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Final Thesis

**The use of GenAI for trend scouting  
in the Fashion Industry:  
sustainable start-ups on the rise**

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## **Abstract**

This thesis explores the use of Generative Artificial Intelligence (GenAI) for the analysis and identification of emerging trends in the Fashion Industry, with a particular focus on sustainable start-ups. In a context where the Fashion Industry is increasingly criticised for unsustainable practices and high environmental impact, this research proposes an analysis of sustainable business models and sustainable trends that are shaping the future of the industry. Through a dual methodology, combining manual trend analysis and automatic classification using natural language processing (NLP) algorithms such as Latent Dirichlet Allocation (LDA) and ChatGPT, the thesis identifies and maps the most significant innovations of sustainable start-ups. The findings highlight an increase in Circular Economy initiatives, the adoption of sustainable materials, the use of immersive technologies and a growing commitment to transparency in supply chains. This research provides a comprehensive overview of the key trends and opportunities for the Fashion Industry in pursuing more sustainable practices, while also proposing an automatic GenAI-based process, that start-ups incubators and/or accelerators, could use, to automatically scout innovative and sustainable start-ups as soon as they are born.

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# Introduction

This thesis will explore the use of GenAI for the purpose of trend scouting in order to identify the most recent trends, investigate scouting methods, and lastly activate a scouting process to identify sustainable start-ups transforming the fashion industry and questioning the status quo. To carry out this research, the thesis will be structured as follows.

The first chapter analyses the context to which this thesis refers to, namely the Fashion Industry, famous for being one of the most polluting industries in the world. This is where the subject of Sustainability and, in particular, that of Sustainable Fashion comes in. The second chapter researches in depth the topic of Sustainability in the Fashion Industry mentioning Sustainable Business Models and the Business Model Canvas for Industry 4.0. It further explores the regulatory pressure, especially coming from the European Union, influencing the sector's change of direction towards a Circular Economy. Moreover, the impact of consumer's demand in this area is also an important aspect to take into account, since consumers are pressuring the industry to consider its environmental impact and asking for new and strict regulations. The third chapter focuses on a manual analysis of emerging trends, starting from an overview of five macro-trends. It becomes clear how the current challenge is being sustainable in a world where fast fashion is still popular. Developing new sustainable practices requires technological advancements, hence the research for technology trends. Finally, I identify seven sustainability trends after an in-depth meta-analysis of leading articles. The fourth chapter explores the automatic classification of start-ups from "traditional" machine learning techniques in the form of Natural Language Processing (NLP) to more recent technologies in the form of Generative AI, especially Chat GPT. For the purpose of the research, an existing database is used and updated manually up to a total of 279 start-ups. The fifth chapter delves deeper into the Automatic Scouting, using the Assistant Functionality of Open AI via its Application



Programming Interface (API). After multiple prompts, the final database is created and each start-up is checked to verify that the output of the GenAI is real and belonging to the right trend. The sixth and last chapter summarises the research, giving insights onto the future of the industry and a personal reflection.

# Chapter 1

## Context

### 1.1 Fashion Industry

Clothes and textiles have a significant role in the global economy and are essential components of daily living. The world without textiles is difficult to envision. As mentioned by the [Ellen MacArthur Foundation \(2017\)](#) in its report, the USD 1.3 trillion clothing industry employs globally more than 300 million people along the value chain. Over 60% of all textiles are used for clothing, and this percentage is predicted to continue to rise. This is also predictable since the clothing production has roughly doubled over the past 15 years due to a growing middle-class population across the globe and increased per capita sales in mature economies. The “Fast Fashion” movement, which features trends changing quickly, a high turnover of annual collections, and low prices, is essentially to blame for. Historically, the Fashion Industry has been connected with unsustainable practices, such as pollution, exploitation of natural resources and poor working conditions, hence, as evidenced by its name, fast fashion is fueling the triple planetary crisis <sup>1</sup>([United Nations Climate Change, 2022](#)) .

Even though, in theory, Sustainable Fashion and circularity are both possible along the textile value chain, consumers worldwide are making the transition difficult. They are purchasing more clothing in this century than in the previous ones, wearing it for shorter periods of time, and throwing it away as soon as a trend changes. Leading the change for a world with zero waste is the United Nations Environment Programme (UNEP).

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<sup>1</sup>The triple planetary crisis refers to the three main interlinked issues that humanity currently faces: climate change, pollution and biodiversity loss ([United Nations Climate Change, 2022](#)).

According to estimates from the UNEP partner [Ellen MacArthur Foundation \(2017\)](#), a truckload of abandoned textiles is reportedly burned or disposed of in landfills every second. Concurrently, in the last fifteen years, on average, consumers purchased 60% more clothing than the pre-2000 average and worn it for 50% less time as shown in Figure (1.1).

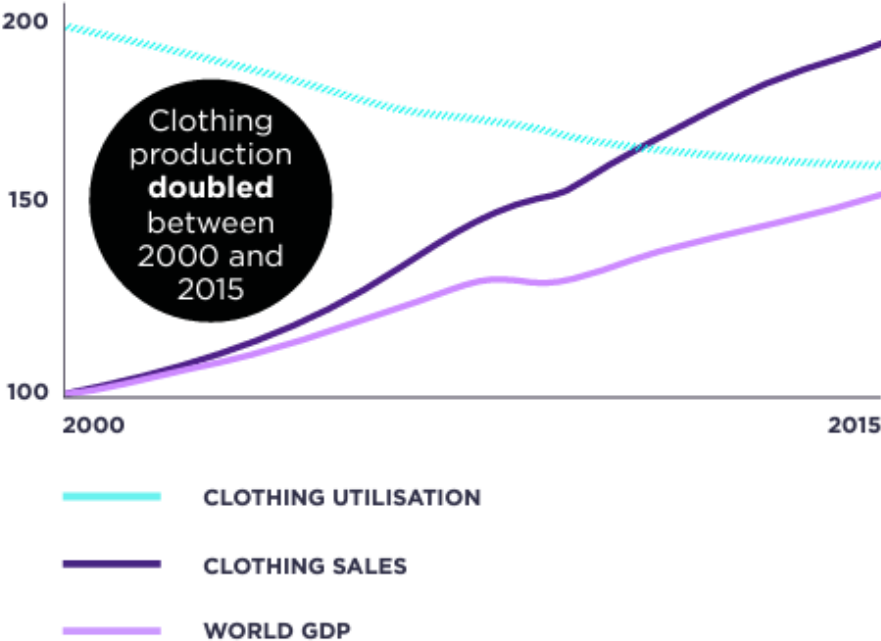


Figure 1.1: Growth of clothing sales and decline in clothing utilisation, 2000 to 2015 ([Ellen MacArthur Foundation, 2017](#))

The problem is caused by the fact that the current system for producing, distributing, and using clothing is almost entirely linear. This linear system is thus putting pressure on resources, polluting the environment and creating negative societal impacts at local, regional, and global scales. This problem is connected to a further issue: the textile sector is mostly dependent on non-renewable resources, which account for 98 million tonnes annually. These resources include oil for the production of synthetic fibers, fertilizers for the growth of cotton, and chemicals for the production, dyeing, and finishing of fibers and textiles. Additionally, every year, the manufacture of textiles, including cotton cultivation, requires around 93 billion cubic meters of water, which is becoming a hard challenge in those areas with limited water resources.

