvão, D. A. G., Nadae, J. de, Clemente, D. H., Chinen, G., & Carvalho, M. M. de. (2018). Circular Economy: Overview of Barriers. *CIRP Conference on Industrial Product-Service Systems*, *CIRP 73*(73), 79–85.
Garba, A. (2020). Biomass Conversion Technologies for Bioenergy Generation: An Introduction. In *Biomass* (p. 16). IntechOpen. https://doi.org/10.5772/intechopen.93669
Geisendorf, S., & Pietrulla, F. (2018). The Circular Economy and Circular Economic Concepts— A Literature Analysis and Redefinition. *Thunderbird International Business Review*, *60*(5), 771–782. https://doi.org/10.1002/tie.21924
Geissdoerfer, M., Savaget, P., Bocken, N., & Hultink, E. J. (2017). The Circular Economy – A New Sustainability Paradigm? *Journal of Cleaner Production*, *143*, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048
Ghisellini, P., Cialani, C., & Ulgiati, S. (2015). A Review on Circular Economy: The Expected Transition to a Balanced Interplay of Environmental and Economic Systems. *Journal of Cleaner Production*, *xxx*, 1–22. https://doi.org/10.1016/j.jclepro.2015.09.007
Giovannoni, E., & Fabietti, G. (2013). What Is Sustainability? A Review of the Concept and Its Applications. *Integrated Reporting: Concepts and Cases That Redefine Corporate Accountability*, *2010*, 21–38. https://doi.org/10.1007/978-3-319-02168-3
Gladwin, T. N., Kennelly, J. J., & Krause, T.-S. (1995). Shifting Paradigms for Sustainable Development: Implications for Management Theory and Research. *Academy of Management*, *20*(4), 874–907. http://www.jstor.com/stable/258959
Glavič, P., & Lukman, R. (2007). Review of Sustainability Terms and Their Definitions. *Journal of Cleaner Production*, *15*(18), 1875–1885. https://doi.org/10.1016/j.jclepro.2006.12.006
Global Fashion Agenda. (2018). *2018 Status Report: 2020 Circular Fashion System Commitment*. https://www.globalfashionagenda.com/wp-content/uploads/2018/07/2020-Commitment-year-one-status-report.pdf
Global Fashion Agenda. (2019). *2019 Status Report: 2020 circular fashion system commitment*.
Global Fashion Agenda & McKinsey&Company. (2020). Fashion on Climate: How the Fashion Industry Can Urgently Act to Reduce its Green House Gas Emissions. In *Global Fashion Agenda & McKinsey&Company*. Global Fashion Agenda & McKinsey&Company.
Green Purpose. (2021, January 26). *Tintex – Sustentabilidade Incorporada na Indústria Têxtil*. Green Purpose; Green Purpose. https://www.greenpurpose.pt/produtos/tintex-sustentabilidade-textil/
Guide, D. R., Harrison, T. P., & van Wassenhove, L. N. (2003). The Challenge of Closed-Loop Supply Chains. *INFORMS Journal on Applied Analytics Publication*, *33*(6), 3–6. https://doi.org/https://doi.org/10.1287/inte.33.6.3.25182
Guide, D. R., & Van Wassenhove, L. N. (2009). The Evolution of Closed-Loop Supply Chain Research. *Operations Research*, *57*(1), 10–18. https://doi.org/10.1287/opre.1080.0628
Gwilt, A., & Rissanen, T. (2011). Shaping Sustainable Fashion: Changing the Way We Make and Use Clothes. In *Shaping Sustainable Fashion: Changing the Way We Make and Use Clothes*. Earthscan. https://doi.org/10.4324/9780203126172
Hartley, J. (2004). Case Study Research. In C. Cassell & G. Symon (Eds.), *Essential Guide to Qualitative Methods in Organizational research* (pp. 323–333). SAGE Publications. https://smpncilebak2011.files.wordpress.com/2011/11/essential-guide-to-qualitative-in-organizational-research.pdf
HATA. (n.d.). *About Us*. HATA. Retrieved October 17, 2022, from https://www.hata.pt/about-us

Henninger, C. E., Bürklin, N., & Niinimäki, K. (2019). The Clothes Swapping Phenomenon – When Consumers Become Suppliers. *Journal of Fashion Marketing and Management*, *23*(3), 327–344. https://doi.org/10.1108/JFMM-04-2018-0057

Henry, M., Bauwens, T., Hekkert, M., & Kirchherr, J. (2020). A Typology of Circular Start-ups: Analysis of 128 Circular Business Models. *Journal of Cleaner Production*, *245*(118528), 1–19. https://doi.org/10.1016/j.jclepro.2019.118528

Hickel, J. (2020). Quantifying National Responsibility for Climate Breakdown: An Equality-Based Attribution Approach for Carbon Dioxide Emissions in Excess of The Planetary Boundary. *The Lancet Planetary Health*, *4*(9), e399–e404. https://doi.org/10.1016/S2542-5196(20)30196-0

Hirsch, P. M., & Levin, D. Z. (1999). Umbrella Advocates Versus Validity Police: A Life-Cycle Model. *Organization Science*, *10*(2), 199–212. https://doi.org/10.1287/orsc.10.2.199

Hollander, M. C. den, Bakker, C. A., & Hultink, E. J. (2017). Product Design in a Circular Economy: Development of a Typology of Key Concepts and Terms. *Journal of Industrial Ecology*, *21*(3), 517–525. https://doi.org/10.1111/jiec.12610

Homrich, A. S., Galvão, G., Abadia, L. G., & Carvalho, M. M. (2018). The Circular Economy Umbrella: Trends and Gaps on Integrating Pathways. *Journal of Cleaner Production*, *175*, 525–543. https://doi.org/10.1016/j.jclepro.2017.11.064

Hond, F. den. (2000). Industrial Ecology: a Review. *Regional Environmental Change*, *1*(2), 60–69.

Huber, J. (2000). Towards Industrial Ecology: Sustainable Development as a Concept of Ecological Modernization. *Journal of Environmental Policy & Planning*, *2*(4), 269–285. https://doi.org/10.1080/714038561

IAPMEI. (2022). *SETOR Têxtil e Vestuário*. iapmei.pt. https://www.iapmei.pt/PRODUTOS-E-SERVICOS/Industria-e-Sustentabilidade/Informacao-Setorial/DOCS_InfSetorial/Ficha_SetorTextileVestuario.aspx

Ibn-Mohammed, T., Mustapha, K. B., Godsell, J., Adamu, Z., Babatunde, K. A., Akintade, D. D., Acquaye, A., Fujii, H., Ndiaye, M. M., Yamoah, F. A., & Koh, S. C. L. (2021). A Critical Review of The Impacts of COVID-19 on The Global Economy and Ecosystems and Opportunities for Circular Economy Strategies. *Resources, Conservation and Recycling*, *164*(105169), 1–22. https://doi.org/10.1016/j.resconrec.2020.105169

Interview Cru Loja, (2022).

Interview Katty Xiomara, (2022).

Interview Recit. (2022).

Interview Rodome & Trevira, (2022).

Interview SKFK, (2022).

Interview Tearfil, (2022).

Interview Tinamar. (2022).

Interview Tintex, (2022).

Interview Triwool, (2022).

Interview Vintage for a Cause, (2022).

Interview White-Stamp, (2022).

Jarrett, H., Boulding, K. E., & Barnett, H. J. (1966). Environmental Quality in a Growing Economy: Essays from the Sixth RFF Forum. In H. Jarrett (Ed.), *RFF Press* (2011th ed., Vol. 3). Resources For The Future, Inc, by The Johns Hopkins Press. https://doi.org/10.4324/9781315064147

Jeurissen, R. (2000). Book review. *Journal of Business Ethics*, *23*, 231–234. https://doi.org/10.1038/eye.1987.103

Jia, F., Yin, S., Chen, L., & Chen, X. (2020). The Circular Economy in The Textile and Apparel Industry: A Systematic Literature Review. *Journal of Cleaner Production*, *259*(120728), 1–20. https://doi.org/10.1016/j.jclepro.2020.120728

Johnston, P., Everard, M., Santillo, D., & Robèrt, K. (2007). Reclaiming the Definition of Sustainability. *Environmental Science and Pollution Research*, *14*(1), 60–66.

Jørgensen, S., & Pedersen, L. J. T. (2018). Why Sustainable Business Model Innovation? In *RESTART Sustainable Business Model Innovation*. https://doi.org/10.1007/978-3-319-91971-3_1

Jung, S., & Jin, B. (2014). A Theoretical Investigation of Slow Fashion: Sustainable Future of the Apparel Industry. *International Journal of Consumer Studies*, *38*(5), 510–519. https://doi.org/10.1111/ijcs.12127

Kalmykova, Y., Sadagopan, M., & Rosado, L. (2018). Circular economy – From Review of Theories and Practices to Development of Implementation Tools. *Resources, Conservation and Recycling*, *135*, 190–201. https://doi.org/10.1016/J.RESCONREC.2017.10.034

Kant Hvass, K., & Pedersen, E. R. G. (2019). Toward Circular Economy of Fashion: Experiences From a Brand's Product Take-Back Initiative. *Journal of Fashion Marketing and Management*, *23*(3), 345–365. https://doi.org/10.1108/JFMM-04-2018-0059

Kay, G. (2021, October 6). *Your Clothes May Be About To Become More Expensive As Cotton Prices Hit A Decade High*. Insider; Business Insider. https://www.businessinsider.com/clothes-may-get-more-expensive-as-cotton-prices-surge-2021-10

Kiørboe, N. K., Sramkova, H., & Krarup, M. (2015). Moving Towards a Circular Economy - Successful Nordic Business Models. In *Norden*. https://doi.org/http://dx.doi.org/10.6027/ANP2015-771

Kiron, D., Kruschwitz, N., Reeves, M., & Goh, E. (2013). The Benefits of Sustainability-Driven Innovation. *MIT Sloan Management Review*, *54*(2), 69–73. https://sloanreview.mit.edu/wp-content/uploads/2012/12/f0bfde1b37.pdf

Knitting Industry. (2019, June 7). *Circular Knitting: Tintex Textiles joins United Nations Global Compact*. Knitting Industry; Knitting Industry.

Kohlbacher, F. (2006). The Use of Qualitative Content Analysis in Case Study Research. *Forum Qualitative Social Research*, *7*(1), 1–30. https://www.proquest.com/scholarly-journals/use-qualitative-content-analysis-case-study/docview/869232470/se-2

Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular Economy: The Concept and its Limitations. *Ecological Economics*, *143*(January), 37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041

Koszewska, M. (2018). Circular Economy - Challenges for the Textile and Clothing Industry. *Autex Research Journal*, *18*(4), 337–347. https://doi.org/10.1515/aut-2018-0023

KPMG. (2018). Threading the Needle: Key Highlights. Weaving the Sustainable Development Goals into the Textile, Retail, and Apparel Industry. In *KPMG International* (pp. 1–4). KPMG International. https://textileexchange.org/checkout/

Kubania, J. (2015, July 6). *How Second-Hand Clothing Donations Are Creating a Dilemma for Kenya*. The Guardian; The Guardian. http://www.theguardian.com/world/2015/jul/06/second?hand?clothing?donations?kenya

Lacy, P., Long, J., & Spindler, W. (2020). *The Circular Economy Handbook* (1st ed., Issue 11). Palgrave Macmillan, London. https://doi.org/https://doi.org/10.1057/978-1-349-95968-6

Larsson, M. (2018). Circular Business Models: Developing a Sustainable Future. In *Circular Business Models: Developing a Sustainable Future* (1st ed.). Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-319-71791-3

Lehmann, M., Tärneberg, S., Tochtermann, T., Chalmer, C., Eder-Hansen, J., F. Seara, J., Boger, S., Hase, C., Berlepsch, V. Von, & Deichmann, S. (2018). *Pulse of the Fashion Industry 2018*. Boston Consulting Group; Global Fashion Agenda. https://www.globalfashionagenda.com/pulse-of-the-fashion-industry-2018-report-released/

Lewandowski, M. (2016). Designing The Business Models For Circular Economy-Towards The Conceptual Framework. *Sustainability (Switzerland)*, *8*(43), 28. https://doi.org/10.3390/su8010043

Li, X. (2018). *Industrial Ecology and Industry Symbiosis for Environmental Sustainability: Definitions, Frameworks and Applications* (1st ed.). Palgrave Pivot, Cham. https://doi.org/https://doi.org/10.1007/978-3-319-67501-5

Lieder, M., & Rashid, A. (2016). Towards Circular Economy Implementation: A Comprehensive Review in Context of Manufacturing Industry. *Journal of Cleaner Production*, *115*, 36–51. https://doi.org/10.1016/j.jclepro.2015.12.042

Lifset, R., & Graedel, T. E. (2019). *Industrial Ecology: Goals and Definitions* (pp. 3–15).

Lindkvist, M., & Baumann, H. (2013). Bring on the 'Soft' Sciences: Exploring Implications of Grounding Life Cycle Methods in Three Socio-Material Philosophies. *The 6th International Conference on Life Cycle Management*, 4. http://publications.lib.chalmers.se/records/fulltext/178581/local_178581.pdf

Liu, Q., Li, H. ming, Zuo, X. li, Zhang, F. fei, & Wang, L. (2009). A Survey and Analysis on Public

Awareness and Performance for Promoting Circular Economy in China: A Case Study From Tianjin. *Journal of Cleaner Production*, *17*(2), 265–270. https://doi.org/10.1016/j.jclepro.2008.06.003
Loiseau, E., Saikku, L., Antikainen, R., Droste, N., Hansjürgens, B., Pitkänen, K., Leskinen, P., Kuikman, P., & Thomsen, M. (2016). Green Economy and Related Concepts: An Overview. *Journal of Cleaner Production*, *139*, 361–371. https://doi.org/10.1016/j.jclepro.2016.08.024
Lopes de Sousa Jabbour, A. B., Rojas Luiz, J. V., Rojas Luiz, O., Jabbour, C. J. C., Ndubisi, N. O., Caldeira de Oliveira, J. H., & Junior, F. H. (2019). Circular Economy Business Models and Operations Management. *Journal of Cleaner Production*, *235*, 1525–1539. https://doi.org/10.1016/j.jclepro.2019.06.349
Lovins, A. B., Lovins, L. H., & Hawken, P. (1999). A Road Map for Natural Capitalism. *Harvard Business Review*, *May-June*, 145–158. https://doi.org/10.4324/9781849776752-50
Lovins, L. H. (2008). Innovations for a Sustainable Economy - CHAPTER 3: Rethinking Production. In *The Worldwatch Institute* (25th Anniv, pp. 32–44). The Worldwatch Institute.
Lowe, E. A., & Evans, L. K. (1995). Industrial Ecology and Industrial Ecosystems. *Journal of Cleaner Production*, *3*(1–2), 47–53. https://doi.org/10.1016/0959-6526(95)00045-G
Lüdeke-Freund, F. (2010). Towards a Conceptual Framework of Business Models for Sustainability. *Knowledge Collaboration & Learning for Sustainable Innovation*, 1–28.
Lüdeke-Freund, F., Gold, S., & Bocken, N. (2018). A Review and Typology of Circular Economy Business Model Patterns. Supporting Information S1. *Journal of Industrial Ecology*, S1_1-4. https://onlinelibrary.wiley.com/action/downloadSupplement?doi=10.1111%2Fjiec.12763&file=jiec12763-sup-0001-SuppInfoS1.pdf
Lüdeke-Freund, F., Gold, S., & Bocken, N. (2018). A Review and Typology of Circular Economy Business Model Patterns. *Journal of Industrial Ecology*, *23*(1), 36–61.
Mallawaarachchi, H., Sandanayake, Y., Karunasena, G., & Liu, C. (2020). Unveiling the Conceptual Development of Industrial Symbiosis: Bibliometric Analysis. *Journal of Cleaner Production*, *258*(120618), 1–10. https://doi.org/10.1016/j.jclepro.2020.120618
Masi, D., Day, S., & Godsell, J. (2017). Supply Chain Configurations in the Circular Economy: A Systematic Literature Review. *Sustainability (Switzerland)*, *9*(1602), 1–22. https://doi.org/10.3390/su9091602
McDonough, W., & Braungart, M. (2002). *Cradle to Cradle: Remaking The Way We Make Things* (First Edit). North Point Press a division of Farrar, Straus and Giroux. www.fsgbooks.com
McDonough, W., Braungart, M., Anastas, P. T., & Zimmerman, J. B. (2003). Applying the Principles of Green Engineering to Cradle-to-Cradle Design. *Environmental Science and Technology*, *37*(23), 435–441. https://doi.org/10.1021/es0326322.
Meadows, D. H., Meadows, D. L., Randers, J., & Behrens III, W. W. (1972). The Limits to Growth. In *Universe Books*. Universe Books. https://doi.org/10.1128/iai.65.9.3944-3946.1997
Merli, R., Preziosi, M., & Acampora, A. (2018). How Do Scholars Approach The Circular Economy? A Systematic Literature Review. *Journal of Cleaner Production*, *178*, 703–722. https://doi.org/10.1016/j.jclepro.2017.12.112
Meyer, A. D. (1991). What Is Strategy's Distinctive Competence? *Journal of Management*, *17*(4), 821–833. https://doi.org/10.1177/014920639101700413
Mistra Future Fashion. (2019). The Outlook Report 2011-2019. In *Mistra Future Fashion Final Program Report*. Mistra Future Fashion. http://mistrafuturefashion.com/wp-content/uploads/2019/10/the-Outlook-Report_Mistra-Future-Fashion-Final-Program-Report_31-okt-2019.pdf
Mitchell, D., & Coles, C. (2003). The Ultimate Competitive Advantage of Continuing Business Model Innovation. *Journal of Business Strategy*, *24*(5), 15–21. https://doi.org/10.1108/02756660310504924
Moberg, F., & Simonsen, S. H. (2015). What Is Resilience ? An Introduction To Social-Ecological Research. In *Stockholm Resilience Center* (pp. 1–20). Stockholm Resilience Center. http://www.stockholmresilience.org/download/18.5ea7abe0139d0dada521ac/resilience_summary_lowX.pdf
Moreno, M., De los Rios, C., Rowe, Z., & Charnley, F. (2016). A Conceptual Framework for Circular Design. *Sustainability (Switzerland)*, *8*(937), 1–15. https://doi.org/10.3390/su8090937

Murray, A., Skene, K., & Haynes, K. (2017). The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics*, *140*(3), 369–380. https://doi.org/10.1007/s10551-015-2693-2

Muthu, S. S. (2017). Sustainability in the Textile Industry. In Muthu Senthilkannan Subramanian (Ed.), *Springer* (Textile Sc). Springer Nature Singapore Pte Ltd. http://www.springer.com/series/13111

Ness, D. (2008). Sustainable Urban Infrastructure In China Towards a Factor 10 Improvement In Resource Productivity Through Integrated Infrastructure Systems. *The International Journal of Sustainable Development & World Ecology*, *15*(4), 288–301.

Nidumolu, R., Prahalad, C. K., & Rangaswami, M. R. (2009). Why Sustainability Is Now the Key Driver of Innovation. *Harvard Business Review*, *September*, 1–10.

O'Rourke, D., Connelly, L., & Koshland, C. P. (1996). Industrial Ecology: A Critical Review. *International Journal of Environment and Pollution*, *6*(2/3), 89–112.

Osterwalder, A., & Pigneur, Y. (2010). *Business Model Generation* (T. Clark (Ed.)). John Wiley & Sons, Inc.

Pal, R., Shen, B., & Sandberg, E. (2019). Circular Fashion Supply Chain Management: Exploring Impediments and Prescribing Future Research Agenda. *Journal of Fashion Marketing and Management*, *23*(3), 298–307. https://doi.org/10.1108/JFMM-07-2019-166

Paras, M. K., Curteza, A., & Varshneya, G. (2019). Identification of Best Reverse Value Chain Alternatives: A study of Romanian used Clothing Industry. *Journal of Fashion Marketing and Management*, *23*(3), 396–412. https://doi.org/10.1108/JFMM-04-2018-0060

Parveen, S. (2014, April 23). *Rana Plaza Factory Collapse Survivors Struggle One Year On*. BBC Bengali, Dhaka. https://www.bbc.com/news/world-asia-27107860

Pearce, D. W., & Turner, R. K. (1990). Economics of Natural Resources and the Environment, Chapter 2: The Circular Economy. In *Economics of Natural Resources and the Environment*. Johns Hopkins University Press.

Pedersen, E. R. G., Andersen, K. R., & Earley, R. (2019). From Singular to Plural: Exploring Organisational Complexities and Circular Business Model Design. *Journal of Fashion Marketing and Management*, *23*(3), 308–326. https://doi.org/10.1108/JFMM-04-2018-0062

Pesce, M., Tamai, I., Guo, D., Critto, A., Brombal, D., Wang, X., Cheng, H., & Marcomini, A. (2020). Circular Economy in China: Translating Principles into Practice. *Sustainability (Switzerland)*, *12*(832), 1–31. https://doi.org/10.3390/su12030832

Peter, Lacy, Jakob, & Rutqvist. (2015). Waste to Wealth: The Circular Economy Advantage. In *Palgrave Macmillan*. Palgrave Macmillan. https://doi.org/10.1057/9781137530707

Planing, P. (2015). Business Model Innovation in a Circular Economy Reasons for Non-Acceptance of Circular Business Models. *Open Journal of Business Model Innovation*, *April*, 1–11.

Poerner, B. (2020). *Where Does Clothing End Up? Modern Colonialism Disguised As Donation*. Fashion Revolution; Fashion Revolution. https://www.fashionrevolution.org/where-does-clothing-end-up-modern-colonialism-disguised-as-donation/

Pongrácz, E., & Pohjola, V. J. (2004). Re-defining Waste, The Concept of Ownership and The Role of Waste Management. *Resources, Conservation and Recycling*, *40*(2), 141–153. https://doi.org/10.1016/S0921-3449(03)00057-0

Preston, F. (2012). A Global Redesign? Shaping the Circular Economy. *Energy, Environment and Resource Governance*, *02*(March), 20. https://doi.org/10.1080/0034676042000253936

Quantis. (2018). Measuring Fashion: Insights from the Environmental Impact of the Global Apparel and Footwear Industries Study. In *Quantis*. https://quantis-intl.com/measuring-fashion-report-2018/

Ranta, V., Aarikka-Stenroos, L., Ritala, P., & Mäkinen, S. J. (2018). Exploring Institutional Drivers and Barriers of the Circular Economy: A Cross-Regional Comparison of China, the US, and Europe. *Resources, Conservation and Recycling*, *135*(August 2017), 70–82. https://doi.org/10.1016/j.resconrec.2017.08.017

Reichel, A., De Schoenmakere, M., & Gillabel, J. (2016). Circular Economy in Europe - Developing the Knowledge Base (European Environment Agency Report No 2/2016). In *Publication Office of the Euopean Union* (Issue 2). Publications Office of the European Union. https://doi.org/10.2800/51444

Reike, D., Vermeulen, W. J. V., & Witjes, S. (2018). The Circular Economy: New or Refurbished as CE 3.0? — Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options. *Resources, Conservation and Recycling*, *135*(November 2017), 246–264. https://doi.org/10.1016/j.resconrec.2017.08.027

Remane, G., Hanelt, A., Tesch, J. F., & Kolbe, L. M. (2016). The Business Model Pattern Database-A Tool For Systematic Business Model Innovation. *International Journal of Innovation Management*, *21*(1), 61. https://doi.org/10.1142/S1363919617500049

Renswoude, K. van, Wolde, A. ten, & Joustra, D. J. (2015). Circular Business Models: Part 1: An Introduction to IMSA's Circular Business Model Scan. In *IMSA Amsterdam* (Issue April). IMSA Amsterdam. https://doi.org/10.1007/978-3-319-71791-3

Ricketts, L. (2019). *Dead White Man's Clothes*. Fashion Revolution; Fashion Revolution. https://www.fashionrevolution.org/dead-white-mans-clothes/

Ricketts, L., & The Slow Factory Foundation. (2021). *Fashion and Waste*. The Slow Factory Foundation. https://vimeo.com/518207401

Ritzén, S., & Sandström, G. Ö. (2017). Barriers to the Circular Economy - Integration of Perspectives and Domains. *Procedia CIRP*, *64*, 7–12. https://doi.org/10.1016/j.procir.2017.03.005

Rizos, V., Tuokko, K., & Behrens, A. (2017). *The Circular Economy: A Review of Definitions, Processes and Impacts* (Issue 08). CEPS Research Report. https://www.ceps.eu/download/publication/?id=9969&pdf=RR2017-08_CircularEconomy_0.pdf

Rockström, J. (2017, March 1). *5 Reasons Why The Economy Is Failing The Environment, and Humanity*. World Economic Forum. https://www.weforum.org/agenda/2017/01/5-reasons-why-the-economy-is-failing-the-environment-and-humanity/

Saavedra, Y. M. B., Iritani, D. R., Pavan, A. L. R., & Ometto, A. R. (2018). Theoretical Contribution of Industrial Ecology to Circular Economy. *Journal of Cleaner Production*, *170*, 1514–1522. https://doi.org/10.1016/j.jclepro.2017.09.260

Sánchez, P., & Ricart, J. E. (2010). Business Model Innovation and Sources of Value Creation in Low-Income Markets. *European Management Review*, *7*(3), 138–154. https://doi.org/l0.1057/emr.2010.16

Santos, R., & TINTEX Textiles. (2019). *Circular Design*. Tintex Textiles. https://tintextextiles.com/circular-design/

Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental Sciences, Sustainable Development and Circular Economy: Alternative Concepts for Trans-Disciplinary Research. *Environmental Development*, *17*, 48–56. https://doi.org/10.1016/j.envdev.2015.09.002

Seadon, J. K. (2006). Integrated Waste Management - Looking Beyond The Solid Waste Horizon. *Waste Management*, *26*(12), 1327–1336. https://doi.org/10.1016/j.wasman.2006.04.009

Silva, M. J., & TINTEX Textiles. (2019). *Tintex Letter of Commitment* (p. 1). United Nations. https://ungc-production.s3.us-west-2.amazonaws.com/commitment_letters/135981/original/Letter_of_Commitment_signed.pdf?1557248503

Spiess-Knafl, W., Mast, C., & Jansen, S. A. (2015). On the Nature of Social Business Model Innovation. *Social Business*, *5*(2), 113–130. https://doi.org/10.1362/204440815x14373846978624

Stahel, W. R. (1981). Jobs for Tomorrow: The Potential for Substituting Manpower for Energy. *Report to the Commission of the European Communities.*, *April*.

Stahel, W. R. (2010). *The Performance Economy* (2nd ed.). Palgrave Macmillan.

Stahel, W. R. (2012). The Business Angle of a Circular Economy – Higher Competitiveness, Higher Resource Security and Material Efficiency. *EMF*, *15.05.12*, 1–10.

Stahel, W. R. (2016). Circular Economy. *Nature*, *531*(7595), 435–438. https://doi.org/10.1038/531435a

Stern, N. (2007). The Economics of Climate Change: The Stern Review. In *Cambridge University Press*. Cambridge University Press. https://doi.org/10.1017/CBO9780511817434

Stern, N. (2009). The Global Deal: Climate Change and The Creation of a New Era of Progress and Prosperity. In *PublicAffairs* (1st ed.). PublicAffairs. https://doi.org/10.1017/CBO9781107415324.004

Thomas, D. R. (2006). A General Inductive Approach for Analyzing Qualitative Evaluation Data.

American Journal of Evaluation, *27*(2), 237–246. https://doi.org/10.1177/1098214005283748
Tibbs, H. B. C. (1992). Industrial Ecology – An Agenda for Environmental Management. *Pollution Prevention Review*, *Spring*, 167–181.
Tibbs, H. B. C. (1993). Industrial Ecology: An Environmental Agenda for Industry. *Global Business Network*, *January 1993*, 1–28.
TINTEX Textiles. (2019). *TINTEX A Purpose Driven Company*. Tintex Textiles. https://ungc-production.s3.us-west-2.amazonaws.com/attachments/cop_2021/498656/original/Relatorio_Tintex_2021_FINAL.pdf?1623249266
TINTEX Textiles. (2020). *TINTEX Relatório Sustentabilidade 2020*. Tintex Textiles. https://tintextextilesportugal.my.salesforce.com/sfc/p/#5J000000CnNB/a/5J000000pJXz/snCqITW0a2RY6BLIt2Y7OlL2AKcRLxm1vPC_zwNnr7A
TINTEX Textiles. (2022a). *About us*. Tintextextiles.Com; Tintex Textiles. https://doi.org/10.22201/ceiich.24485705e.2013.1.46541
TINTEX Textiles. (2022b). *Future Earth*. Tintex Textiles. https://tintextextiles.com/future-earth/?amp=1
TINTEX Textiles. (2022c). *Purpose*. Tintextextiles.Com; Tintex Textiles. https://tintextextiles.com/purpose/
Todeschini, B. V., Cortimiglia, M. N., Callegaro-de-Menezes, D., & Ghezzi, A. (2017). Innovative and sustainable business models in the fashion industry: Entrepreneurial drivers, opportunities, and challenges. *Business Horizons*, *60*(6), 759–770. https://doi.org/10.1016/J.BUSHOR.2017.07.003
Tokatli, N., Wrigley, N., & Kizilgün, Ö. (2008). Shifting Global Supply Networks and Fast Fashion: Made In Turkey for Marks and Spencer. *Global Networks*, *8*(3), 261–280. https://doi.org/10.1111/j.1471-0374.2008.00195.x
Toxopeus, M. E., De Koeijer, B. L. A., & Meij, A. G. G. H. (2015). Cradle to Cradle: Effective Vision vs. Efficient Practice? *Procedia CIRP*, *29*, 384–389. https://doi.org/10.1016/j.procir.2015.02.068
Tukker, A. (2004). Eight Types of Product-Service System: Eight Ways to Sutainability? Experiences From Suspronet. *Business Strategy and the Environment*, *13*, 246–260. https://doi.org/10.1002/bse.414 EIGHT
Tukker, A. (2015). Product Services For a Resource-Efficient and Circular Economy – A Review. *Journal of Cleaner Production*, *97*, 76–91. https://doi.org/10.1016/J.JCLEPRO.2013.11.049
UNFCCC/CCNUCC. (2005). *Clarifications of Definitions of Biomass and Consideration of Changes in Carbon Pools Due To a CDM Project Activity. Framework Convention on Climate Change—Secretariat. CDM-EB-20, Appendix 8*. https://cdm.unfccc.int/Reference/Guidclarif/mclbiocarbon.pdf
Unruh, G. (2016). Sustainability Reporting: One Size Fits Nobody. *MITSloan Management Review*, 0–3.
van Beers, D., Grossi, F., Brüggemann, N., & Kiørboe, N. (2014). *Reflections and Lessons Learnt from EEA's Work on Innovative Business Models for Sustainable Lifestyles*. http://www.scp-centre.org/fileadmin/content/files/6_Resources/1_Publications_pdfs/91_ETC_InnovativeBusinessModelsforSustainableLifestyles.pdf
Van Halewyck, T. (2020). *The Pioneering Companies of The New Normal.* (p. 35). Bundl.
Van Teijlingen, E., & Hundley, V. (2002). The Importance of Pilot Studies. *Nursing Standard (through 2013)*, *16*(40), 33–36. https://www.proquest.com/openview/e1c79ecc86d8b228530d189b81b25f63/1?cbl=30130&pq-origsite=gscholar&parentSessionId=tM1gLv51acnR9j5lnPQszOf1jI%2B2lVc9iKhUQbJxOBc%3D
Vecchi, A. (2020). The Circular Fashion Framework-The Implementation of the Circular Economy by the Fashion Industry. *Fashion Technology & Textile Engineering*, *6*(2), 31–35. https://doi.org/10.19080/CTFTTE.2020.06.555681
WEF. (2020). The Future of Nature and Business - New Nature Economy Report II. In *New Nature Economy Report*. World Economic Forum.
WEF, EMF, & McKinsey. (2014). Towards the Circular Economy: Accelerating the scale-up across global supply chains. In *World Economic Forum* (Issue January). World Economic Forum.

http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf
Wells, P., & Seitz, M. (2005). Business Models and Closed-Loop Supply Chains: A Typology. *Supply Chain Management*, *10*(4), 249–251. https://doi.org/10.1108/13598540510612712
Westley, F., Olsson, P., Folke, C., Homer-Dixon, T., Vredenburg, H., Loorbach, D., Thompson, J., Nilsson, M., Lambin, E., Sendzimir, J., Banerjee, B., Galaz, V., & Van Der Leeuw, S. (2011). Tipping toward Sustainability: Emerging Pathways of Transformation. *Ambio*, *40*(7), 762–780. https://doi.org/10.1007/s13280-011-0186-9
Winans, K., Kendall, A., & Deng, H. (2017). The History and Current Applications of the Circular Economy Concept. *Renewable and Sustainable Energy Reviews*, *68*(2017), 825–833. https://doi.org/10.1016/j.rser.2016.09.123
World Health Organization. (2018). Climate Change and Health. In *Fact sheets on sustainable development goals: health targets*. https://doi.org/10.4324/9781315272085-4
WRAP UK. (2017). *Innovative business model map*. The Waste and Resources Action Programme. https://archive.wrap.org.uk/content/innovative-business-model-map-old
Yong, G., & Doberstein, B. (2008). Developing the Circular Economy in China: Challenges and Opportunities for Achieving 'Leapfrog Development? *International Journal of Sustainable Development & World Ecology*, *15*(917036417), 231–239. https://doi.org/10.3843/SusDev.15.3
Yuan, Z., Bi, J., & Moriguichi, Y. (2006). The Circular Economy: A New Development Strategy in China. *Journal of Industrial Ecology*, *10*(1–2), 4–8. https://doi.org/10.1162/108819806775545321
Zott, C., Amit, R., & Massa, L. (2011). The Business Model: Recent Developments and Future Research. *Journal of Management*, *37*(4), 1019–1042. https://doi.org/10.1177/0149206311406265

7. APPENDICES

APPENDIX A : Related Concepts Contributions to the Development of the CE Framework

Table 1 - *Related Concepts Contributions to the Development of the CE Framework*

Concept	*Key-Takeaways used by the CE Framework*
Sustainability	Long term perspective linked to the present; Future consequences of present activities; Associated to the Ecology concept; Nature is self-regenerative; Integrated TBL concept (social, economic, environmental dimensions).
Sustainable Development	Long term perspective linked to the present; Future consequences of present activities; Intergenerational thinking of not compromising the future; Sustainable growth as an economic dimension; Benign production processes.
Industrial Ecology and Industrial Symbiosis	Downstream and upstream analysis of the industrial operations; Three levels of initiatives: Single-firm, Interorganizational and Intersectional collaboration and cooperation; Local, Regional and Global relationships and networks; Design for the environment: symbiotic industrial networks as Eco-Industrial Parks; Nature inspired system and compatible with it; Cyclical system with multiple loops based on material flow integration; Waste as a resource; Long-term large scale strategy; Integrated model using technology to optimize and reduce the use of energy and materials; Seeks to improve environmental, social, and financial performance. Incorporation of Industrial Metabolism.
Biomimicry	Sustainability from a design perspective: mimicking Nature and the biological metabolism; If waste is created it is seen as a resource and it should be as safe as if it was created by Nature; Complete Life-Cycle maximization; Use of clean energy.