Although it is difficult to put a number on the economic impact of these negative externalities, a recent report published by [Global Fashion Agenda and Boston Consulting](#)

[Group \(2017\)](#) estimated that if the Fashion Industry addressed the social and environmental consequences of the status quo, the global economy could benefit by roughly EUR 160 billion (USD 192 billion) in 2030.

In recent years, the Fashion Industry has also been held accountable for contributing to the issue of plastic entering the ocean. As explained in an article of [The Guardian O'Connor \(2014\)](#), every year, an estimated 500,000 tons of plastic microfibres are lost to the ocean when textiles made of plastic, including acrylic, nylon, or polyester, are washed.

Moreover, Fashion production is linked to the additional issue of underpaid labourers. However, this is not the only societal problem related to the industry. Because of the hazardous materials used in production and the risky procedures, many workers are exposed to dangerous working conditions causing negative impacts on their health.

To give an overview, the pain points highlighted in the report by the [Ellen MacArthur Foundation \(2017\)](#) can be summarized as follows: 1. Clothing is massively underutilised: according to estimates, more than half of fast fashion produced is disposed of in under a year. 2. Less than 1% of material used to produce clothing is recycled into new clothing, representing a loss of more than USD 100 as billion worth of materials each year as mentioned by [Wicker \(2017\)](#). 3. On current trend, the negative impacts of the industry will be potentially catastrophic both for the society and the environment.

Although the environmental costs of Fast Fashion are increasing, experts point out that there is another option: the Sustainable Fashion movement, including among other practices, a circular economy for textiles, as mentioned by [UNEP \(2023\)](#). Finally, the moment has come to switch to a textile system that produces better results for society, the economy, and the environment. Based on this idea of circular economy, the study from the [Ellen MacArthur Foundation \(2017\)](#) presents a course of action underscoring the urgency of adopting new business models and innovative technologies that can foster a more efficient use of resources. For example, the need for improved recycling and upcycling of textiles is key to reducing the environmental impact of the industry. The paper introduces an essential distinction between terms that are often incorrectly interchanged. Both recycling and upcycling have to do with the second life of products, but they have the opposite production approach. In *recycling*, where the components of an object require a conversion process to be reused, the role of scientific research is crucial as it makes possible to repeat this process indefinitely as outlined by [Tarallo \(2022\)](#). Second-hand

clothing is one example of recycling that increases a product’s lifespan through reuse. Clothing reuse contributes to a decrease in the quantity of clothing disposed of, which in turn reduces pollution in the environment (Farrant, Olsen, & Wangel, 2010). Clothes that are vintage or secondhand have become more and more desirable for both personal style and environmental reasons. In *upcycling*, which involves giving an object a new life without it undergoing further processing, creativity is key, allowing the value of the original product to be increased by transforming it into something else as further illustrated by Tarallo (2022).

A part from radically improving recycling (and upcycling) and making effective use of resources and switching to renewable ones, other courses of action mentioned in the paper of the Ellen MacArthur Foundation (2017) include phasing out substances of concern and microfibre release and lastly increasing clothing utilisation.

It is clear that these ambitions will not happen overnight, but this thesis will explore how a growing number of start-ups are dedicating time and money in order to address these issues starting from the Fashion Industry and leading the Sustainable Fashion change. This change is made possible by the transformation of the linear economy into a circular one and the ‘exploitation’ of new sustainable business models.

## 1.2 Definition of Sustainability

Many definitions of the term “Sustainability” exist depending on the context.

As per the Cambridge dictionary, sustainability is defined as *“the quality of being able to continue over a period of time”* or *“the quality of causing little or no damage to the environment and therefore able to continue for a long time”*<sup>2</sup>.

A widely used definition is the one from the 1987 Brundtland Report of the U.N. World Commission on Environment and Development (WCED). In the report, sustainability is described as *“meeting the needs of the present without compromising the ability of future generations to meet their own needs”* (World Commission on Environment and Development, 1987). Still according to the United Nations Environment Programme (UNEP) Annual Report of 2011 by Nuttall, Crompton, Darani, and Ngaira (2012), there will be significant stress on the finite natural resources due to the rate of consumption,

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<sup>2</sup><https://dictionary.cambridge.org/dictionary/english/sustainability>

which is expected to increase threefold by 2050 once the current rate of consumption is taken into account.

The simplest explanation of the existence of the term “sustainability” is that rates of natural resources generations and consumption should match, as explained by [Muthu \(2016\)](#).

While the Brundtland definition is general and involves multiple sectors, the Fashion Industry presents peculiarities that must be analysed before I can examine how the sector is engaging in sustainable practices. In fashion sustainability, the aim is to make and use clothing in a “sustained” manner that safeguards both the environment and the people working in the industry. On a deeper level, sustainability should also guarantee that the entire creation process—from raw materials to manufacturing and from worker conditions to compensation—is socially and environmentally sound.

Before Brundtland, as early as 1973, the first Environmental Action Program was drafted at the initiative of the Council of Ministers of the European Communities ([Di Giamberardino, 2024](#)). However, only in the last five years intentions have turned into actions.

In recent years, the growing awareness of environmental, social and economic challenges has led to the development of new paradigms aimed at promoting sustainability and business ethics. Two key concepts that have emerged in this context are the ESG (Environmental, Social, and Governance) criteria and the SDGs (Sustainable Development Goals), which are fundamental tools to guide companies and institutions towards sustainable and responsible growth.

In the following paragraphs, ESG criteria and their growing impact in the corporate world will be explored in detail, followed by an examination of the SDGs and the role they play in shaping global sustainability strategies.

### **1.2.1 ESG**

As mentioned earlier, in order to ensure that future generations enjoy a higher standard of living than the present, sustainability entails ongoing improvements to environmental, social, and economic well-being ([Dicuonzo, Donofrio, Ranaldo, & Atti, 2022](#)). Hence, ESG (Environmental, Social, and Governance) factors represent fundamental criteria that companies must consider in order to operate responsibly and sustainably.

First, **environmental factors (E)** include pollution, energy and water use, natural resource conservation, and carbon emissions from businesses. They entail evaluating the risks that the environment poses to the company's earnings and how that risk is managed. For instance, businesses may have to deal with hazards related to wastewater disposal, for which they may be subject to fines for noncompliance.

The second is a social element, which speaks to how the business interacts with the community. **Social factors (S)** include social philanthropy, product safety, worker rights, and employee wellness. Inadequate workplace health and safety measures can reduce hazards such as labor inefficiencies and compliance costs.

Lastly, transparency of information, diversity on the board, shareholder rights, and independence are all considered **governance (G) factors**. Information on conflicts of interest, the effectiveness of governance mechanisms, and accounting transparency that stakeholders and investors require ([Atif, Liu, & Nadarajah, 2022](#)).

ESG goals are seen more significant in light of the growing impact of CSR-related concerns on the economy ([Fuadah, Mukhtarudin, Andriana, & Arisman, 2023](#)). According to [Kumar and Firoz \(2022\)](#) findings, implementing improved ESG practices may aid organizations in enhancing their Corporate Financial Performance (CFP), building trust and a positive reputation, and advancing their ethical procedures. Investors should pay attention to organizations with high ESG disclosure levels because of their decreased likelihood of financial problems. Sufficient regulatory policies that can reveal ESG are required in order to promote market growth through standard regulation ([Yuan, Li, Xu, & Shang, 2022](#)). Enabling ESG transparency helps organizations grow more productively. This is to both support the demands of stakeholders and the sustainable growth of the organization through ESG disclosure.

Furthermore, a firm with transparent and high-quality internal management would lower the chance of fraud, save money on hiring new staff training, and increase productivity per employee as well as the quality of its products as mentioned by [Suttipun and Yordudom \(2022\)](#).