Cradle-to-Cradle	Sustainability from a design perspective based on learning from Nature; Elimination of the waste concept: "Waste equals food"; Eco-effectiveness instead of eco-efficiency (performance related); Positive impact creation: benign production processes. Introduction of the two metabolic cycles: biological and technical; Design to re-design; for reassembly, composting and recycling; Complete Life-Cycle maximization; Use of clean energy.
Reverse Logistics	Management of upstream flows of products, materials, and information: From end-user to recovery to new user.
Closed-Loop Supply Chains	"Everything is an input into everything else"; Integrated approach that coordinates both Forward and Reverse Logistics; Closing inbound and outbound flows; Cascading process is introduced; narrowing and slowing loops are considered; Collaborative dynamics system across companies, industries, cities and communities; Micro-, meso- and macro-level strategy.

Notes:

[1]This table was built based on the literature (Bocken et al., 2016; Brown et al., 1987; Brundtland, 1987; Chertow, 2000; Cohen-Rosenthal, 2000; De Pauw et al., 2010; Dekker et al., 2004; Elkington, 2017; Erkman, 1997; Geisendorf & Pietrulla, 2018; Geissdoerfer et al., 2017; Giovannoni & Fabietti, 2013; Guide et al., 2003; Huber, 2000; Johnston et al., 2007; L. H. Lovins, 2008; McDonough & Braungart, 2002; Murray et al., 2017; O'Rourke et al., 1996; Stahel, 2010)

APPENDIX B : Terms Definition for the Different Problem-solution Combinations to Reach a CE

Table 2 - *Terms Definition for the Different Problem-solution Combinations to Reach a CE*

	Articles:	(Yuan et al., 2006)	(EMF, 2013a)	(EMF, 2013b)	(Bocken et al., 2014)	(Bonciu, 2014)	(van Beers et al., 2014)	(EMF, 2015)	(Ghisellini et al., 2015)	(Planing, 2015)	(Bocken et al., 2016)	(De Angelis, 2016)	(Reichel et al., 2016)	(Lewandowski, 2016)	(Lieder & Rashid, 2016)	(Moreno et al., 2016)	(Sauvé et al., 2016)	(Blomsma & Brennan, 2017)	(D' Amato et al., 2017)	(Esposito et al., 2017)	(Geissdoerfer et al., 2017)	(Masi et al., 2017)	(Murray et al., 2017)	(Winans et al., 2017)	(Esposito et al., 2018)	(Geisendorf & Pietrulla, 2018)	(Korhonen et al., 2018)	(Lüdeke-Freund et al., 2018)	(Merli et al., 2018)	(Reike et al., 2018)	(Saavedra et al., 2018)	(Franco, 2019)	(Lopes de Sousa Jabbour et al., 2019)	(Pedersen et al., 2019)	(Pesce et al., 2020)	References count:
	Terminology:																																			
CE	Strategy	x							x		x		x			x					x	x	x							x	x				x	11
	Combination																				x															1
	Approach	x	x	x		x		x	x		x		x	x	x		x					x	x		x	x	x			x				x	x	19
	Model		x	x				x					x			x	x		x	x			x	x			x	x		x				x	x	15
	Framework	x	x	x		x	x				x	x		x	x		x	x				x	x	x		x		x	x		x	x				19
Sub-terms of CE	Strategies		x	x			x	x			x	x	x	x		x		x	x		x	x			x			x	x			x	x	x	x	20
	Configurations			x														x				x											x				4
	Combinations				x																								x		x		x		x		5
	Categories						x			x	x	x		x							x			x				x	x				x				10
	Typologies						x					x	x																x		x		x				6
	Patterns			x										x										x				x	x	x							6
	Design options/ strategies										x				x	x												x		x		x			x	7

	Archetypes			x	x							x				x					x							x		x					x	8
	Types										x	x	x	x								x							x	x		x				x	9
	Subset																					x							x								2
	Approaches	x	x	x	x		x	x				x	x	x	x	x		x				x		x	x			x	x	x				x		19
	Models/ Sub-models			x	x		x	x	x	x		x	x	x	x	x		x		x		x	x	x	x	x	x	x	x			x		x	x	24
	Designs	x																										x									2
	Dimensions						x														x							x									3
	Frameworks		x					x						x	x																		x	x			6
	Initiatives														x		x					x	x	x			x					x					7
	Practices		x	x			x				x	x	x		x	x						x							x					x	x	x	13
	Solutions		x	x			x																				x							x	x	x	7

APPENDIX C : The Relation Between Circular Product Design Strategies and Resource Cycles

Table 3 - *The Relation Between Circular Product Design Strategies and Resource Cycles*

	Circular Product Design Strategies:	Resource Cycles		
		Slowing Loops	**Narrowing Loops**	**Closing Loops**
		Retain product value	Resource saving over efficiency	Retain material value
Design for Integrity	**A. Design for long-life products or design for longevity/ classic long-life**			
	- Attachment & trust;	x	x	
	- Reliability & durability;	x	x	
	- High levels of guarantees and services;	x	x	
	- Design for buy back and re-use;	x	x	x
	- Provision of spare parts & adaptability to easy repair & value retain;	x	x	x
	- Refurbish and resell.		x	x
	B. Design for product life extension or value recovery			
	- Design for buy back and re-use;	x	x	x
	- Maintenance & repair;	x	x	
	- Upgradability & adaptability;	x	x	x
	- Standardization & compatibility/modular design;	x	x	
	- Dis- & reassembly;	x	x	x
	- Re-manufacture (via recaptured components);	x	x	x
	- Provision of spare parts & adaptability to easy repair & value retain;	x	x	x
	- Refurbish and resell.		x	x
Design for material recovery	**C. Design for Technical Cycles** Using technical nutrients (e.g., synthetic, mineral materials)			
	- Recycle (upcycle and downcycle);		x	x
	- Repurpose;	x	x	x
	- Re-manufacture (via recaptured materials);		x	x
	- Less-resource intensive or fully recyclable materials/products.		x	x
	D. Design for Biological Cycles Using biological nutrients (e.g., organic, plant-based materials)			
	- Biodegradability and Compost;			x
	- Recycle (upcycle and downcycle);		x	x
	- Circular bio-based re-captured materials;		x	x
	- Less-resource intensive or fully recyclable materials/products.		x	x

Notes:

[1]This table was built based on the literature (Achterberg et al., 2016; Bocken et al., 2016; EMF, 2015; Franco, 2019; Hollander et al., 2017; Lüdeke-Freund et al., 2018; Moreno et al., 2016)

APPENDIX D : Circular Business Models and Sub-models Definition

Table 4 - *Circular Business Models and Sub-models Definition*

	CBM's	Definition	Literature References
Resources ----Manufactured Products----------	**1. Dematerialised Services**	Any to few resources used. Service and function based offerings, that do not require the purchase of a physical product, which reduces the need for raw materials input while performance is maintained.	(Ayres & Ayres, 2002; Bigano et al., 2016; Braungart et al., 2006, p. 4; De Angelis, 2018; J. Ehrenfeld & Gertler, 1997; Erkman, 1997; Esposito et al., 2017; Franco, 2019; Glavič & Lukman, 2007; Hond, 2000; Lacy et al., 2020; Larsson, 2018; Lewandowski, 2016; Loiseau et al., 2016; Moreno et al., 2016; Peter et al., 2015; Renswoude et al., 2015; Tibbs, 1993; WRAP UK, 2017)
	1.1 Physical to Digital	Utility is delivered through virtual products and services. Still, even if digital, this model requires support tools as hardware to function, Artificial Intelligence (AI) and the Internet of Things (IoT) knowledge and infrastructures as contributors to possible solutions.	(De Angelis, 2018; EMF, 2015; Esposito et al., 2017; Peter et al., 2015; Renswoude et al., 2015; Rizos et al., 2017; Van Halewyck, 2020)
	1.2 Subscription-based Rental	Product or Service access and use for a specific period of time over the payment of a periodic fee, normally in a monthly or annual basis.	(Lewandowski, 2016; Peter et al., 2015; Renswoude et al., 2015)

2. Access and Performance Models or Product Service Systems (PSS)/ Product as a Service / Servitization	Not necessarily digital, these models are based on the concept of collaborative consumption. Tangible products and intangible services are combined to deliver capability, access, performance, and results of a product without the need of ownership. This increases the utilization rates, as well as the efficacy of the deployed resources.	(Bocken et al., 2014, 2016; De Angelis, 2018; Erkman, 1997; European Commission, 2014; Franco, 2019; Glavič & Lukman, 2007; Lacy et al., 2020; Larsson, 2018; Lewandowski, 2016; Loiseau et al., 2016; Lüdeke-Freund et al., 2018; Moreno et al., 2016; Peter et al., 2015; Planing, 2015; Preston, 2012; Reichel et al., 2016; Rizos et al., 2017; Stahel, 2012, 2016; Tukker, 2004, 2015; van Beers et al., 2014)
a) **Result Oriented Services**	Solutions based on the sale of the desired outcome rather than the product that would allow so. The focus is on the function, not the product.	(Loiseau et al., 2016; Planing, 2015; Tukker, 2004, 2015; van Beers et al., 2014)
2.1 Pay per use/ Pay per service unit	One-off payment to access the service or the product functionality and performance. Payment model in which the more the customer uses the product, the more they pay.	(Bocken et al., 2014, 2016; De Angelis, 2018; EMF, 2013a; European Commission, 2014; Peter et al., 2015; Renswoude et al., 2015; Rizos et al., 2017; Stahel, 2012; Tukker, 2004)
2.2 Performance-based contracting	The customers' needs are met through a service that is hired instead of buying the product and performing the job themselves.	(Bocken et al., 2016; De Angelis, 2018; Lewandowski, 2016; A. B. Lovins et al., 1999; Peter et al., 2015; Remane et

		al., 2016; Renswoude et al., 2015; Rizos et al., 2017; Stahel, 2012)
b) Use Oriented Services	The physical product still has an important role, but the final goal is not its sale, but the access from the user. The product remains property of the supplier that makes it available under different propositions.	(Loiseau et al., 2016; Tukker, 2004, 2015; van Beers et al., 2014)
2.3 Leasing/ Lending	The product is provided by its owner that is responsible for its maintenance, repair, and control. The user pays in exchange of unlimited and exclusive use of the product for the agreed period of the paid fee/lease/rent (normally over a longer period).	(Bocken et al., 2014, 2016; De Angelis, 2018; EMF, 2013a, 2013b, 2015; Esposito et al., 2017; European Commission, 2014; Larsson, 2018; Lewandowski, 2016; Loiseau et al., 2016; Lüdeke-Freund et al., 2018; Peter et al., 2015; Preston, 2012; Rizos et al., 2017; Stahel, 2012, 2016; Tukker, 2004; van Beers et al., 2014)
2.4 Renting	Similar to the leasing model, the product is provided by its owner. The user pays for the use of the product for, normally periods of 30 days, but in a more flexible arrangement than if they were leasing. In this model, the user does not have guaranteed unlimited access to the product, as others can use the same product at other times – it is sequentially used by different users.	
2.5 Sharing (including Sharing Platforms)	The product remains the property of its owner/ supplier, but different users can use it in turns and, sequentially, just like when renting. It may be peer-to-peer, business-to-peer, B2B or public sharing of products. Normally the sharing model is focused on short-term transactions of services and products. This is enabled by using online platforms that connect owners and users.	(Bocken et al., 2014, 2016; De Angelis, 2018; EMF, 2013b, 2013a, 2015; Esposito et al., 2017; European Commission, 2014; Lacy et al., 2020; Larsson, 2018; Lewandowski, 2016; Loiseau et al., 2016; Lüdeke-Freund et al., 2018; Moreno et al., 2016; Peter et

			al., 2015; Preston, 2012; Renswoude et al., 2015; Rizos et al., 2017; Stahel, 2016; van Beers et al., 2014)
	2.6 Swapping/Bartering/Pooling/ Gifting/Borrowing	Models fostered by technology and peer-to-peer communities that allow for collaborative consumption and traditional old market behaviours to be reinvented. Based on more direct exchanges between consumers that share the use, access, or ownership of the product. Swapping/Bartering: synonyms that refer to the act of trading one good or service for another, in a negotiated, mutually beneficial, fair trade way, without the need for monetary exchange. Pooling: a supply of products or services made available for use by a group of consumers, thus minimizing their risk and maximizing their advantages. Very similar to renting/sharing. Gifting/Borrowing: underused or unwanted goods are exchanged between individuals or groups.	(EMF, 2013a; European Commission, 2014; Kiørboe et al., 2015; Lewandowski, 2016; Botsman and Rodgers, 2010 apud Preston, 2012; van Beers et al., 2014)
	3. Produce on Demand	These models integrate new technologies and more customised forms of production. The production of a good or the delivery of a service is only made when there is a need and demand to be fulfilled and products or services where ordered. The production is made in	(De Angelis, 2018; Larsson, 2018; Peter et al., 2015; Preston, 2012; Renswoude et al., 2015)

	near real time, therefore the need for large inventories and warehouses for storage is reduced or eliminated.	
3.1 Customer Vote (Design)	Consumers are asked to vote on which product to manufacture and subsequent production of the most voted product(s).	(De Angelis, 2018; Renswoude et al., 2015)
3.2 Design and Produce to Order	Design and consequent fabrication of products or specific parts on demand for each customer order. With this, over-stocking of products is avoided.	(De Angelis, 2018; Peter et al., 2015; Renswoude et al., 2015; WRAP UK, 2017)
3.3 3D Printing	This technology presents a new production method where resource efficacy is attained, and material waste is reduced to zero. It allows for bigger personalisation of products, without the need of a minimum production output. Reduces cost and time of transportation, design and development to market, as it leads to shorter and local value chains.	(De Angelis, 2018; Despeisse et al., 2017; EMF, 2015; Esposito et al., 2017; Larsson, 2018; Peter et al., 2015; Preston, 2012; Renswoude et al., 2015; Stahel, 2016)
4. Take-Back Management & Next-Life Sales	Based on the implementation of Reverse Supply Chains with customer involvement to ensure take-back actions that allow for posterior product-life extension (either by redistribution and/or reusage). Even if components need to be replaced or repaired, no new complete products are produced.	(Bocken et al., 2014; De Angelis, 2018; EMF, 2015; Lüdeke-Freund et al., 2018; Peter et al., 2015; Renswoude et al., 2015)
4.1 Second-hand (including Second-hand Platforms)	The product is given a second life by changing consumer, having the possibility to be re-sold several times, developing new resource flows for the original company or being the first revenue stream for the secondary one. Different and new customer segments are targeted, and the life span of the product is prolonged.	(EMF, 2013a, 2013b, 2015; Lüdeke-Freund et al., 2018; Peter et al., 2015)