To put it in simpler words, integrating ESG factors into corporate strategies not only promotes sustainability, but can also improve long-term financial performance and attract responsible investments.

The following Table (1.1) shows the ESG framework (international frameworks) elab-

oration based on the EBA report on ESG risk management and supervision <sup>3</sup>.

Table 1.1: ESG framework (international frameworks) elaboration by Li et al. (2021)

Dimension	Factors	Definition
Environmental (E)	<i>GHG emissions</i>	<i>Environmental matters that may have a positive or negative impact on the financial performance or solvency of an entity, sovereign, or individual.</i>
	<i>Energy consumption and efficiency</i>	
	<i>Air pollutants</i>	
	<i>Water usage and recycling</i>	
	<i>Waste production and management (water, solid, hazardous)</i>	
	<i>Impact and dependence on biodiversity</i>	
	<i>Impact and dependence on ecosystems</i>	
Social (S)	<i>Innovation in environmentally friendly products and services</i>	<i>Social matters that may have a positive or negative impact on the financial performance or solvency of an entity, sovereign, or individual.</i>
	<i>Workforce freedom of association</i>	
	<i>Child labor</i>	
	<i>Forced and compulsory labor</i>	
	<i>Workplace health and safety</i>	
	<i>Customer health and safety</i>	
	<i>Discrimination, diversity, and equal</i>	
	<i>Opportunity</i>	
	<i>Poverty and community impact</i>	
	<i>Supply chain management</i>	
	<i>Training and education</i>	
	<i>Customer privacy</i>	
Governance (G)	<i>Community impacts</i>	<i>Governance matters that may have a positive or negative impact on the financial performance or solvency of an entity, sovereign, or individual</i>
	<i>Codes of conduct and business principles</i>	
	<i>Accountability</i>	
	<i>Transparency and disclosure</i>	
	<i>Executive pay</i>	
	<i>Board diversity and structure</i>	
	<i>Bribery and corruption</i>	
	<i>Stakeholder engagement</i>	
<i>Shareholder rights</i>		

Therefore, it has become crucial for start-ups and established businesses to put the UN SDGs and ESG principles front and centre when designing business models. As explained by VeniSIA (2024), proactively addressing material ESG risks and opportunities will be an essential competitive advantage in the age of Industry 4.0, i.e. the fourth industrial revolution, namely the profound and irreversible digital transformation of the production system.

In fact, increasing long-term resilience and competitiveness requires integrating ESG factors. Organisations should ensure that sustainability is included in each of the Business Model Canvas's many building blocks. Thus, by aligning their business models with the UN Sustainable Development Goals, start-ups and firms may prepare for future legal changes and market upheavals, as well as attract conscious investors and consumers.

<sup>3</sup><https://www.eba.europa.eu>



## 1.2.2 SDGs

In 2015, the 2030 Agenda for sustainable development was signed by 193 United Nations countries, including Italy, with the aim of sharing their commitment for a better present and future for our Planet and the people who inhabit it. The Global Agenda defines 17 Sustainable Development Goals (SDGs) (see Table 1.2 aiming at ending poverty, protecting the planet and ensuring prosperity for all by 2030. The Goals were adopted in response to the massive body of practical and scientific evidence that the world needs a drastically more sustainable strategy (Morton, Pencheon, & Squires, 2017). Indeed, these goals address issues such as climate change, economic inequality, innovation, sustainable consumption, peace and justice according to the United Nations (2015). Even though the 17 objectives are backed by indicators and targets, the most important lesson is that all 17 goals are closely related to one another; failing to recognize this will result in an approach that is, at best, non-aligned and, at worst, extremely unproductive.



Figure 1.2: Sustainable Development Goals (SDGs)

Knowing what came before the SDGs is necessary to fully comprehend their practical and political significance as well as the difficulties they present. From 2000 to 2015, the Millennium Development Goals (MDGs), which consisted of eight international develop-

ment goals, were in place. Despite being a step in the right direction, the MDGs received some criticism. Perhaps most importantly, the Millennium Development Goals prioritized the needs of developing nations, reinforcing a dichotomous view of rich and poor nations, donors and recipients. This suggests that the global challenge is best approached as a development problem that can be addressed by international aid rather than as a collection of shared issues that require global cooperation to solve.

As opposed to the MDGs, the SDGs have a clearer message that every country must act in order to succeed, and they are also more specific in content and have a greater reach as explained by [Morton et al. \(2017\)](#).

Finally, the SDGs provide a strategic vision and operational framework that businesses can adopt to contribute to sustainable global development.

In this context, business model innovation plays a key role for companies wishing to actively contribute to the achievement of the Sustainable Development Goals. According to [Rosati et al. \(2023\)](#), the adoption of the SDGs by companies can provide a clear direction to identify new opportunities for innovation and sustainable growth by promoting a strategic approach that integrates economic development with social and environmental responsibility. The innovation of SDG-oriented business models is not only limited to improving a company's internal sustainability, but can also serve as leverage to address global challenges such as climate change, economic inequality, and social justice.

[Rosati et al. \(2023\)](#) point out that companies can use the SDGs to identify risks and opportunities in their own business sectors, thus ensuring greater alignment between their operational strategies and global needs.

The approach outlined in their study expands on the investigation of SDG-driven business opportunities and hazards, which when combined with an evaluation of an organization's present SDG contribution can help formulate an organization's intended future SDG contribution. The next step is to imagine a future desired business model and encourage business model innovation for the SDGs through the articulation of an organizational future desired SDG contribution. This strategy makes use of a three-dimensional framework for sustainable business models, which includes value proposition, value capture, and sustainable value creation and delivery ([Bocken, Short, Rana, & Evans, 2014](#)). The strategy seeks to assist managers and entrepreneurs in thinking through various approaches to conducting business model innovation for the SDGs. Specifically, the six

phases of the suggested approach are displayed in Table 1.3 and they can be outlined as follows:

1. Analysis of the current business model: the objective is to analyse the company's current business model, using tools such as the Adapted Sustainable Business Model Canvas. This provides an understanding of how the company creates and captures value, highlighting strengths and areas for improvement in relation to sustainability.
2. Assessment of current contribution to the SDGs: in this step, the company can assess how the current business model contributes to the relevant SDGs. A scale is used to determine the company's impact on each SDG (e.g. direct/indirect positive or negative impact). This assessment helps to identify which SDGs are already supported and where there is room for improvement.
3. Exploration of SDG-oriented opportunities and risks: in this phase, the company reflects on possible SDG-related opportunities and risks that might arise from its business sector. For example, promoting renewable energy or reducing carbon emissions may represent both opportunities for growth and solutions to reputational risks.
4. Vision of the future contribution to the SDGs: the objective here is to envision how the company can contribute to the SDGs in the future by identifying a 'desired model' for the years to come. At this stage, specific targets are set, such as reducing emissions or increasing the use of renewable energy within a set period of time.
5. Gap analysis of contribution to the SDGs: by comparing the current contribution to the SDGs with the desired contribution, the 'gaps' that the company needs to close to achieve its targets are identified. This step is used to define the specific areas the company needs to focus on to improve its impact.
6. Vision of the future business model: the last phase involves the construction of the future business model, which addresses the gaps identified in phase 5. Tools such as the Adapted Sustainable Business Model Canvas are used to graphically represent the new business model, highlighting how the company intends to sustainably capture value through innovation.