	4.2 Buy-back, Refurbish and Resell	Products can be return or bought by other entity after an agreed period. When taken back, if needed, used products can be refurbished or improved -"just as new", before being sold again so that their new life is also extended. Thus, customers can use products with as-new quality.	(Achterberg et al., 2016; De Angelis, 2018; EMF, 2013a, 2015; European Commission, 2014; Lüdeke-Freund et al., 2018; Peter et al., 2015; Renswoude et al., 2015)
	4.3 Remanufacturing and Product Transformation	Product transformation through recovered materials and components. The remanufacturing process is more profound than refurbishing, since the product is transformed and/or upgraded, so that more value is added (better then new) and obsolescence is avoided. “Hence it involves dismantling, cleaning, checking, testing for compliance, replacing worn-out-parts and warranty promise. Often whole components (that are donated, bought-back, taken-back or saved from landfilling) are reused leading to material and cost savings.” (Lüdeke-Freund et al., 2018, p. 49)	(Achterberg et al., 2016; Damen, 2012; De Angelis, 2018; EMF, 2013a; European Commission, 2014; Lüdeke-Freund et al., 2018; Planing, 2015; Stahel, 2012)
	5. Repair & Maintenance: Extend Product Value	A **c) Product Oriented Service** model which is still mainly focused on the sale of products, where some extra services are added, as maintenance contracts, insurance, take-back agreements.	(Bocken et al., 2016; De Angelis, 2018; EMF, 2013a; Peter et al., 2015; Renswoude et al., 2015; Stahel, 2012)
	5.1 Product-Life Extension and Value Recovery	The product’s usage rate and duration are prolonged at the end of its first use, through activities as: reuse, repair, component reconditioning, upgrading and resale. If the product’s life cannot be extended, the residual value of its components and/or materials should be exploited.	(Achterberg et al., 2016; De Angelis, 2018; Lüdeke-Freund et al., 2018; Moreno et al., 2016; Peter et al., 2015; Rizos et al., 2017; Stahel, 2012)

5.2 Gap-Exploiter Model	Model that addresses a system failure (not provided by the original company) by providing a service (to the end-consumer or B2B) of repairing, refurbishing, remanufacturing and upgrading the items with a high level of quality or even guarantee on the replaced components. Up-to-date technology and great customer experience are essential.	(Bocken et al., 2016; European Commission, 2014; Lüdeke-Freund, 2010; Peter et al., 2015)
6. Classic Long-Life Model	Encourage efficiency by delivering products that last longer supported by design for durability and other factor as: responsible and slower production, premium branding or product, limited availability.	(Achterberg et al., 2016; Bocken et al., 2016; De Angelis, 2018; EMF, 2015; European Commission, 2014; Lüdeke-Freund et al., 2018; Moreno et al., 2016; Peter et al., 2015; Stahel, 2012)
6.1 High Levels of Warranties & implicit associated services of Maintenance and Repair	By making warranties last longer, products are designed with longer life spans from the start. This is also supported by after-sale repair and upgradability services to prolong product's life.	(Achterberg et al., 2016; De Angelis, 2018; Lüdeke-Freund et al., 2018; Peter et al., 2015)
6.2 Encourage Sufficiency	Selling low volumes of products with profitability ensured by a high price per item. The focus is to change end-user consumption patterns to consume less, waste less, and use products for longer. Maintenance and repair services are also offered to end-consumer.	(Achterberg et al., 2016; Bocken et al., 2014, 2016; De Angelis, 2018; Stahel, 2012)
6.3 Progressive Purchase	The consumer pays for the product or service in small amounts, periodically, before purchase. Like a lease-to-own programme, where the customer gets the item without a big upfront payment. Not confuse with progressive pricing.	(Lewandowski, 2016; Renswoude et al., 2015)

7. Pure Circles or Create Value from Waste	The concept of "waste" is eliminated by acknowledging it as resources, fully closing resource loops and mimicking Nature's operating system.	(Bocken et al., 2014; De Angelis, 2018; EMF, 2013a; Renswoude et al., 2015)
7.1 Circular Sourcing	Only materials and products that are fully circular, uncontaminated, safe and environmentally beneficial are sourced for production. This requires a 100% C2C product design approach to close material loops.	(Bocken et al., 2014; De Angelis, 2018; EMF, 2013a; Lacy et al., 2020; Renswoude et al., 2015)
7.2 Industrial Symbiosis	Collaborative sourcing & production model, where outputs of one industry are resources of another. If cooperation exists in the sourcing and production value chains, closing material loops will be enabled.	(Bocken et al., 2014, 2016; Lüdeke-Freund et al., 2018; Moreno et al., 2016; Peter et al., 2015; Reichel et al., 2016; Renswoude et al., 2015)
7.3 Eco-Industrial Parks	The practical application of the Industrial Symbiosis concept. Businesses are located in the same or nearby properties and work collaboratively in managing resources (by-products, energy, water, etc.) in close cycles.	(Bocken et al., 2014, 2016; Erkman, 1997; Loiseau et al., 2016; Lüdeke-Freund et al., 2018; Peter et al., 2015)
8. Waste Management: Waste as a resource	Models that operate the processes that prioritise the prevention, minimisation and elimination of material and energy waste. This includes monitoring of activities as: collection, transport, recovery and disposal of waste, as well as supervision and after-care of disposal sites, requiring a LCA understanding of products and services.	(Blomsma & Brennan, 2017; EMF, 2015; European Commission, 2014; Lüdeke-Freund et al., 2018; Peter et al., 2015; Pongrácz & Pohjola, 2004; Seadon, 2006)

8.1 Waste Handling and Processing	Process of treating and sorting waste depending on its origin and composition. Includes but is not limited to: monitoring, collection, transport, sorting of waste according to its origin and composition, disposal or forwarding of waste, so that other solutions as recovery, recycling or composting can be applied before landfilling or incineration.	(Esposito et al., 2017; Larsson, 2018; Lüdeke-Freund et al., 2018; Renswoude et al., 2015)
8.2 Waste/ Resource Redistribution	This model is the base of reuse (with or without treatments), refurbishing and remanufacturing schemes and dictates its success or failure. It ensures life-cycle expansion, as products are conducted to where they are needed, while used and re-used to their full potential, replacing or diminishing the need for raw materials and creating new value streams.	(EMF, 2013b, 2013a; Peter et al., 2015; Planing, 2015)
8.3 Cascading and Repurposing	Transformation of materials and components across different value streams (cascades) for consecutive, different use options by different users, firms and industries until its biological nutrients are reintroduced into Nature or if technical, moved to incineration or landfilling.	(EMF, 2013a, 2013b, 2015; Esposito et al., 2017; European Commission, 2014; Geisendorf & Pietrulla, 2018; Paras et al., 2019; Renswoude et al., 2015)
8.4 Recycling & Waste Management: Downcycling	When the recycling method reduces the quality of the material over time. Downcycling does not enable a fully circular system, only slowing the linear flow of resources from production to waste.	(Bocken et al., 2016; De Angelis, 2018; EMF, 2013a, 2013b; Lacy et al., 2020; McDonough & Braungart, 2002)
8.5 Recycling & Waste Management: Upcycling	Recycling process that converts used materials into materials of higher quality and improved functionality.	(Bocken et al., 2016; De Angelis, 2018; EMF, 2013a, 2013b; Lacy et al., 2020;

			Larsson, 2018; Peter et al., 2015; Preston, 2012; Renswoude et al., 2015)
	9. Dealing with Residuals	Once all cascades are explored and, before materials are scraped from the system, they can be turned into energy or transformed into feedstock that enters another system, supporting other manufacturing processes and replacing virgin materials that would be needed. These models do not include solely the process of turning a residual into feedstock, but also, to find appropriate new uses for it, transport from the generator to the user, dealing with regulations, amongst others.	(Ayres & Ayres, 2002; Chertow, 2000; J. Ehrenfeld & Gertler, 1997; European Commission, 2014; Lacy et al., 2020; Lüdeke-Freund et al., 2018; Planing, 2015; Reike et al., 2018; van Beers et al., 2014)
	9.1 Organic Feedstock	Residuals are broken down so they can be used as feedstock (raw material) and enter new production processes. This transformation returns biological materials back to Nature as nutrients.	(Chertow, 2000; De Angelis, 2018; EMF, 2013b; Henry et al., 2020; Lacy et al., 2020; Lüdeke-Freund et al., 2018; Moreno et al., 2016)
	9.2 Biomass Conversion	Method through which organic waste ("products, by-products, residuals and waste from agriculture, forestry and related industries, as well as the non-fertilized and biodegradable organic fractions of industrial and municipal wastes") is converted by gasification, combustion, liquefaction or pyrolysis into "non-fossilized and biodegradable organic material" such as liquid biofuels, biogas, alcohol fuels and other chemicals. (UNFCCC/CCNUCC, 2005) This closing the loop method is not fully clean and can lead to other problems as deforestation.	(Ayres & Ayres, 2002; De Angelis, 2018; EMF, 2013a, 2013b, 2015; European Commission, 2014; Frosch & Gallopoulos, 1989; Garba, 2020; Peter et al., 2015; Stern, 2009, 2007; UNFCCC/CCNUCC, 2005; WEF et al., 2014)

9.3 Anaerobic Digestion	Natural process through which microorganisms, as bacteria, break down/decompose organic waste (animal mature, wastewater bio sludge, food scraps) without the presence of oxygen, to create nutrient rich biofuels, biogases, bioenergy and fertilizers.	(Ayres et al., 1989; De Angelis, 2016, 2018; EMF, 2013a, 2013b, 2015; European Commission, 2014; Korhonen et al., 2018; Peter et al., 2015; Stern, 2009, 2007; WEF et al., 2014)
9.4 Composting	Disposed biological organic non-toxic matter decomposes naturally under oxygen-rich conditions (microorganisms as bacteria and fungi, as well as insects, snails and earthworms break down the organic materials) into a nutrient rich soil-like blend, that is returned to Nature, closing the loop.	(Ayres & Ayres, 2002; De Angelis, 2016, 2018; EMF, 2013a, 2013b, 2015; European Commission, 2014; Lüdeke-Freund et al., 2018; Peter et al., 2015; Stern, 2009; WEF et al., 2014)
9.5 Fertilizer Production	Biological residual products and waste are processed into useful products such as organic fertilizers.	(Ayres & Ayres, 2002; Esposito et al., 2017; Lüdeke-Freund et al., 2018; van Beers et al., 2014)
9.6 Bio-based materials	These materials use "substances derived from living organisms to produce new materials. These substances can include biopolymers and other natural fibres created partially or wholly by using plant feedstock" (Lacy et al., 2020, p. 50).	(Lacy et al., 2020; Larsson, 2018)
9.7 Energy from Waste (EfW) or Waste-to-Energy	The last option to prevent materials to go to landfill is to recover the energy still present in them. Energy can be recovered from biological waste to bioenergy or from non-recyclable waste. These processes include the generation of energy (heat, electricity, fuel) via waste combustion, gasification, pyrolysis, biomass conversion,	(Ayres & Ayres, 2002; Blomsma & Brennan, 2017; Chertow, 2000; EMF, 2013b, 2013a; Esposito et al., 2017; European Commission, 2014; Garba, 2020; Lacy et al., 2020; Peter et al.,

		anaerobic digestion, or landfill gas recovery, ideally in combination with carbon capture and utilization technology.	2015; Planing, 2015; Reike et al., 2018; van Beers et al., 2014)
	10. System Scraping	Total disposal/destruction of residues so that they "cease to exist". When no other options are available, the materials can be sent to landfill or scrapped from the system by incineration.	(EMF, 2013a, 2013b; Lacy et al., 2020)

APPENDIX E : Questionnaire on Circular Business Models and Circular Design Strategies applied by Portuguese Fashion and Textile Companies

Questionnaire on Circular Business Models and Circular Design Strategies applied by Portuguese Fashion and Textile Companies

Section 1 // Informed Consent

The present study derives from a research project for the elaboration of a Master's thesis in the scope of the Master in Business Management at Iscte - Instituto Universitário de Lisboa. The study aims to evaluate how the transition process from a Linear Business Model to a Circular Economy Business Model can take place in the context of the Fashion and Textiles Industry.

The study is being conducted by Madalena Martins, who may be contacted through the following e- mail address: mascm1@iscte-iul.pt, if you have any questions or comments.

Your participation in the study will be highly valued, as it will contribute to the progress and knowledge in this field of science, consisting in answering to this questionnaire. This descriptive questionnaire, which will serve as a complement to the main case study, aims to be a purely descriptive survey of the Circular Business Models and Circular Design Strategies that are being applied by companies in the Portuguese Fashion and Textile Industry.

As advisors of the Master's dissertation in which the present study is included, Professors Ana Margarida Madureira Simaens (Assistant Professor, Department of Marketing, Operations and General Management, Iscte Business School - Iscte) and Carla Cristina da Costa Pereira (Assistant Professor, Department of Technologies in Architecture, Urbanism and Design, Faculty of Architecture - University of Lisbon) will also have access to the information collected and resulting analysis.

Being part of a Master's dissertation, the study will be publicly accessible in the Scientific Repository of Iscte. The analysis of the answers obtained in the questionnaire will be done as a whole, so the participating organisations will not be identified.

The participation in the study is strictly voluntary: you may freely choose to participate or not. If you have chosen to participate, you may interrupt the participation at any time without having to provide any justification. By proceeding to answer the questionnaire, you state that you have understood the objectives of what was proposed to you, and so you agree to participate in this study.

E-mail:

Section 2 // General Information about the Company

Name of the Company:

Country Region:

- Região Autónoma da Madeira
- Região Autónoma dos Açores
- Norte
- Lisboa e Vale do Tejo
- Centro
- Alentejo
- Algarve

Number of Employees:

- 1-10 (micro company)
- 10-50 (small company)
- 50-250 (medium company)
- ≥ 250 (large company)

Activity Sector:

- Design and Product Development
- Raw Materials Production
- Manufacture of textiles Preparation and Spinning of Textile Fibres
- Manufacture of textiles: Weaving of textiles
- Manufacture of textiles: Knitting
- Manufacture of textiles: Textile finishing (bleaching, dyeing, printing, texturising, etc.)
- Apparel Manufacturing
- Transport
- Retail and Online Sales
- Product Marketing
- Post-Sales
- Collection, Sorting and Recycling
- Research
- Other option: (add option here)

Section 3 // Circular Product Design Strategies:

From the following Circular Product Design strategies, please select the ones being applied in your company.

The strategies fall into two main groups:

- Design for integrity/conservation:

A. Design for long-life products or design for longevity/ classic long-life

B. Design for product life extension or value recovery

- Design for material recovery:

C. Design for Technical Cycles - Using technical nutrients (e.g., synthetic, mineral materials)

D. Design for Biological Cycles - Using biological nutrients (e.g., organic, plant-based materials)

A. Design for long-life products or design for longevity/ classic long-life

- Attachment & trust;
- Reliability & durability;
- High levels of guarantees and services;
- Design for buy back and re-use;
- Provision of spare parts & adaptability to easy repair & value retain;
- Refurbish and resell.
- None of the above mentioned options (make sure that no option above is selected)

B. Design for product life extension or value recovery

- Design for buy back and re-use;
- Maintenance & repair;
- Upgradability & adaptability;
- Standardization & compatibility/modular design;
- Dis- & reassembly;
- Re-manufacture (via recaptured components);
- Provision of spare parts & adaptability to easy repair & value retain;
- Refurbish and resell.
- None of the above mentioned options (make sure that no option above is selected)

C. Design for Technical Cycles - Using technical nutrients (e.g., synthetic, mineral materials)

- Recycle (upcycle and downcycle);
- Repurpose;
- Re-manufacture (via recaptured materials);
- Less-resource intensive or fully recyclable materials/products.
- None of the above mentioned options (make sure that no option above is selected)

D. Design for Biological Cycles - Using biological nutrients (e.g., organic, plant-based materials)

- Biodegradability and Compost;
- Recycle (upcycle and downcycle);
- Circular bio-based re-captured materials;
- Less-resource intensive or fully recyclable materials/products.
- None of the above mentioned options (make sure that no option above is selected)

Section 4 // Circular Business Models

Circular Economy, in practice, materialises in the construction and application of Circular Business Models. The list presented starts with Circular Business Models and sub-models based on offering services, thus requiring fewer resources to manufacture physical products. As we move further down the list, the level of ownership increases, as does the need for resources and materials. Finally, models are presented that use the waste of the former, as resources to create value and reintegrate it back into the system until they are eliminated, as there are no more cascading options available, for this reintegration to be done.

So, from the following Circular Business Models, please select the ones that are being applied in your company.

1. **DAppendix M, Figure M Services** (Based purely on service offerings that do not require the purchase of a physical product, reducing the need for raw materials.)
   - **1.1 Physical to Digital** (Utility is provided through virtual products and services.)
   - **1.2 Subscription-based Rental** (Product or Service access and use for a period over a periodic fee.)
   - None of the above mentioned options (make sure that no option above is selected)

2. **Access and Performance Models or Product Service Systems (PSS)/ Product as a Service / Servitization** (Not necessarily digital, these collaborative consumption-based models deliver access, performance and results of a product without the need for ownership.)
   - **2.1 Result Oriented Services: Pay per use/ Pay per service unit** (One-off payment to access the service or product. The more the customer uses the product, the more they pay.)
   - **2.2 Result Oriented Services: Performance-based contracting** (Customer needs are met through a service that is hired).
   - **2.3 Use Oriented Services: Leasing/ Lending** (The user pays for unlimited and exclusive use of the product for the agreed period - normally over a long period.)