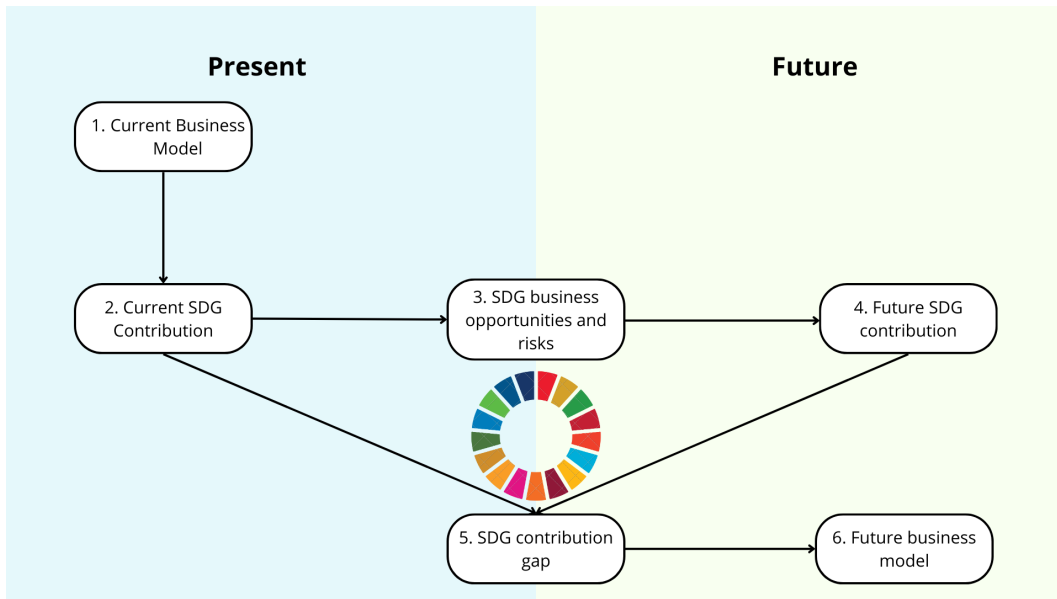


Figure 1.3: The architecture of the proposed managerial approach (Rosati et al., 2023)

The six-step structure provides a clear and easily followed path for companies, helping them to translate global goals into concrete and measurable actions. This practical approach is key to transforming sustainability theory into tangible changes within organisations.

Overall, having analysed the literature on this subject, I can say that the SDGs represent a turning point in the global vision of sustainable development, shifting the focus from a sectoral or national perspective to a more integrated and universal one. One of the key aspects is the deep interconnection between the goals, which implies that progress towards one SDG cannot be fully achieved without coordinated action on others. For companies, this means understanding that sustainability is not just about environmental impact, but includes social and economic dimensions such as equality, justice and innovation. This holistic approach not only helps reduce operational and reputational risks, but also provides opportunities for growth and innovation, stimulating the creation of innovative solutions and business models that meet new global needs.

### 1.3 Sustainable Fashion

There has never been so much talk about Sustainable Fashion as there has been in recent years. It was the concept of sustainable development that provided the foundation for debate and action in the Fashion Industry, pushing towards the adoption of more responsible

and sustainable practices. As a result, the Fashion Industry became aware of its environmental and social impacts, initiating the search for innovative solutions and collaborations between brands, manufacturers, consumers and non-governmental organisations.

In the last few years, increasingly conscious and discerning consumers are no longer satisfied with garments that look good to wear; they also want to know how those garments are produced and to make sure that the methods, times and places of production do not contribute to the deterioration of the planet's environmental conditions as well as the working conditions of the people involved in production.

The proliferation of Fast Fashion has had an unprecedented environmental impact, therefore the media spotlight has focused on how to cope with the problem. The solution seems to focus on Sustainable Fashion. But what exactly is Sustainable Fashion? The following section attempts to give a definition of it through literature review.

As it emerges from [Carey and Cervellon \(2014\)](#), the terms eco-fashion, green-fashion, and ethical-fashion are interchangeable with Sustainable Fashion, which is a subset of the slow fashion movement that emerged over the past few decades. Sustainable Fashion first appeared when consumers realized how clothing manufacturing affected the environment in the 1960s and demanded that the industry changed its practices ([Jung & Jin, 2014](#)). Although eco-fashion was initially seen negatively, this began to change in the 1980s and 1990s when anti-fur campaigns emerged, and in the late 1990s, there was a surge in interest in ethical clothing. Fair working conditions, a sustainable business model ([Jørgens, 2006](#)), organic and environmentally friendly materials, certifications, traceability ([Henninger, Alevizou, & Oates, 2016](#)), and environmentally friendly materials ([Johnston, 2012](#)) are all linked to ethical fashion.

### *So what is Sustainable Fashion?*

It is a common misconception that Sustainable Fashion, which is a component of the Slow Fashion movement, is the reverse of Fast Fashion. According to [Bourland \(2011\)](#) and [Pookulangara and Shephard \(2013\)](#), among others, Slow Fashion is founded on a philosophical ideal that emphasizes sustainability values, such as improving working conditions and minimizing environmental destruction. As per [Battaglia, Testa, Bianchi, Iraldo, and Frey \(2014\)](#), the significance of Sustainable Fashion and the Slow Fashion movement is

growing. Slow Fashion challenges the Fast Fashion paradigm by breaking down existing barriers between the company and its stakeholders, slowing down production to a more manageable pace, rejecting the Fast Fashion paradigm, straying from the self-concept, and focusing on worker empowerment through choice that promotes change as stated by [Mukendi et al. \(2020\)](#).

Finally, the slow fashion movement was born in response to “unsustainable” business growth and fast fashion cycles. Moreover, it encourages moral behavior, less fashion production, and the purchase of high-quality rather than low-quality apparel ([Fletcher, 2012](#) ; [Ertekin & Atik, 2014](#)). Using upcycling, recycling, traditional production methods, and organic and renewable raw materials, slow fashion, and more especially Sustainable Fashion, aims to empower workers at every stage of the supply chain ([Johnston, 2012](#)). Additionally, slow fashion departs from fast Fashion Industry practices currently in use, as it calls for modifications to infrastructure, system thinking, and the speed at which goods are produced ([Fletcher, 2012](#)). A balanced approach to fashion production that prioritizes transparency, develops local production, and cultivates long-term relationships is essential to the slow fashion movement and Sustainable Fashion ([Ertekin & Atik, 2014](#)).

As a result of its research about current and future direction of Sustainable Fashion, the paper of [Mukendi et al. \(2020\)](#) offers a working definition of Sustainable Fashion: *the variety of means by which a fashion item or behaviour could be perceived to be more sustainable, including (but not limited to) environmental, social, slow fashion, reuse, recycling, cruelty-free and anticonsumption and production practices*.

The table 1.2 sums up the literature review that was carried out by [Mukendi et al. \(2020\)](#) in order to arrive at the definition above.

Moreover, the following attributes of Sustainable Fashion emerged from the data analysis of [Mukendi et al. \(2020\)](#): “Sourcing and production process” and “Transparency and traceability”.

The first one emphasizes the importance of using eco-friendly and locally sourced materials, reducing carbon footprints, ensuring fair wages, and promoting safe working conditions, aligning with the principles of Slow Fashion researched by [Joergens \(2006\)](#); [Pookulangara and Shephard \(2013\)](#); [Shen, Zheng, Chow, and Chow \(2014\)](#); and [McNeill and Moore \(2015\)](#).

The latter highlights the need for clear communication regarding the origins of raw

Table 1.2: Definition of Sustainable Fashion ([Mukendi et al., 2020](#))

Term	Definition	Reference
<b>Ethical fashion</b>	<i>“fashionable clothes that incorporate fair trade principles with sweatshop-free labour conditions while not harming the environment or workers by using biodegradable and organic cotton”</i>	<a href="#">Joergens (2006)</a>
	<i>“the positive impact of a designer, a consumer choice, or method of production as experienced by workers, consumers, animals, society and the environment”</i>	<a href="#">Thomas (2008)</a>
	<i>“clothing that seeks to minimise its negative impact on the environment, employees, and animals via processes that include, but are not limited to, slow fashion”</i>	<a href="#">Reimers, Magnuson, and Chao (2016)</a>
<b>Eco fashion</b>	<i>“Any clothing item made in an environmentally friendly process including recycled materials, nontextile materials, and reused clothing”</i>	<a href="#">Carey and Cervellon (2014)</a>
<b>Slow fashion</b>	<i>“A philosophy, design approach, and method of consumption that prioritises the relationship between the wearer and the clothing, local production and resources, and ethical treatment of workers”</i>	<a href="#">Pookulangara and Shephard (2013)</a> and <a href="#">Tama Birkocak, Cureklibatir Encan, and Ondogan (2017)</a>
<b>Sustainable fashion</b>	<i>“. . . ecological integrity, social quality, and human flourishing through products, action, relationships and practices of use”</i>	<a href="#">Fletcher (2012)</a>

materials, production processes, and working conditions, ensuring that the entire supply chain is visible and ethically sound. This emphasis on transparency aligns with the broader understanding that Sustainable Fashion requires long-term relationships and the ability to trace and communicate ethical practices along the supply chain ([Fletcher, 2012](#); [Ertekin & Atik, 2014](#)).

In conclusion, there are many different perspectives on Sustainable Fashion encompassing multiple facets. Research suggests that trying to define Sustainable Fashion in a single way is extremely hard. However, the common denominator of every research is the importance of altering the way the Fashion Industry operates now and the need to try to shorten the current cycle of Fashion by paying closer attention to raw materials.

## 1.4 Research question

This thesis aims at grouping start-ups in the Fashion Industry according to the type of innovation they are pursuing. The goal is to identify new trends or confirm those that have already emerged and have been mapped to highlight the most innovative start-ups.

The challenge of this thesis is therefore threefold:

1. Identify the most recent trends in the Fashion Industry related to sustainability through manual scouting of trends followed by a meta analysis of those trends.
2. Investigate methods for scouting start-ups related to these trends automatically by reviewing NLP algorithms, up to the most recent forms represented by Generative AI, specifically ChatGPT.
3. Activate a scouting process of trends inherent in sustainability matters in the Fashion Industry by leveraging the use of GenAI.



# Chapter 2

## Sustainability in the Fashion Industry

### 2.1 Sustainable Business Models

In this paragraph, I carry out a literature review on Sustainable Business Models. It is therefore important to start from a basic definition of Business Model. The majority of authors refers to it as “the rationale of how an organization creates, delivers, and captures value” as suggested in the article by [Biloslavo, Bagnoli, Massaro, and Cosentino \(2020\)](#). This is a definition with a long standing history in the literature originally brought forward by [Osterwalder and Pigneur \(2010\)](#).

Adopting a Sustainable Business Model approach, according to [Zott, Amit, and Massa \(2011\)](#), helps in understanding how businesses can produce value and “how it is captured or dispersed across a wide range of stakeholders, including customers, society, and the natural environment among the others”. On the other hand, [Leudeke Freund, Gold, and Bocken \(2019\)](#) proposes an alternative interpretation, defining a Sustainable Business Model as “a business model that creates competitive advantage through superior customer value and contributes to the sustainable development of the company and society”. This definition acknowledges that producing and delivering value to customers remains at the heart of a sustainable business as pointed out by [Teece \(2010\)](#) and [Zott et al. \(2011\)](#), but it also incorporates social and environmental advantages.

[Bocken et al. \(2014\)](#), in their article, go further by explaining that customers, shareholders, local communities, governments, the environment, and even future generations

can all benefit from Sustainable Business Models. The literature defines this as the “triple bottom line” of business principles in the paper of [Elkington \(1997\)](#), also known as “economy, social equity, and environment” in [United Nations General Assembly \(2005\)](#) and “people, planet, and profit” in [Wilson and Post \(2013\)](#). Economic value is about profitability and long-term stability, while social value focuses on social justice and community development, and finally, environmental value focuses on resource renewal and emissions management.

As stated by [Cosenz, Rodrigues, and Rosati \(2019\)](#), Sustainable Business Models incorporate “concepts, principles, or goals that aim at Sustainability, or integrating sustainability into their value proposition, value creation and delivery activities, and/or value capture mechanisms”. Whilst [Lozano \(2018\)](#) offers a holistic view, describing Sustainable Business Model as operational strategies that improve resource efficiency, ensuring that business outcomes are more valuable than inputs, especially in terms of sustainability.

In summary, Sustainable Business Models are central to modern business strategy, promoting sustainable development while ensuring profitability and competitive advantage. These models represent a holistic approach that aligns business success with broader environmental and social objectives.

### **2.1.1 Circular Business Models**

A circular economy seeks to reinvent growth by emphasizing positive effects on society as a whole. To do this, economic activity must be progressively separated from the use of limited resources, and waste must be eliminated from the system. The circular model, based on the switch to renewable energy sources, is therefore expected to increase social, natural, and economic capital.

As explained by [Allwood \(2014\)](#), Circular Economy is characterised by a better utilisation of resources that pushes the entire economic system towards a circular rather than a linear approach, based on product use rather than consumption. In detail, Circular Economy is characterised by the valorisation of consumption waste, the extension of product life cycles, the sharing of resources, the use of raw materials from recycling, and finally, the use of energy from renewable sources. [Webster and MacArthur \(2017\)](#) explain that it is an economic system characterised by a rethinking of products and production processes, designed to regenerate itself, where material flows fall into two types: first,

biological waste, capable of being reintegrated into the biosphere; and second, technical waste, intended to be revalorised without entering the biosphere.

The articles of [Krikke \(2004\)](#) and [Yeo and Yang \(2017\)](#) mention that by closing the loop, companies can enhance the value creation process through a multiplication in input generation, extension of product life cycle and all by avoiding emissions. Indeed, Circular Economy-oriented companies are interested in monitoring the use of their products within the consumption sphere to extend their life cycle or reduce waste as mentioned by [Bakker \(2014\)](#). [Tukker \(2015\)](#) and [Schulte \(2013\)](#) extend the definition by explaining that Circular Economy is also connected with new business models in which the company does not merely sell a product, but offers a service.

The challenge of Circular Economy is not only about improving efficiency in production, but also about changing consumption patterns by creating greater awareness of the effects that a certain purchasing choice or behaviour has on the environment and on the economy.

As further explained by the [Ellen MacArthur Foundation \(2017\)](#), the concept of Circular Economy is based on three pillars: 1. prevent waste and pollution through design; 2. maintain items and materials in use; and 3. restore natural systems.

Lately, as mentioned by [Atasu et al. \(2021\)](#) a growing number of manufacturing businesses has been talking about Circular Economy, where companies can create supply chains that recycle or recover the materials used to create their products. CEOs are undoubtedly drawn to the idea of reducing their environmental impact, eliminating operational waste, and making better use of costly resources. However, developing a circular business model is difficult, and making a mistake can cost a lot of money.