- **2.4 Use Oriented Services: Renting** (Similar to leasing model, but more flexible - with no unlimited use, usually for 30 days. The product is used sequentially by different users.)
- **2.5 Use Oriented Services: Sharing** (including Sharing Platforms) (The product remains the supplier's, but different users may use it in turns. Focuses on short-term transactions of services and products, where use is not exclusive.)
- **2.6 Use Oriented Services: Swapping/Bartering/Pooling/Gifting/Borrowing** (Fostered by technology and peer-to-peer communities, that allow for collaborative consumption and traditional old market behaviours to be reinvented, based on direct exchanges between consumers.)
- None of the above mentioned options (make sure that no option above is selected)

3. **Produce on Demand** (These models integrate new technologies and more customised forms of production, when there is a need and demand to be fulfilled).
   - **3.1 Customer Vote (Design)** (Consumers vote for a product and subsequent production of the most voted product(s).)
   - **3.2 Design and Produce to Order**
   - **3.3 3D Printing**
   - None of the above mentioned options (make sure that no option above is selected)

4. **Take-Back Management & Next-Life Sales** (Based on the implementation of "Reverse Supply Chains" with customer involvement in take-back actions that allow for posterior product-life extension - either by redistribution, reuse, repair or transformation.)
   - **4.1 Second-hand (including Second-hand Platforms)** (The product is given a second life, through resale.)
   - **4.2 Buy-back, Refurbish and Resell** (When taken back, used products are refurbished or improved - "just as new" - before being resold.)
   - **4.3 Remanufacturing and Product Transformation** (Product transformation through recovered materials and components. Deeper process than refurbishment: the product is transformed and/or upgraded, so that more value is added (better than new) and obsolescence is avoided).
   - None of the above mentioned options (make sure that no option above is selected)

5. **Repair & Maintenance: Extend Product Value** (Models still focused on the sale of products, but where extra services are added: maintenance contracts, insurance, take-back agreements.)
   - **5.1 Product-Life Extension and Value Recovery** (The product's usage rate is increased through: reuse, repair, component reconditioning, improvement, upgrading and resale. If the

product's life cannot be extended, the residual value of its components and/or materials should be exploited.)

- **5.2 Gap-Exploiter Model** (Model that addresses a system failure (not provided by the original company) by providing a service (to the end-consumer or B2B) of repairing, refurbishing, remanufacturing and upgrading the items with a high level of quality or even guarantee on the replaced components.)
- None of the above mentioned options (make sure that no option above is selected)

6. **Classic Long-Life Model** (Encouraging efficiency through products that last longer, supported by durability, quality, responsible and slower production, premium brand or product, limited availability.)
   - **6.1 High Levels of Warranties & Implicit Associated Services of Maintenance and Repair**
   - **6.2 Encourage Sufficiency** (Selling low volumes of products for a high price per item. The focus is to change end-user consumption patterns to consume less, waste less, and use products for longer.)
   - **6.3 Progressive Purchase (**The consumer pays for the product or service in small amounts periodically before purchase. The customer receives the item without a big upfront payment. Not confuse with progressive pricing.)
   - None of the above mentioned options (make sure that no option above is selected)

7. **Pure Circles or Create Value from Waste** (The concept of "waste" is eliminated by acknowledging it as resources, fully closing resource loops and mimicking Nature.)
   - **7.1 Circular Sourcing** (Only circular, uncontaminated, safe and environmentally beneficial materials and products are sourced for production.)
   - **7.2 Industrial Symbiosis** (Collaborative sourcing and production model, where one industry's outputs' are another's resource.)
   - **7.3 Eco-Industrial Parks** (The practical application of the Industrial Symbiosis concept. Geographically close companies work on managing resources (by-products, energy, water, etc.) in closed cycles.)
   - None of the above mentioned options (make sure that no option above is selected)

8. **Waste Management: Waste as a resource** (Models that prioritise the prevention, minimisation and elimination of material and energy waste. They include monitoring of activities such as: collection, transport, recovery and disposal of waste.)

- **8.1 Waste Handling and Processing** (Includes but is not limited to: monitoring, collection, transport, sorting of waste according to its origin and composition and disposal of waste so that recovery, recycling or composting can be applied before landfilling or incineration.)
- **8.2 Waste/ Resource Redistribution** (Model that ensures the products' life-cycle expansion, which are conducted to where they are needed, then refurbished, remanufactured and reused, diminishing the need for raw materials and creating new value streams.)
- **8.3 Cascading** (re-introduction of waste into the system, through different value creation streams - cascades) **and Repurposing** (by different users, firms and industries until its biological nutrients are reintroduced into Nature or, if technical, moved to incineration or landfilling.)
- **8.4 Recycling & Waste Management: Downcycling** (When the recycling method reduces the quality of the material. Downcycling does not enable a fully circular system, only slowing down the linear flow of resources.)
- **8.5 Recycling & Waste Management: Upcycling** (Recycling process that converts used materials into materials of higher quality and better functionality.)
- None of the above mentioned options (make sure that no option above is selected)

9. **Dealing with Residuals** (All cascades are exploited and, before the materials are scraped from the system, they can be turned into energy or raw material – feedstock.)
   - **9.1 Organic Feedstock** (Residuals are broken down so they can be used as feedstock (raw material) and enter new production processes or as nutrients returned to Nature.)
   - **9.2 Biomass Conversion** (Organic waste is converted into non-fossil and biodegradable organic matter such as liquid biofuels, biogas, alcohol fuels and other chemicals.)
   - **9.3 Anaerobic Digestion** (Natural process through which microorganisms, such as bacteria, break down organic waste without the presence of oxygen, to create biofuels, biogases, bioenergy and fertilizers.)
   - **9.4 Composting** (Biological non-toxic organic matter decomposes naturally under oxygen-rich conditions into a nutrient-rich soil-like blend that is returned to Nature.)
   - **9.5 Fertilizer Production** (Biological residual products are processed into useful products such as fertilizers.)
   - **9.6 Bio-based materials** (These materials can include biopolymers and other natural fibres through the use of plant feedstock.)
   - **9.7 Energy from Waste (EfW) or Waste-to-Energy** (Last option to prevent materials going to landfill is to recover the energy present in them, ideally in combination with carbon capture and use.)
   - None of the above mentioned options (make sure that no option above is selected)

10. System Scraping

- **10. Total disposal/destruction of residues so that they "cease to exist".** (When no other options are available, the materials can be sent to landfill or scrapped from the system by incineration.)
- None of the above mentioned options (make sure that no option above is selected)

Notes:

[1]The present questionnaire was conducted in Portuguese and later translated to English, based on the Literature Review information gathered on: Appendix C, Table 3 and Appendix D, Table 4.

[2]**Country Regions:** nomenclature based on the CCDR (*Comissões de Coordenação e Desenvolvimento Regional*) which replaced the *Direções Regionais*, plus Autonomous Regions.

[3]**Number of employees:** division based on the Portuguese *Decreto-Lei* 372/2007, of 6th November, which stipulates the division into categories of SME's, available on INE's (*Instituto Nacional de Estatística*) website.

[4]**Activity Sector**: division based on the references: (Direção-Geral das Atividades Económicas, 2018; EMF, 2013b; Global Fashion Agenda & McKinsey&Company, 2020; Koszewska, 2018; Quantis, 2018)

[5]As some sub-models' names are self-explanatory, a definition was not presented.

APPENDIX F : TINTEX Value Chain Interviewed Companies

TINTEX Value Chain Interviewed Companies

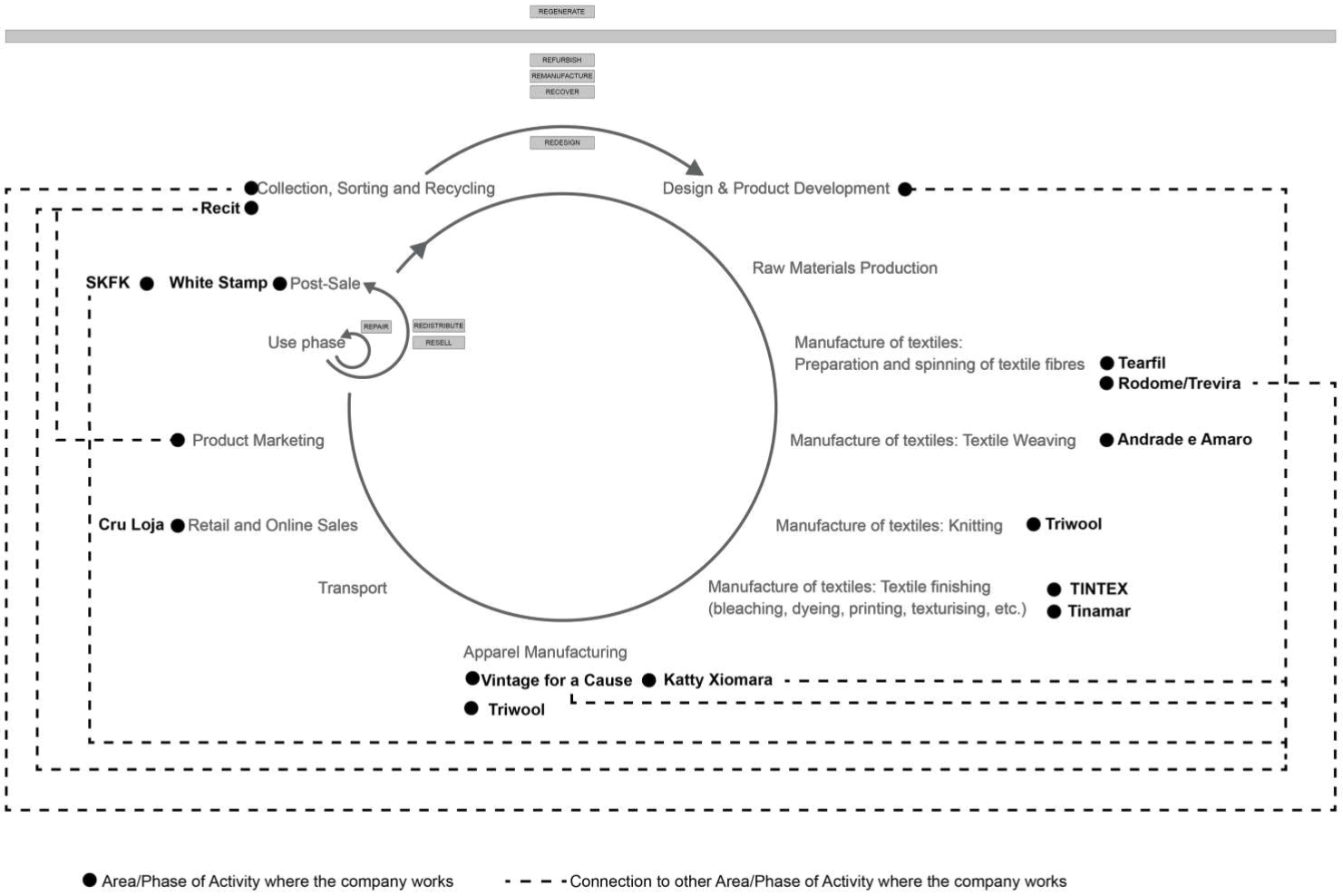

Figure F.1 - *TINTEX Value Chain Links Within A Circular Economic Model (Source: Author, based on the literature* (Blomsma & Brennan, 2017; Stahel, 2016))

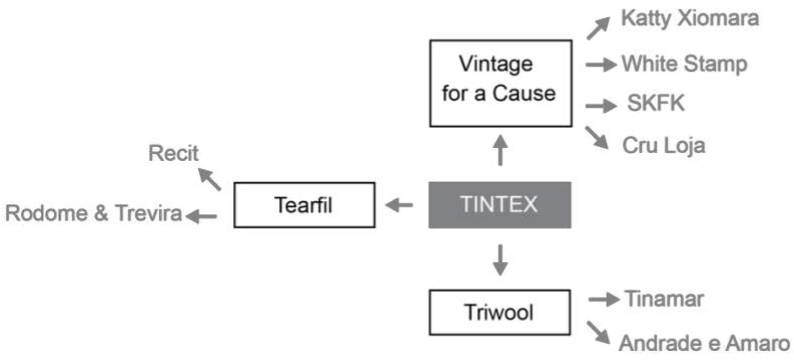

Figure F.2 *// TINTEX Value Chain Interviewed Companies (Source: Author)*

APPENDIX G : Interviews Informed Consent

Interviews Informed Consent

The present study derives from a research project for the elaboration of a Master's thesis in the scope of the Master in Business Management at Iscte - Instituto Universitário de Lisboa. The study aims to evaluate how the transition process from a Linear Business Model to a Circular Economy Business Model can take place in the context of the Fashion and Textiles Industry. The study is being conducted by Madalena Martins, who may be contacted through the following e-mail address: mascm1@iscte-iul.pt, if you have any questions or comments.

Your participation in the study will be highly valued, as it will contribute to the progress and knowledge in this field of science, consisting in the realization of a semi-structured interview, under written form or recorded via video or phone call. Questions will be asked according to the case study and subsequently the data will be collected after consent for the development of the intended analysis. There are no significant expected risks associated with the participation in the study.

As advisors of the Master's dissertation in which the present study is included, Professors Ana Margarida Madureira Simaens (Assistant Professor, Department of Marketing, Operations and General Management, Iscte Business School - Iscte) and Carla Cristina da Costa Pereira (Assistant Professor, Department of Technologies in Architecture, Urbanism and Design, Faculty of Architecture - University of Lisbon) will also have access to the information collected and resulting analysis.

Being part of a Master's dissertation, the study will be publicly accessible in the Scientific Repository of Iscte. The participation in the study is strictly voluntary: you may freely choose to participate or not. If you have chosen to participate, you may interrupt the participation at any time without having to provide any justification.

I declare to have understood the objectives of what was proposed to me, and to have been given the opportunity to ask all the questions about the present study and for all of them to have obtained an enlightening answer, so I agree to participate in this study. I have been given a copy of this consent document.

_____(local), ___ /_____/_____ (date)

Name: _____

Signature:_____

APPENDIX H : Interview Script TINTEX Textiles

Interview Script TINTEX Textiles

Q1// According to the company's chronology, over the years TINTEX has invested to be at the forefront of the transformation to a more sustainable Industry, with, for example, the integration of the GOTS certification, the involvement with the EMF's Make Fashion Circular initiative and, more recently, the partnership with Quinta do Soalheiro and Nespresso in the use of waste. How have the Sustainability concerns the company has relatively to the Fashion and Textiles Industry been reflected in the company's processes and strategies over the years?

Q2// What are some of the processes, strategies and (circular) business models that the company is applying that contribute to close the loop and for the transformation of the company closer to a CE?

Q3// In the process of incorporating Sustainability, and transform to a CE, how important was/and is innovation and BMI, as enablers of CBMs and consequentially of a CE in the FTI?

Q4// What were the drivers (internal necessity, pressure from the Industry, from the consumers, from being a competitive advantage) and the challenges you faced/are facing in the transition process,/constructing a circular business (being integrated in an overall linear industry and system)?

Q5// How does this transformation occurs in practice and what are the effects on the performance of TINTEX (including investment, costs, profits), processes, supply chains and innovation systems within the FTI?

The collaborative mindset and supply chain overview is key to the application of a CE and surges as a possible route for the FTI to remain economically competitive.(Homrich et al., 2018).

Q6// What is the importance of partnerships for the transition to happen, not only with other businesses but also with other players as schools, universities, research centres, the government and other regulators?

Q7// To what extent do you think the fashion industry and companies (in Portugal and worldwide) would be open to collaborate with other companies and industries? Is this already happening?

Q8// TINTEX is on the middle of the supply chain, influencing all the others that follow and precede them. How do you influence your partners? Can you name your main upstream and downstream partners? How do your partners influence your activity?

Q9// Is Portugal a factor/element that can influence – either by helping or undermining/harming CE implementation and have a context advantage in the transition?

Q10// What is needed to enable CBMs and circularity at scale? Do you think there is advanced enough technology, of machines, procedures, process and materials to transform the industry? What do you think are the most important technological advances in the years to come?

Notes:

[1]The present interview was conducted in Portuguese, as it was the mother language of either the interviewer and the interviewee and later translated to English.

APPENDIX I : Interview Script - First level companies

Interview Script - First level companies (Vintage for a Cause; Triwool; Tearfil)

Q1// What is your company's connection (supplier, buyer, etc.) with TINTEX?