Numerous strategies exist for manufacturing firms to develop a circular business model, however, the majority of them combines three fundamental tactics:

- **Retain product ownership (RPO):** the company retains ownership of the product, e.g. through leasing, and manages recovery and recycling;
- **Product life extension (PLE):** companies design more durable products, reducing the need for new production and potentially opening up markets for used products;
- **Design for recycling (DFR):** companies redesign products and processes to max-

imise material recovery, often collaborating with technology partners.

Several concrete and detailed questions must be answered in order to identify which of the three fundamental strategies would maximize the value for each specific business.

Only when value can be profitably extracted from the product, a circular business model can be considered sustainable. Hence, the product can be reused, increasing the value of the materials and energy used in its manufacture, or it can be broken down into raw materials or components that can be recycled for different purposes. As one would expect, value doesn't always have to be tangible. As the Fashion Industry has shown, one may construct a circular business model where value is almost totally intangible as explained in an Harvard Business Review article by [Atasu et al. \(2021\)](#).

Generally speaking, a product's ability to support a circular business model increases with the amount of value locked into it. Manufacturers' ability to derive maximum value from a circular model would also depend on external variables including active markets for commodity components, secondary markets for old products, and laws. However, it is hard to say how much of that potential a circular business model may actually unlock.

Evaluating the viability of a certain circularity approach necessitates a thorough analysis of costs and benefits as well as some trial and error. But, according to [Atasu et al. \(2021\)](#), businesses can make their thoughts clearer by responding to these two questions: 1. *How easy is it to get my product back?*; 2. *How easy is it to recover value from my product?*

The answers to those two questions help in determining a company's proper placement within a two-by-two matrix (3.2) that displays the strategic alternatives for developing a circular business model.

## The Circularity Matrix

For companies looking to create circular business models for their products, the right model will involve one or more of three basic strategies: retain product ownership (RPO), product life extension (PLE), and design for recycling (DFR). The right strategy can be determined by how easily the manufacturer can get the product back and how easily value can be recovered from it. The challenges each company faces along each dimension will depend on its capabilities and competitive context and may change in response to innovations it and its competitors make.

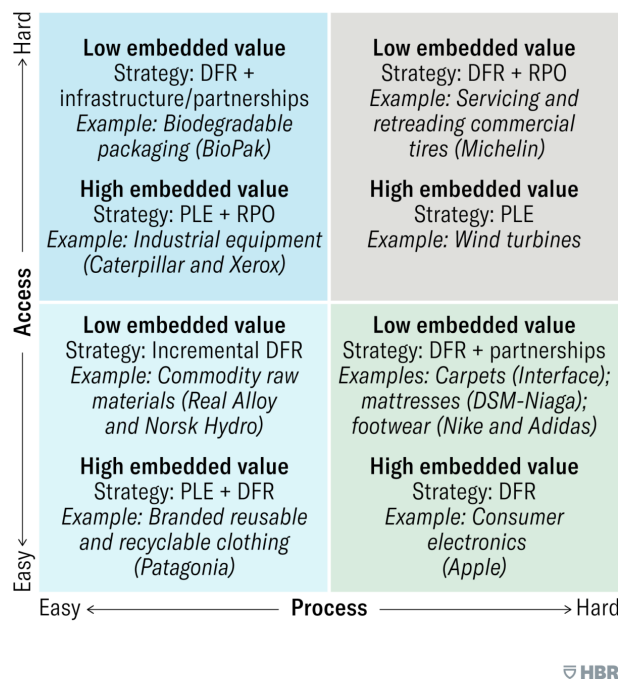


Figure 2.1: The Circularity Matrix (Atasu et al., 2021)

The Circularity Matrix above is designed to assist companies in identifying optimal strategies for adopting circular business models and is structured into four quadrants, which result from the combination of two key variables: product accessibility and processability for value recovery.

The quadrants of the matrix are distinguished as follows: first, difficult to access and difficult to process that includes products that present significant difficulties both in the physical recovery phase, due to factors such as their location or end use, and in the disassembly or recycling phase, due to their structural complexity or material composition. In such cases, recommended strategies include Product Life Extension (PLE) through design for durability and modularity, as well as Design for Recycling (DFR), which facilitates material separation and recovery. Second, easy to access but difficult to process that in-

cludes products that can be recovered relatively easily, due to the absence of a profitable secondary market or ease of transport, but which present significant complexities in the disassembly or recycling phase. For such products, the most effective circularity strategies involve recycling-oriented design (DFR), which involves designing products in a way that facilitates the separation and recovery of materials. Third, difficult to access but easy to process that includes products that, due to their nature of use or other characteristics, are difficult to recover but relatively easy to dismantle or recycle once obtained. In this context, the optimal strategy is based on DFR, with an emphasis on the development of recovery infrastructures that facilitate the collection and processing of materials. Finally, easy to access and easy to process: this quadrant includes products that are easily recoverable and also easily recyclable or repairable. Appropriate circularity strategies for this quadrant focus on expanding and optimising existing recovery and recycling processes, with the aim of improving efficiency and profitability. To sum up, the circular business model aims to reduce environmental impact by recovering or recycling resources used in production. However, implementing it can be complex and costly if not aligned with the company's capabilities and resources.

If I apply this knowledge to the industry I took into consideration, the distinction between Circular Fashion and Sustainable Fashion becomes clearer as it lies in the systemic approach taken by each. Sustainable Fashion aims to reduce the environmental and social impact of the industry through more responsible management of resources throughout the production chain. This includes using environmentally friendly materials, reducing carbon emissions, fairer working conditions and minimising pollution. However, Sustainable Fashion remains anchored to a linear model, in which products are created, consumed and finally disposed of, while seeking to improve each stage of the product life cycle. In contrast, Circular Fashion completely abandons linear logic in favour of a “infinite” cycle, where the main objective is to keep materials and products in use as long as possible through recycling, regeneration, and reuse.

In this context, circularity does not merely reduce impact, but seeks to eliminate waste altogether and regenerate resources, transforming the concept of production and consumption. Thus, while Sustainable Fashion focuses on minimising environmental damage, Circular Fashion represents a paradigm shift, promoting the creation of a system in which products never become waste, but resources for new production cycles.

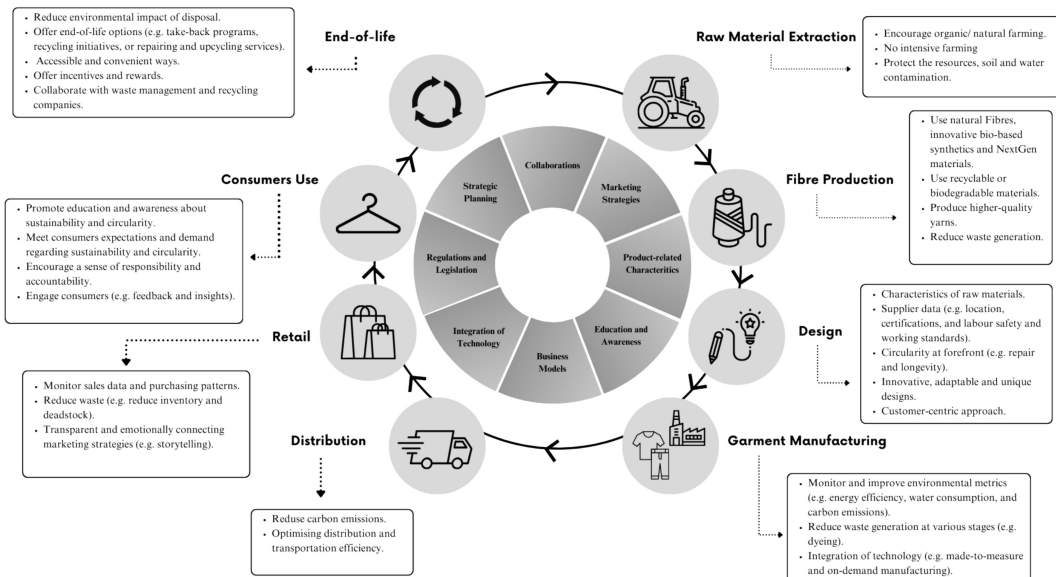


Figure 2.2: Framework for promoting circular behaviour along the Fashion value chain (Abdelmeguid et al., 2024).