Q2// How does TINTEX's business model, sustainable and circular strategies influence your own?

Q3// What are some of the processes, strategies and (circular) business models that the company is applying that contribute to close the loop and for the transformation of the company closer to a CE?

Q4// How does your business model (even if not circular) influences the one of TINTEX?

Q5// How does your business model influences the ones of your partner companies (already at a second level of stakeholders)?

Q6// Can you name your main upstream and downstream partners? How do your partners influence your activity?

Q7// What is needed to enable CBMs and circularity at scale? Do you think there is advanced enough technology, of machines, procedures, process and materials to transform the industry? What do you think are the most important technological advances in the years to come?

Notes:

[1]The present interview was conducted in Portuguese, as it was the mother language of either the interviewer and the interviewee and later translated to English.

Notes:

[1]The present interview was conducted in Portuguese, as it was the mother language of either the interviewer and the interviewee and later translated to English.

APPENDIX J : Interview Script - Second level companies

Interview Script - Second level companies (SKFK; Katty Xiomara; White Stamp; Cru Loja; Andrade e Amaro; Tinamar; Recit; Rodome/Trevira)

Q1// What is your company's connection (supplier, buyer, etc.) with Vintage for a Cause?

Q2// Does your company have any connection with TINTEX?

Q3//

1. If so, what is the connection and how does TINTEX's business model, sustainable and circular strategies influence your own?
2. If you do not have any direct business connection with TINTEX, do you know that you are connected through the supply chain? Do you have any idea if TINTEX's business model influences your own, even if your company does not have direct contact with TINTEX?

Q4// What are some of the processes, strategies and (circular) business models that the company is applying that contribute to close the loop and for the transformation of the company closer to a CE?

Q5// How does your business model influences the ones of your partner companies (already at a second level of stakeholders) ?

Q6// What is needed to enable CBMs and circularity at scale? Do you think there is advanced enough technology, of machines, procedures, process and materials to transform the industry? What do you think are the most important technological advances in the years to come?

Notes:

[1]The present interview was conducted in Portuguese (with the exception for SKFK, that was in English), as it was the mother language of either the interviewer and the interviewee and later translated to English.

APPENDIX K : Overall Interviews' Description

Table 5 - *Overall Interviews' Description (Source: Author)*

Company Name	***Company's Nationality***	***Interviewee Job Position***	***Interview Platform***	***Interview Duration***
TINTEX	Portuguese	Head of Product	On site; recorded	60 min
Vintage for a Cause	Portuguese	CEO & Founder	Online Platform	27 min
Triwool	Portuguese	Compliance Supervisor	Recorded Phone Call	21 min
Tearfil	Portuguese	Sales & Marketing Director	Written Format	N/A
SKFK	Spanish	Founder & Director	Written Format	N/A
Katty Xiomara	Portuguese	Owner & Fashion Designer	Written Format	N/A
White Stamp	Portuguese	CEO & Founder	Online Platform	30 min
Cru Loja	Portuguese	Owner & Manager	Online Platform	23 min
Andrade e Amaro	Portuguese	N/A	Online Platform	12 min
Tinamar	Portuguese	Group Administrator	Recorded Phone Call	14 min
Recit	Portuguese	Owner & Engineer	Online Platform	37 min
Rodome/Trevira	Portuguese	CEO/Country Manager	Online Platform	20 min

APPENDIX L : MAXQDA Software Usage for Data Analysis Print Screen Examples

MAXQDA Software Usage for Data Analysis Print Screen Examples

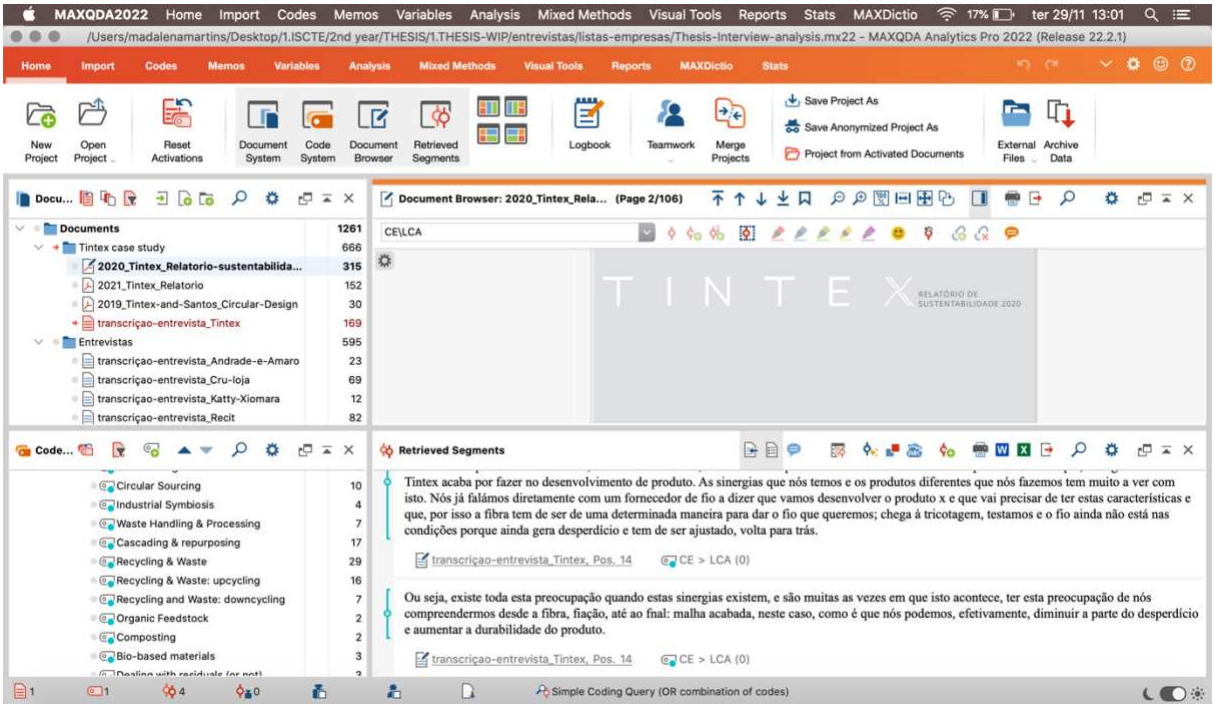

Figure L.1 - *MAXQDA Software Usage for Data Analysis Print Screen Example (1) (Source: Author)*

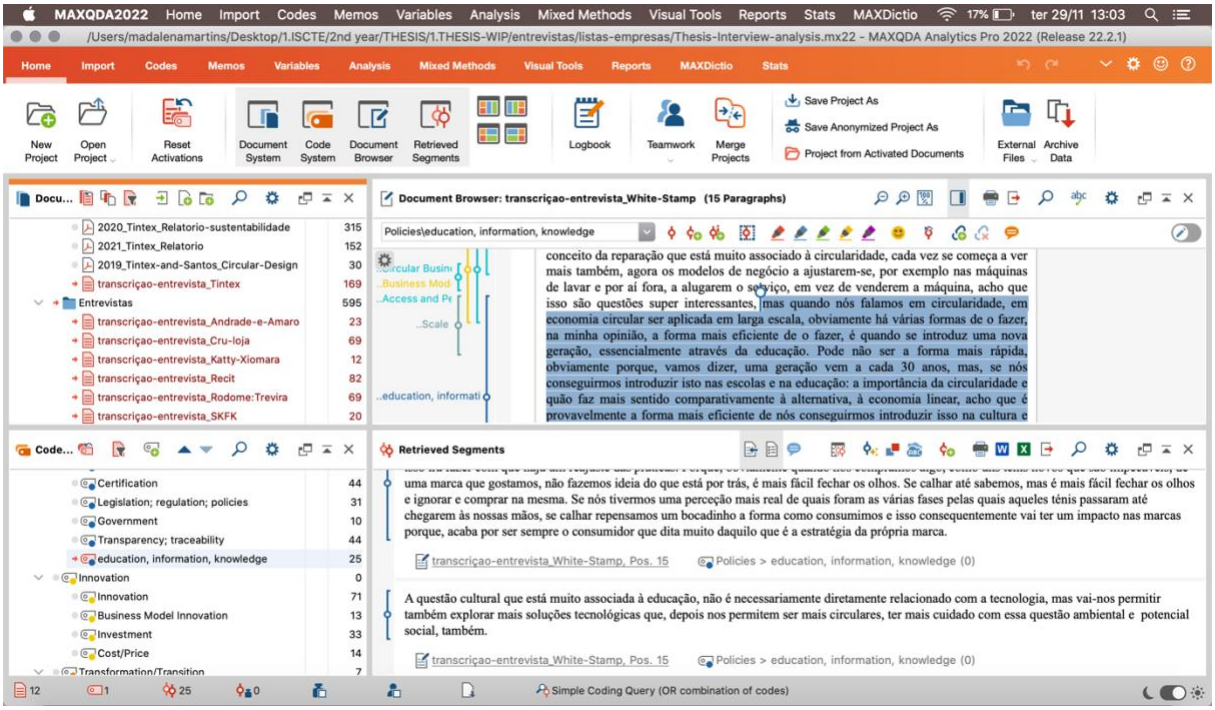

Figure L.2 - *MAXQDA Software Usage for Data Analysis Print Screen Example (2) (Source: Author)*

APPENDIX M : Data Results from the Questionnaire on Circular Business Models and Circular Design Strategies applied by Portuguese Fashion and Textile Companies

Data Results from the Questionnaire on Circular Business Models and Circular Design Strategies applied by Portuguese Fashion and Textile Companies (Appendix E) (Source: Author)

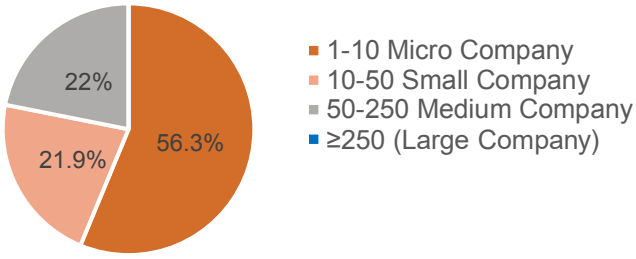

Figure M.1 - *Number of Employees and Company Size of the Portuguese FTI Sample (Source: Author)*

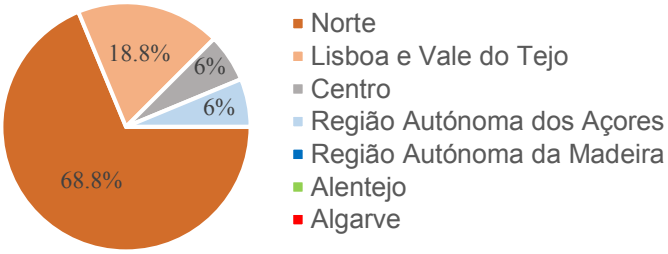

Figure M.2 - *Country Region of FTI Companies Sample Operating in Portugal (Source: Author)*

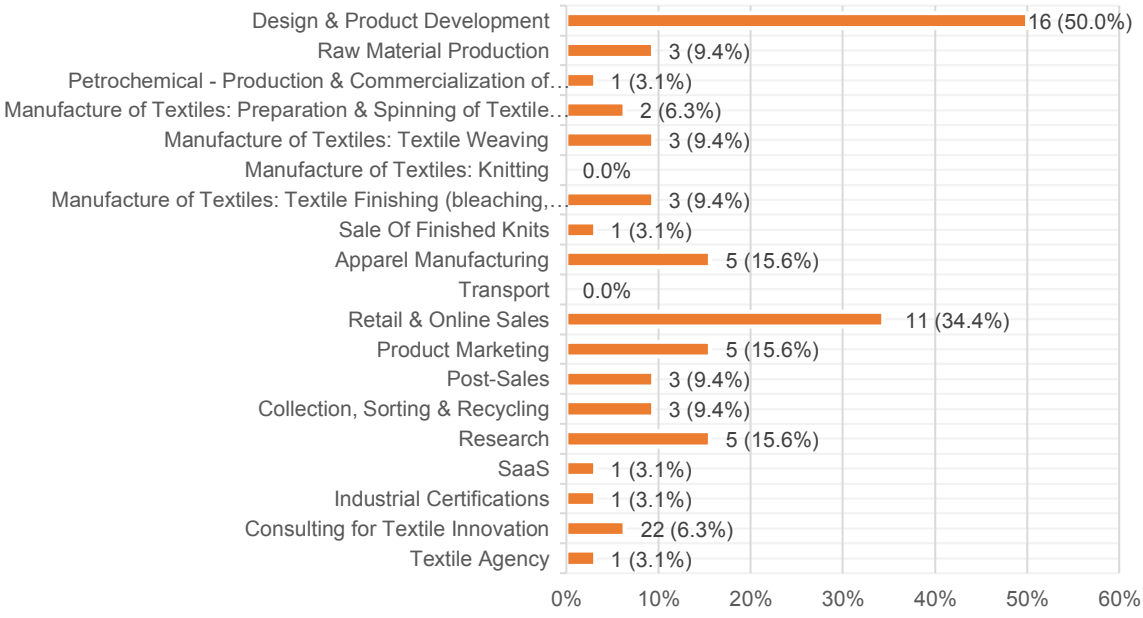

Figure M.3 - *Sector of Activity of Portuguese FTI Companies Sample (Source: Author)*

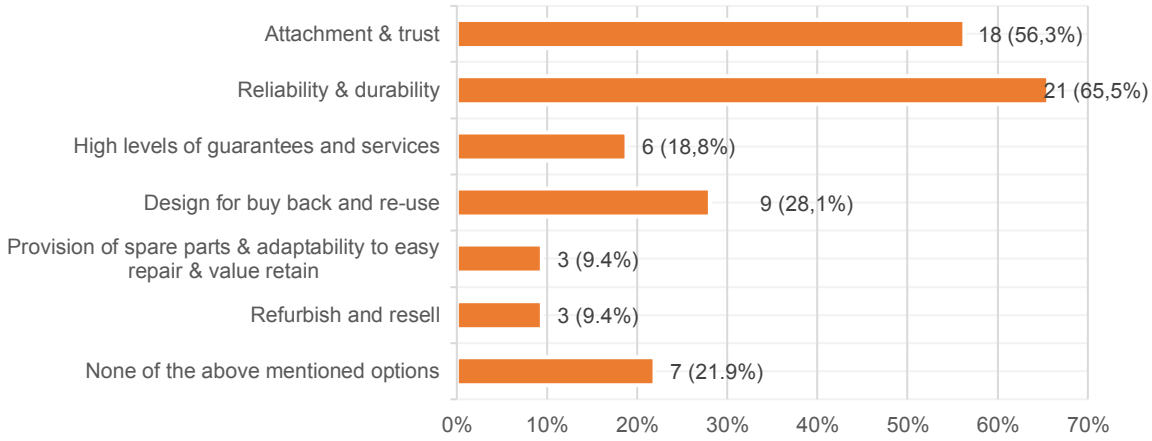

Figure M.4 - *Portuguese FTI Companies Sample Application of Circular Product Design Strategies: A. Design for Long-Life Products or Design for Longevity/ Classic Long-Life (Source: Author)*

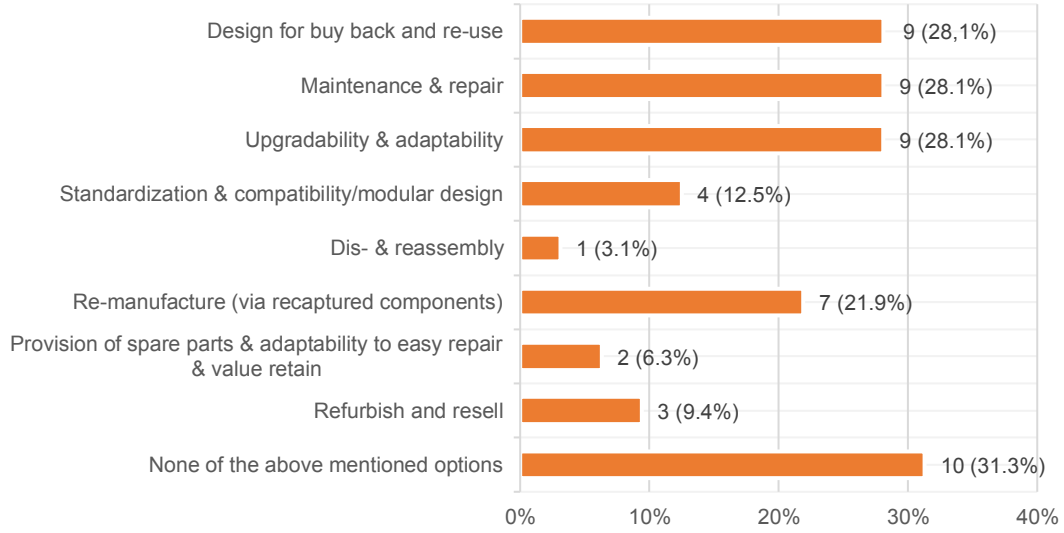

Figure M.5 - *Portuguese FTI Companies Sample Application of Circular Product Design Strategies: B. Design for Product Life Extension or Value Recovery (Source: Author)*

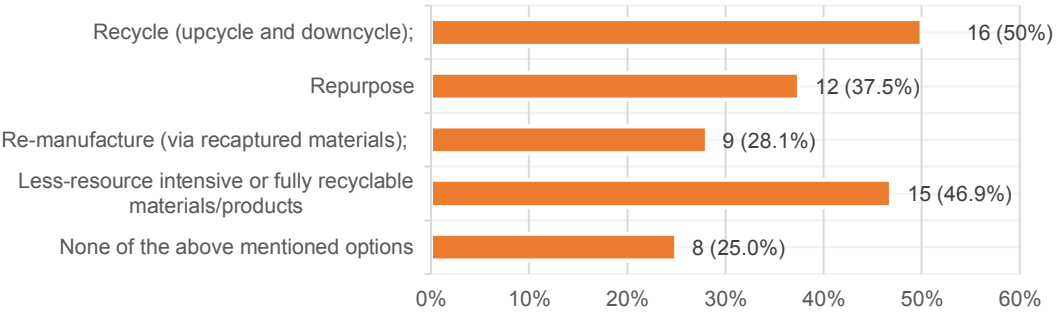

Figure M.6 - *Portuguese FTI Companies Sample Application of Circular Product Design Strategies: C. Design for Technical Cycles - Using Technical Nutrients (e.g., Synthetic, Mineral Materials) (Source: Author)*

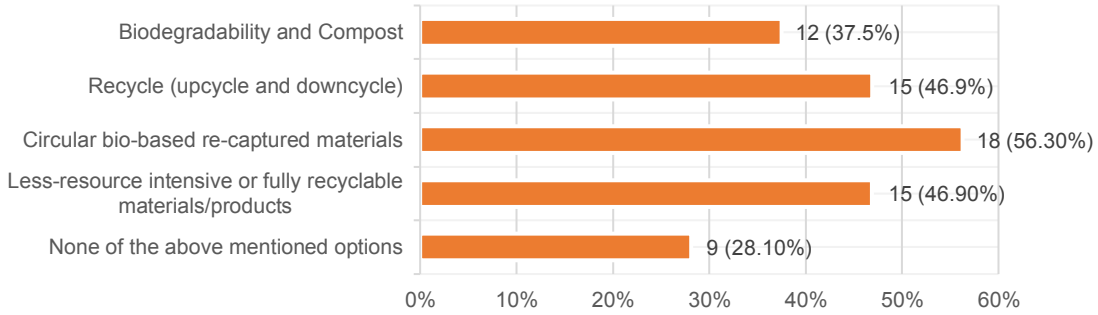

Figure M.7 - *Portuguese FTI Companies Sample Application of Circular Product Design Strategies: D. Design for Biological Cycles - Using Biological Nutrients (e.g., Organic, Plant-based Materials) (Source: Author)*

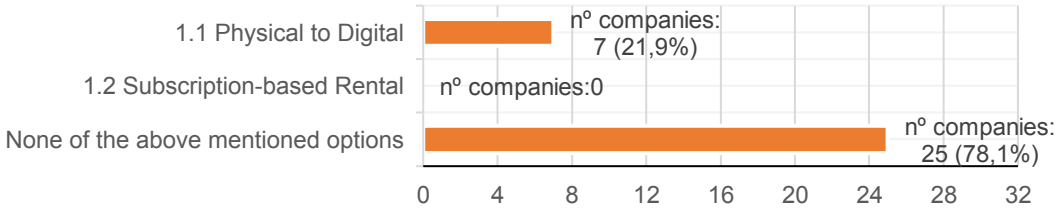

Figure M.8 - *Portuguese FTI Companies Sample Application of CBMs: 1. Dematerialised Services (Source: Author)*

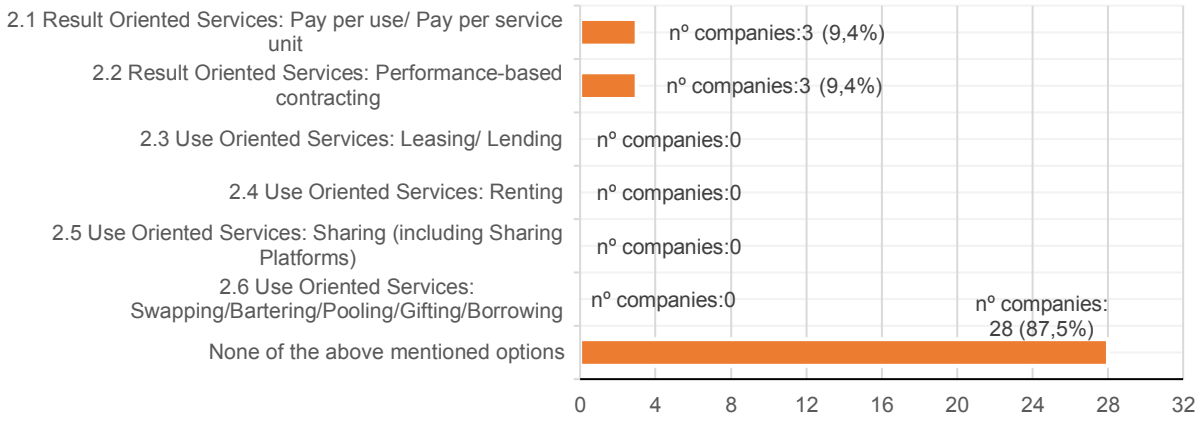

Figure M.9 - *Portuguese FTI Companies Sample Application of CBMs:*

2. Access and Performance Models or Product Service Systems (PSS)/ Product as a Service / Servitization (Source: Author)

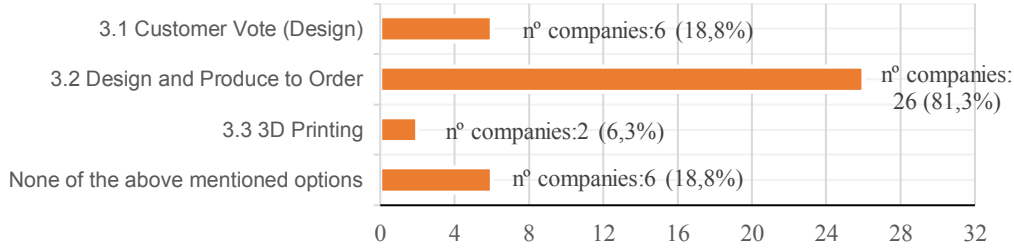

Figure M.10 - *Portuguese FTI Companies Sample Application of CBMs:*

3. Produce on Demand (Source: Author)

Figure M.11 - *Portuguese FTI Companies Sample Application of CBMs:*

4. Take-Back Management & Next-Life Sales (Source: Author)

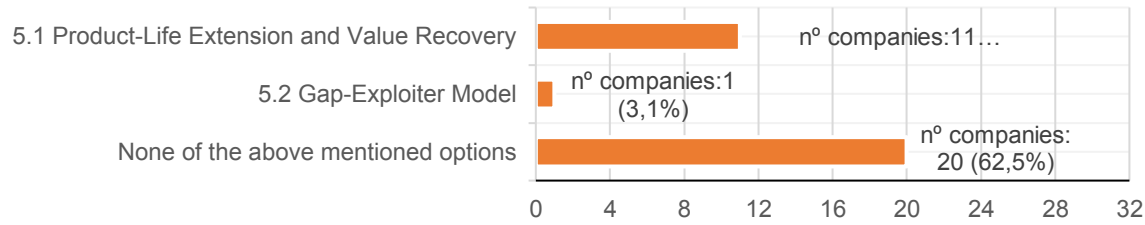

Figure M.12 - *Portuguese FTI Companies Sample Application of CBMs: 5.Repair & Maintenance: Extend Product Value (Source: Author)*

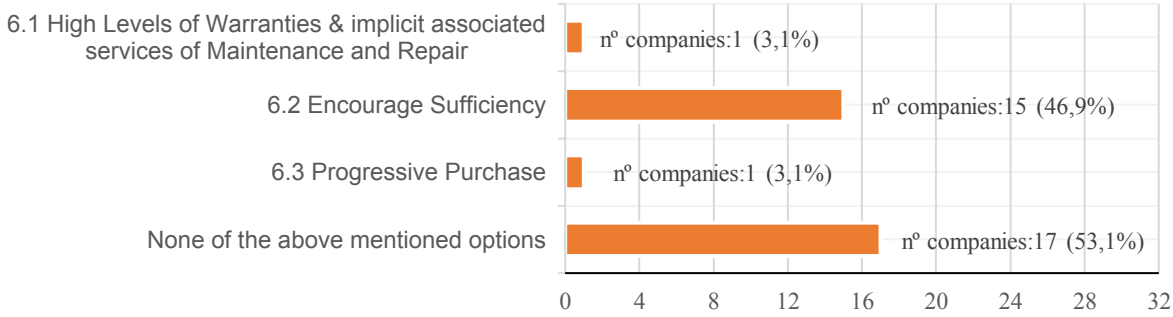

Figure M.13 - *Portuguese FTI Companies Sample Application of CBMs: 6. Classic Long-Life Model (Source: Author)*

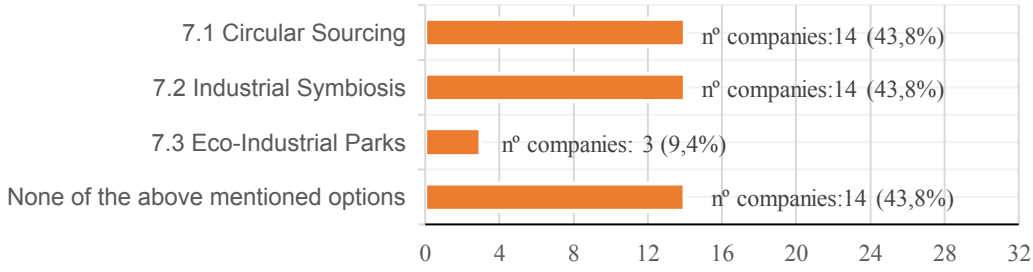

Figure M.14 - *Portuguese FTI Companies Sample Application of CBMs: 7. Pure Circles or Create Value from Waste (Source: Author)*

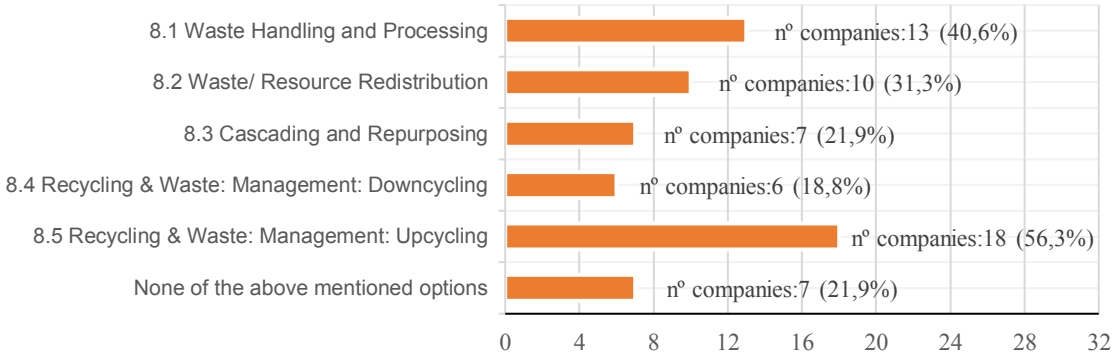

Figure M.15 - *Portuguese FTI Companies Sample Application of CBMs: 8. Waste Management: Waste as a Resource (Source: Author)*

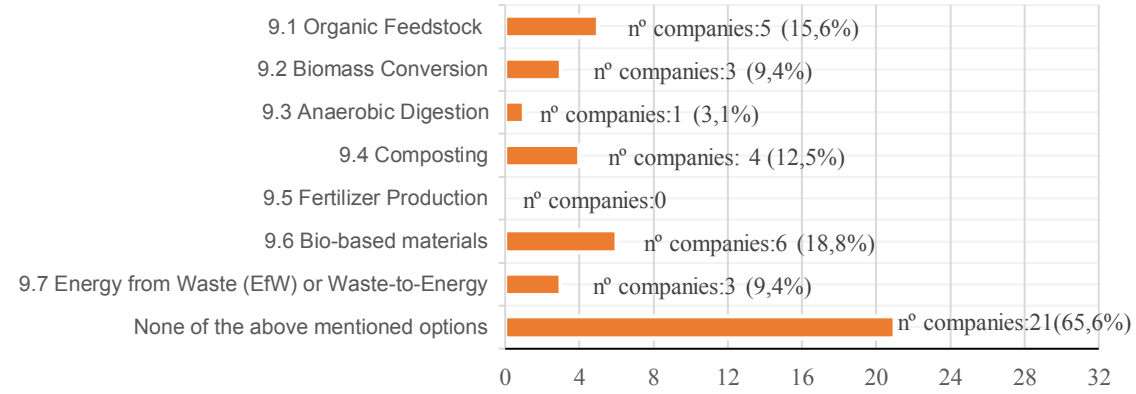

Figure M.16 - *Portuguese FTI Companies Sample Application of CBMs: 9. Dealing with Residuals (Source: Author)*

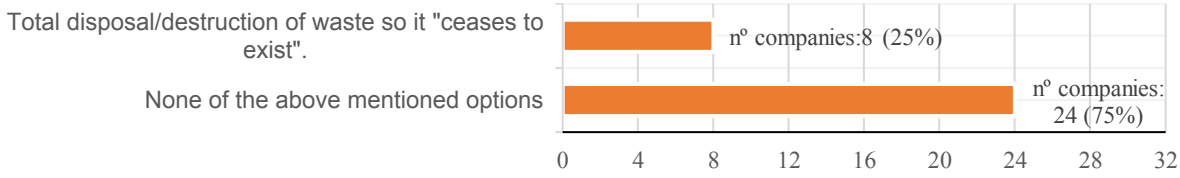

Figure M.17 - *Portuguese FTI Companies Sample Application of CBMs: 10. System Scraping (Source: Author)*

APPENDIX N: Interviews Complete Transcriptions (Divided by Themes)

Interviews Complete Transcriptions (Divided by Themes)

Table 6 - *Overall Transition to a FTI Circular Economy*

Description	*Citation Examples:*
Overall Transition to a FTI Circular Economy	*"There is still a lot to do, and in this respect it can be a little difficult, because we know that the road is still so long, but we are also making small advances, small victories."* (*Interview Triwool*, 2022). *"I don't believe the Industry is prepared to change from one day to the other, this has to be all very sustained, there has to be a restructuring of many things so that we can effectively improve. I think it's going to be a very long process; I don't believe it's impossible, however there's a lot of work ahead."* (*Interview Tintex*, 2022).