According to Abdelmeguid et al. (2024), Circular Fashion not only focuses on the aspect of environmental Sustainability, but also implies a profound transformation of business practices and consumer behaviour along the entire value chain as in the example shown in the framework 2.2.

The authors highlight how different management strategies can be implemented to promote circular behaviour, e.g. through sustainable design, the choice of recyclable materials and the promotion of conscious consumption practices. A key element of Circular Fashion is collaboration between the various actors in the supply chain, including designers, manufacturers, distributors and consumers. This implies the need to adopt a mindset that favours the “infinite” product cycle, i.e. the ability to regenerate materials and extend the life of garments through repair, reuse and recycling. Furthermore, the article by Abdelmeguid et al. (2024) emphasises the importance of reverse logistics to facilitate the collection and processing of used clothes. Among the strategies discussed in the article, particular emphasis is given to the business model based on sharing, like clothing rental, and the concept of production on demand, which, as explained by its own name, helps to reduce overproduction and waste, by producing only when requested. This approach is also supported by innovative technologies such as the blockchain, which makes it possible to trace the origin of materials and monitor the entire life cycle of products, ensuring greater transparency and improving consumer trust. Finally, the article emphasises the

need to educate consumers on more responsible consumption practices, incentivising the purchase of garments of higher quality and durability and raising their awareness of the importance of the second-hand market, which is another fundamental pillar of Circular Fashion.

As far as the Fashion Industry is concerned, the [Ellen MacArthur Foundation \(n.d\)](#) identifies four main circular business models: rental, repair, resale and remaking. Rental covers both large-scale rental and subscription models by multi-brand platforms or individual companies, as well as one-time peer-to-peer rentals by private owners. This process puts a defective or damaged product or component back into serviceable condition. Repair includes alteration and repair services for products currently owned by customers; however, it does not include product returns or damaged inventory. Resale covers own-brand resale, third-party marketplaces, and peer-to-peer second-hand item sales. Lastly, the concept of remaking involves taking an existing product or component and turning it into a new one. Repurposing, re-dying, and disassembly are some examples of remaking.

Circular business models can provide better product margins and competitiveness as explained by the [Ellen MacArthur Foundation \(n.d\)](#). By enabling companies to offer new services like restoration, customization, and tailoring, circular business models create multiple revenue streams. Benefits to revenue include a larger customer base, improved customer loyalty, and access to customer and product usage data. Simultaneously, cost reductions can be achieved through enhanced resource productivity and risk mitigation (e.g. better inventory management). Nowadays, popular business concepts like renting and reselling do not always result in environmental benefits, despite their considerable promise. Their revenue must be separated from production and resource usage in order to create circular business models that work. The process of positive environmental impacts presents numerous obstacles. Firstly, sales volume is a common metric used by the business to determine performance. For instance, in order to encourage product return for resale, remake, or recycling, a company measuring its success based on sales volumes may provide coupons for new items, which would stimulate growth in the linear industry. Second, not all products are made to last as many times as the circular business models would demand. An example of unsuitable alternative, both financially and ecologically, would be a dress for an occasion that is provided by a rental model but appears torn or unfit after being washed twice. Third, whereas circular business models require local



and global networks that facilitate services (i.e. cleaning, repair and remaking), present supply chains are optimized for predictable, one-way production and distribution. Aside from this, companies in the Fashion sector lose out on further financial and ecological prospects by not integrating or investigating alternative or new business models that have the potential to separate income sources from resource consumption and production.

Finally, Fashion businesses have a great chance to grow in new and better ways thanks to circular business models, which generate income without requiring the production of new clothing. These business models have the potential to save significant amounts of greenhouse gas emissions. By 2030, they might be valued at USD 700 billion, representing 23% of the world market for Fashion. But in order to accomplish this, according to the [Ellen MacArthur Foundation](#) (n.d) firms need to take four crucial steps. First, reevaluate customer experiences, customer incentives, and performance indicators. Instead of creating and selling more products, the company must now focus on increasing the use of its products. To do this, it must reconsider its definition of success and provide incentives and improved customer experiences that will attract customers to choose its circular offering. Second, create items that have a greater and longer useful life. Indeed, products must be developed and manufactured to be emotionally and physically durable, able to be recycled after their use, and physically robust in order to maximize the economic and environmental possibilities of circular business models. Third, co-create supply networks that can circulate goods both locally and globally. This means that, by working together and utilizing digital technologies, Fashion supply chains—which are currently set up for a predictable, one-way flow of goods—need to be changed to become supply networks that can circulate goods both locally and globally. Fourth, expand the scope of circular business models at scale. In fact, long-term economic and environmental opportunities can be enhanced by scaling a range of circular business models that create income without creating new goods.

### **2.1.2 Social Business Model**

The article by [Wilson and Post \(2013\)](#) examines the hybrid phenomena known as “social business” which represents an innovative, hybrid approach that integrates social missions with market-based strategies to address complex societal challenges. This model seeks to bridge the gap between traditional for-profit and non-profit organisations by combining

social objectives with entrepreneurial methods, thereby creating both social and economic value.

The article researches how social businesses are designed, suggesting that “clear intentionality around social purpose drives the design of these ventures” and their associated missions and business models such that they can creatively synthesize competing paradigms (economic and social purpose) within one venture. The close alignment of a company’s mission, strategic approach, and implementation ensures the effective realization of its business model’s commitment to serving multiple stakeholders.

[Wilson and Post \(2013\)](#) point out that social enterprises are distinctive because they intentionally design their operations to achieve dual goals from the outset. This integration is not simply a by-product of their activities, but a central aspect of their business model, in which social impact and economic sustainability are prioritised in equal measure. This strategic alignment allows social enterprises to creatively synthesise what are traditionally seen as competing paradigms within a single enterprise.

The origins of the social business model are rooted in the need to overcome the limitations of purely charitable approaches or profit-oriented enterprises. As [Yunus \(2007\)](#) proposed in his concept of social business, these entities focus primarily on achieving social or environmental goals rather than personal financial gain. This concept challenges the traditional capitalist framework, suggesting that business can be a powerful tool for social change if it incorporates the right intentions and structures from its inception. [Yunus \(2007\)](#) advocated the introduction of a new type of enterprise that uses market dynamics to serve social purposes without sacrificing financial sustainability.

The article by [Yunus, Moingeon, and Lehmann-Ortega \(2010\)](#) further emphasises the importance of innovation in the social business model, noting that these models require new value propositions, value constellations and profit equations, making it necessary to challenge conventional thinking and find complementary partners to initiate a process of continuous experimentation.