Table 7 - *Integrated Sustainability*

Description	*Citation Examples:*
Integrated Sustainability	*"Everything is thought out in detail, so that it can have the greatest impact on an economic and social level and the least impact on an environmental level. Since, at least, these three pillars must always be in the structure or at the base of everything that is done in the company, because if we miss one it no longer makes sense."* (*Interview Tintex*, 2022) *"As we are a service company, we do not exactly have a product to present to companies, unlike TINTEX. There is a nuance here, TINTEX sells finished knitwear and therefore highlights these characteristics in its products, we don't,*

	we are a service company, we don't have our own product, we only dye for our customers. So we do what our customers ask us to do." (*Interview Tinamar*, 2022) *"We are a company, like TINTEX, which is subject to very strong scrutiny by the authorities in regard to environmental protection, we comply with these areas, as TINTEX certainly does. But, let's say, it is not our marketing strategy to emphasise this aspect of Sustainability, it is not our strategy. Our strategy is to provide a good service to our clients, when it is necessary to highlight Sustainability, we highlight it, when it is not, we do what we can and in accordance with what the client requests."* (*Interview Tinamar*, 2022) *"TINTEX has already integrated our circular product line with the brand EcoHeather in its offer."* (*Interview Tearfil*, 2022)
Sustainability Influence	*"We have requests from our customers with challenges in the area of Sustainability and, then yes, the Triwool Group talks to those partners who are better prepared to deal with this type of requests. In this aspect, the challenge may come from TINTEX to us or from us to TINTEX, it ends up being a relationship, a partnership"*. (*Interview Triwool*, 2022); *"I would say that although there is no direct contact, there is always an influence. The fact that TINTEX is directly linked to some of the brands we work with, promotes Sustainability and Circular Economy, helps to further highlight and create more interest and give importance to this topic for the different fashion brands. (...) then when the brand reaches the stage of offering its products and realizing what it is that customers want and realizing the importance of this issue for customers, it becomes much easier for us to also partner with brands because they already come sensitized from behind, namely from the relationship with TINTEX, for example."* (*Interview White-Stamp*, 2022)

Table 8 - *Circular Economy & CBMs*

Description	*Citation Examples:*
Circular Economy Definition	*"today, when we talk about Circular Economy, we talk about Sustainability and, as I said, most people are very ill-informed."* (*Interview Rodome & Trevira*, 2022); *"So, the first question is, in fact, for the competent entities discuss with Universities, with whoever they want, to define exactly what environmental, sustainable, green or whatever they wanted to call it, but to clearly define the criteria with which this could be applied."* (*Interview Tinamar*, 2022); *"Everyone is under pressure with the Sustainable Development Goals, so it's on all the policies and agendas to do Circular Economy, but often you don't really know where to start."* (*Interview Vintage for a Cause*, 2022); *"there is something missing here, especially at government level, that defines rules for the Circular Economy, that defines Circular Economy. We have to think about stopping using these words as buzzwords, but, when saying them, knowing what they effectively imply and mean in a product, a process, a raw material. This is extremely important to understand. I think, only after this perception exists, will we have the ability to raise consumer awareness, otherwise they will remain as pretty words."* (*Interview Tintex*, 2022); *"Let's say that TINTEX considers itself circular and has a competitor company that also considers itself circular, what does that mean? How do you know that? Ok, they have processes... I think it's great that this is already in place, if the processes are more efficient you have less waste, you are working with innovative yarns, in the part they are natural raw materials: spectacular; you don't make mixtures: incredible; you are already starting to respect some of the*

Circular Product Design Strategies and LCA	*circular design strategies, but it is by motivation*" (it is self-motivated and in practice if no one wanted no one would do it). (*Interview Tintex*, 2022); "*accessing stock that is certified and we know the composition, our upcycling practice, which is our core business, gains more credibility and has more commercial viability, because knowing the composition of fabrics is quite important*" (*Interview Vintage for a Cause*, 2022) *"The garments are made by applying some eco-design concepts, avoiding the use of zippers and other metallic and plastic accessories that disturb the end-of-life of the pieces. We also frequently resort to our internal stock of raw materials to make small repairs to old pieces brought in by customers."* (*Interview Katty Xiomara*, 2022); *"When you have a knit or a garment made with a natural fibre, like cotton, for example, it can be reused. Of course we will always have to add some virgin material, but at the limit, when there is no more, since there is always a limit, let's not be hypocritical to the point of thinking that we will always be able to put this in the value chain, no. At the limit of its use, that fibre, if it is not mixed, it is biodegradable; if you have cotton mixed with polyester, elastane and polyamide, at first it is not possible to separate it, as if it is mixed it is very complicated and then, at the level of degradation, it will end up in the landfill for many years"* (*Interview Tintex*, 2022). *"In terms of the production chain, there is nothing purer than plastic, contrary to what people think. It uses little water, few secondary products, cheap, easy to transform, but unfortunately, the last 5 minutes of its life will define whether plastic is good or bad."* (*Interview Rodome & Trevira*, 2022) "*almost all the collections we have are made, indeed regarding clothing, they are all made from surplus production, from recycling old collections, from unlikely materials*." (*Interview Vintage for a Cause*, 2022)

Partnerships to close the loop	"*The way in which we do sourcing, in this logic of partnerships, of contacting companies, with the emphasis on collaborations and almost joint work and of defining a joint strategy"* (*Interview Vintage for a Cause*, 2022). "*The raw materials that are 100% cotton or those composed of two fibres, cotton and polyester, are segregated, are separated and sent to the Valérius group project, Project 360.*" (*Interview Triwool*, 2022); "*We collect discarded garments from our end-customers and send them to KOOPERA, a social enterprise for its selection. Then they sell part of it and whatever cannot be resold is selected for its recycling mainly with RECOVER*" (*Interview SKFK*, 2022).

Table 9 - *Innovation and Investments*

Description	*Citation Examples:*
Technology	*"at the moment there are already machines for that, but, perhaps they are aimed at a market other than ours, the sustainable one, and also, a large scale, that's not so much the intention of the sustainable and circular market."* (*Interview Cru Loja*, 2022); *"I think the technology exists, and we see the technology that exists in other fields, we can take rockets into space, bring them back and land them in exact the same place, so I don't believe it is not possible to develop technology for us to make manufacturing more circular than it is today. I think it's just that it's not optimised and it's not industrialised to the point where it's cheaper, or at least at the same price as the conventional methods that are associated with the linear economy."* (*Interview White-Stamp*, 2022); *"The existing technological means are already a great help, but technology is precisely the sector that has the least "right" to accommodate itself, technology must have a thirst for evolution, constantly questioning its ideas and solutions*

	and it should be in the sector of Sustainability that it will have to work more persistently in the coming years." (*Interview Katty Xiomara*, 2022)
Recycling Technology	*"Technology is there, but it needs regulation and it needs scale to be economically feasible."* (*Interview SKFK*, 2022). "*the dimension we are talking about is so large that this will not be solved. With the current spinning or defibration capacities and the production of recycled fibres, what exists is clearly too little. It is impossible. And even these companies will make new investments, they will grow, they will double or triple their capacities, but new investments will certainly appear in the market.*" (*Interview Recit*, 2022) *"we are coming to the conclusion that everything that is being done is manual. We are at a scale of 100/200 kg, we have to reach the scale of thousands of tons. Only in Portugal we have 200 thousand tons to treat (of post-consumer materials), and this has a brutal scale."* (*Interview Recit*, 2022) *"The technology of fibre reading and sorting and that of generating new fibre, both mechanically or chemically will be well developed. In short, whatever now is posing a huge problem of textile waste will become another raw material available for the ever hungry textile industry."* (*Interview SKFK*, 2022).
Produce on Demand: Personalisation Technology	*"I think 3D can also have a very interesting impact on the issue, for example, of returns, I'm not sure, but I believe it's a very significant part of the items carbon footprint, more and more with the growth of online commerce"* (*Interview White-Stamp*, 2022). *"The return process is super simple and that's great for the consumer, but it means that it's one more trip that the article will make, so, if we know exactly the measures that will fit us perfectly, maybe this will allow for more customization."* (*Interview White-Stamp*, 2022).

Technology for Transparency	*"the issue of blockchain, perhaps, due to the issue of traceability. That is, if we, let's imagine that we all have an App on our mobile phones, where we buy a t-shirt, let's imagine, from Fast Fashion, and we can see on the app by copying a code, the whole process of development of that piece. From the place where it was collected, by which company it was initially manufactured, or who, under what conditions do these people operate, what is the salary of these people and so on."* (*Interview White-Stamp*, 2022) *"where you could see the water consumption needed to produce that yarn, the geographical distance,... this type of information is what ends up making the difference."* (*Interview Tintex*, 2022). *"we have knowledge, machinery, excellent professionals and we cannot let go of everything we are good at. Which is what happens, export talent."* (*Interview Tintex*, 2022)
The Portugal Factor	"*we have so many people who know how to do things well, that if there was greater support, better working conditions, better salaries, there would certainly be many more people wanting to work in this area."* (*Interview Cru Loja*, 2022) *"whether we like it or not, technology, is not often developed in Portugal. We are good at executing, at the development level there are things we are exceptional at, but there is a lot of technology that is imported, that is the truth*." (*Interview Tintex*, 2022). "*We have many brands, many foreign companies that come to us for the quality of our products; and I'm talking about TINTEX, as surely there will be other Portuguese textile companies that have exactly the same type of demand."*(*Interview Tintex*, 2022)

Financial Capacity	*"The textile industry here in Portugal, people are not aware of it, but it's all high-tech, it's has much more higher technology than people imagine. Everything is almost robotised, there is no longer that intensive labour... Intensive labour only exists in the apparel manufacturing stage. For the rest, before, we could have, for example, a spinning mill with 300 people and, nowadays, we can have it working with 10 or 12 people per shift; everything is robotised."*(*Interview Rodome & Trevira*, 2022) *"And that, depends on us approaching a potential economic crisis, and facing a rise in unemployment, people end up buying the cheapest product that tends to be made of synthetic materials. This is a big obstacle for circularity."* (*Interview Triwool*, 2022); *"although we have brands that are increasingly focused on Sustainability, with the concern of offering a quality product, (...) this is still for a consumer with greater purchasing power."* (*Interview Triwool*, 2022); *"TINTEX as it is in a medium/high market, we end up not encountering this type of barrier/limitation in terms of price. Implementation, buying new machinery to increase process efficiency, these projects we are implementing to recycle water, these things all mean investment because you have to restructure for this to work."* (*Interview Tintex*, 2022). *"just imagining a company that has several decades working same way, having to adjust the way of operating, apart from taking time, carries risks, because we don't know exactly what the results of those changes will be and then obviously it also costs a lot of money. So it's not necessarily easy."* (*Interview White-Stamp*, 2022).

Table 10 - *Legislation, Regulations, Transparency*

Description	*Citation Examples:*
Legislation	"*is often more of a political will, than the actual technological levels."* (*Interview Rodome & Trevira*, 2022); *"It doesn't depend so much on technology as on legislation, which is extremely important and people are forgetting a bit that part. Since you will always find barriers if you don't have rules, if you have no way of knowing, of proving that it has to be "x", "y", "z"; otherwise each one ends up doing it in his own thing and you end up never achieving the circularity process."* (*Interview Tintex*, 2022); *"Yes, I think that when laws change it will make a huge difference. The legislation part gives the push that many times we really have to comply, we really have to move forward and, we are all resistant to change, some more than others, but when an order comes from above, the legislative part and that the clients themselves impose through audits and control, it ends up being a big driver for change, too."* (*Interview Triwool*, 2022); *"Laws have to be implemented that make companies comply with rates of reuse, recycling, recovery or repair of their waste."* (*Interview Tearfil*, 2022); *"Now, for that to happen, there has to be a systemic approach, which is accompanied by legislation, by will, by training of the leaders who are at the head of the economic agents who can do something and that has to be, perhaps, rethought with regard to scale, because, if we only replace the process and only replace the materials, but continue to do it at the same pace, with the same principles that we have done until now, we are only changing the product, we are not changing the paradigm."* (*Interview Vintage for a Cause*, 2022). *"until we create a legislative strategy so that companies can have an idea of the path and what needs to be changed, it will be very difficult for us to move organically towards a more Circular Economy. Because I might be optimising*

	my processes, making more durable products, in the same way that other companies are doing it, but are we making them in the same way? Is the impact you have from the processes exactly the same? You don't know." (*Interview Tintex*, 2022); *"The legislation has to be a little more worked out, because at the level of textile products and even at the level of this understanding of the value chain, there is nothing very specific that regulates things, everything is a little "up in the air"."* (*Interview Tintex*, 2022).
Certifications	*"there needs to be regulation so that there are not four or five labels or certifications with each one having its own ideas on Sustainability."* (*Interview Tinamar*, 2022) *"And now the European Climate Pact, which I don't know what impact it will have on the activity; I think it will be big, because the textile industry is the second most polluting industry."* (*Interview Triwool*, 2022);
European Legislation	*"Even European legislation will no longer allow the burning and incineration of textiles and many other materials."* (*Interview Recit*, 2022); *"The moment the EU decides to give help to those companies that go for CE (via tax exemptions for instance) and that it penalises the ones who create high volume of textile waste and overproduction, the game will change. Also, I advocate strongly for public buying under these parameters. (...) Over the years we will see this developing further, the extent of it will be linked to regulation as this will boost the need and therefore the economic viability of such enterprises."* (*Interview SKFK*, 2022);

	"adjusting the production process and so on, reducing emissions, thinking and designing in a different way, all of this has associated costs and, therefore, the support from the European Union is super important in this sense too." (*Interview White-Stamp*, 2022).
European Carbon Border Adjustment Mechanism	*"How does a consumer understand how a garment made here or in China or I don't know where, is more environmentally friendly than another?"* (…) *"let's say you buy a thousand pieces of a t-shirt from China and then make something here and want to export it there, you can't, because they consider it's no longer environmentally friendly. That is, it does not have the environmental procedures that they understand that it should have"* (*Interview Tinamar*, 2022);
	"You would no longer have this issue of having a €3 t-shirt and a €20 t-shirt, for example (…) *and so there would no longer be this question of green washing and all these things that we know exist, but which we end up putting a little behind us, and we don't want to talk about it, but unfortunately they exist."* (*Interview Tintex*, 2022)
Consumer Awareness	*"raising awareness in society depends on political will, nothing else."* (*Interview Rodome & Trevira*, 2022)
	"So, it's not a problem to build factories to recycle, the problem is in the collection of plastic. And, that doesn't depend on the factories, it depends on the political power." (*Interview Rodome & Trevira*, 2022)
	"Unfortunately no matter how many steps the textile industry tries to take to reduce the impact, in this case I'm going to talk about the environmental impact, there is an issue that has to be worked on: legislation and also consumer awareness." (*Interview Tintex*, 2022).

Table 11 - *Partnerships and Collaborations*

Description	*Citation Examples:*
Consumer Awareness	"*because the consumer still doesn't understand the impact of the things he buys*" (*Interview Tintex*, 2022). "*people don't know, they don't have the knowledge, they don't have to know"*. (*Interview Tinamar*, 2022). *"it's is an attempt to raise awareness even among the client (...) all customers who come in I explain the concept of Sustainability, how important it is that we support fashion, but a fashion that is lasting, that is a conscious purchase, that we know exactly where each project comes from, who makes each project, what the materials are."* (*Interview Cru Loja*, 2022).
Transparency and Information Access	*"In other words, as soon as we have access to this information and it cannot be manipulated, I think it will probably cost us a lot more to buy from brands that do not have, perhaps, the due respect both from an environmental and a social point of view, and obviously this will lead to a readjustment of practices."* (*Interview White-Stamp*, 2022); *"The media has a very big responsibility, especially towards young people, where they often transmit ideas that are not true; they are not lies, nor are they truths, they are half-truths or half-lies, depending on the point of view. They give a framework which is often the incorrect one."* (*Interview Rodome & Trevira*, 2022).
Education	*"when we talk about circularity, about circular economy being applied on a large scale, obviously there are various ways of doing it, in my opinion, the most efficient way of doing it, is when you introduce a new generation, essentially through education. It might not be the quickest way, obviously because, let's say, a generation comes every 30 years, but if we manage to introduce this in schools and education: the importance of circularity and how much more sense*

	it makes compared to the alternative, to the linear economy, I think it's probably the most efficient way for us to manage to introduce that in the culture and in the mindset of people and, therefore, that will then spill over into everything: into legislation, into business, into those who are creating new businesses, they will always think with that mindset, a more circular one. It's something that may take some time, but while super urgent, maybe if we look at things in the perspective of mankind history, 30 years, perhaps it's not that significant." (*Interview White-Stamp*, 2022). *"I can even say that the focus and the acceptance of these partnerships has a lot to do with this"* (with finding new solutions and creating new processes, new products). (*Interview Tintex*, 2022)
Partnerships	"*How can we become better, considering a new yarn, a new chemical, a new finish; how will we have the ability to handle something we have never done before? And it's easier if you don't do it alone. (..) having the whole value chain, or part of the value chain, joining you, forming a team with you because they believe in the same values that TINTEX has and believes in and this is what makes all the sense for us to manage, in the future, of course it won't be close, but to make the economy more circular and not so linear."* (*Interview Tintex*, 2022)
Universities and Schools	*"within the curricular plans it is noticeable that there is more and more space to talk about sustainability"* (*Interview Vintage for a Cause*, 2022); *"they are finally focusing on more sustainable innovation and one can see this attempt at partnerships, even with small projects and with people that until now would not have crossed the minds of these Universities, who would sooner turn to multinational firms."* (*Interview Cru Loja*, 2022)
BMs based on partnerships	*"what I think it's quite relevant, and I believe it's one of the motivations for them to be available and invest some time with the innovation teams and in this type of contacts and partnerships, is that, we are an external solution that doesn't*

bring logistic costs and even changes in terms of factory floor for the stock they have; on the other hand it is a way for them to reach different consumers, or to approach, possibly new ones, the B2C market." (*Interview Vintage for a Cause*, 2022).

"with designers, one realises that, after having a field of experimentation here, they adopt or create changes in their own brand, of course always limited to risk."(*Interview Vintage for a Cause*, 2022).
"*Vintage for a Cause is part of an ecosystem of over 40 brands at the moment that have the Sell 1 Buy 1 programme on their website, (...) which allows clients of Vintage for a Cause or any partner of White Stamp that is part of this ecosystem, to offer their clients the possibility of exchanging used items for new ones."* (*Interview White-Stamp*, 2022)*;*

"So, what we see is some brands are starting to put the hypothesis of only having a discount with purpose, rather than having it for discount's sake. Only allow, only offer a discount to customers if, associated to that, there is an action that contributes to the reduction of textile waste." (*Interview White-Stamp*, 2022).