Several studies have highlighted the challenges and opportunities associated with this hybrid model. For example, [Hockerts \(2006\)](#) pointed out the difficulty of running an enterprise that aims to create a public good while also incurring in private costs, observing that achieving both social and economic goals within the same structure can be counterintuitive from a purely economic perspective. However, the interdependence of social

and economic value creation is increasingly recognised as not only possible, but essential for long-term sustainability. Social enterprises illustrate how intentional design and reinvention of traditional value chains, by directly connecting producers and consumers, can redistribute economic benefits and emancipate marginalised communities.

In this context, the study carried out by [Yunus et al. \(2010\)](#) shows that continuous innovation and strategic experimentation are crucial to adapt social business models to local needs and market conditions. Collaboration between social enterprises and multinationals highlights the importance of involving social profit-oriented shareholders and clearly specifying social profit goals from the very beginning of the project, in order to avoid conflicts and align all stakeholders with the achievement of common goals.

Furthermore, [Wilson and Post \(2013\)](#) argue that the success of social enterprises depends heavily on their ability to attract mission-aligned capital and create governance structures that support their dual goals. By focusing on investors who value social returns along with moderate financial returns, these enterprises can avoid the pressures typical of profit-maximising models, allowing them to remain true to their social missions. This careful alignment of capital, governance and strategy is crucial to maintaining the integrity and effectiveness of the social business model.

Finally, building social business models, as suggested by [Yunus et al. \(2010\)](#), can be a ‘learning laboratory’ for managers and companies eager to challenge conventional wisdom and develop dynamic capabilities that can also be applied to conventional businesses. The case study analysed in the paper demonstrates that the shift from a paradigm of maximising shareholder value to one of maximising value for all stakeholders can offer a way out of the systemic crises afflicting contemporary capitalism.

In conclusion, the social business model represents a transformative approach that harnesses the strengths of both non-profit and for-profit paradigms to generate positive social impact while ensuring economic sustainability. By incorporating social purposes into their core operations and aligning them with market-based methods, social enterprises offer a promising framework to sustainably and scalably address some of the world’s most pressing challenges.

### 2.1.3 Sustainable Fashion Business Model

The literature has recognized and examined a wide range of sustainable business models in the Fashion Industry.

Sustainable business models in the Fashion Industry represent innovative approaches aimed at reducing the negative environmental and social impact of the Fashion Industry while promoting more responsible consumption practices. The literature points to a variety of sustainable business models ranging from collaborative fashion consumption (CFC), such as renting, sharing and bartering (Pedersen & Netter, 2015; Armstrong & Lang, 2015; Iran, 2018), to selling second-hand clothing (McColl & Shearer, 2013; Strähle & Höhn, 2017), to upcycled products (Janigo & Wu, 2015; Pal, 2017). These models aim to extend the life cycle of clothes and reduce resource consumption through the promotion of reuse and recycling, addressing issues of overproduction and waste. However, the large-scale adoption of such models presents significant challenges, such as the difficulty of ensuring consistent style and quality on a large scale (Cassidy & Han, 2013; Pal & Gander, 2018), and the need to redefine the criteria by which institutional investors evaluate the performance of sustainable companies (Di Vito & Bohnsack, 2017).

Circular models, such as Fashion rental and clothing leasing services, offer potential reductions in the environmental impact associated with Fashion consumption. However, the effectiveness of these models depends on the level of consumer adoption and the actual Sustainability of internal processes (Armstrong & Lang, 2015; Becker-Leifhold & Iran, 2018). Furthermore, there is an ongoing debate on how far these solutions really represent a shift towards Sustainability or are simply new ways of maximising corporate profitability through ‘servitization’ (Neely, 2008). Research is still limited in exploring the long-term environmental and social effects of these models, suggesting the need for further studies to assess their potential contribution towards a more sustainable future for the Fashion Industry (Zamani & Peters, 2017; Pal & Gander, 2018).

More recently, the Fashion Industry is heading for a reality check and the pace of transformation is evident. Experts have no doubts, Fashion Sustainability is strongly linked to the future of this Industry. Vanessa Rothschild, H&M Group’s global sustainability steering and development manager companies, in the interview for McKinsey & Company (2020) shared her point of view on the future of Sustainable Fashion by mentioning that companies that *“embrace circularity and digitization at the same time will dominate the*

*Fashion Industry*” and many of her colleagues agree.

## 2.2 The Business Model Canvas

This paragraph delves deeper into how re-imagining new business models is, in the context of Industry 4.0, the first step towards embracing strategic innovation.

The fourth industrial revolution is characterized primarily by reducing the positive effects of economies of scale, where the small size of a company from an element of disadvantage becomes a source of advantage. This means that it is no longer the size of the individual organization that matters, but rather its ability to position itself at the point that is strategically most suitable for it in its value (eco)system.

According to [The Boston Consulting Group \(2015\)](#), with the fourth industrial revolution, we are witnessing the emergence of a digital industry based on nine technological pillars:

1. **Additive Manufacturing** better known as 3D printing, refers to the production of objects in three dimensions from virtual models. Additive manufacturing, unlike machining mechanics makes an object by adding layers of material polymeric, metallic, in the form of powders, liquids or combinations of the previous ones. With this technology, the product is made from two-dimensional machining to which a one-dimensional translation of the machining plane is added, the so-called layer-by-layer technique ([Intelligente, 2015](#));
2. **Autonomous Robots** also known as advanced manufacturing solutions, are interconnected and easily programmable collaborative robots. [Murphy \(2000\)](#), in the book *Introduction to AI Robotics*, defines intelligent robots as “mechanical creatures that can function autonomously.” Specifically they are defined as creatures because they have acquired the ability to make autonomous decisions; mechanical because they are built by humans; and, finally, autonomous functioning refers to the intelligence of the robot, capable of perceiving, acting, and potentially even reasoning;
3. **Augmented Reality Systems** are systems that, through mobile, viewing, listening or manipulating devices, are able to add multimedia information to the reality

that humans can naturally perceive (Peressotti, 2016). This technology is potentially usable by every category of user and is mainly used in the field of 3D vision through smart glasses. Augmented Reality is one of the two dimensions of digital reality; the other aspect is Virtual Reality. While Augmented Reality allows the user to see digital parts, superimposed on physical parts, Virtual Reality isolates the user from the external environment, immersing him or her in a parallel digital reality, which absorbs him completely (BCG, 2016; McKinsey Company, 2016; Deloitte, 2016; Seth, Vance, & Oliver, 2011);

4. **Cloud Computing Solutions.** The increasing amount of data that businesses collect and the processing of those data for business intelligence control cannot be handled with traditional servers (PwC, 2015), but requires additional computing resources, available flexibly to avoid the high costs of overprovisioning, and can be met through cloud computing solutions (Obitko & Jirkovský, 2015).
5. **Simulation** which consists of the use of simulation systems of the production processes that can reprocess data collected in real time to analyze and improve processes and assess possible problems that may arise in reality (Peressotti, 2016; Carminati, 2016);
6. **Industrial Internet of Things**, or IoT, was conceived by a British entrepreneur, Kevin Ashton, who in 1999 envisioned a system in which the entire material world is interconnected, exchanges information collected through sensors and makes decisions based on the processing of that information (Witkowski, 2017). In the ten years since, the number of connected devices has surpassed the number of the world's inhabitants (Witkowski, 2017). The IoT can be defined as a network of systems physical, which can interact with each other, thanks to standard communication protocols (Waitzinger, Ohlhausen, & Spath, 2015), to achieve a common goal (Obitko & Jirkovský, 2015);
7. **Big data & Analytics** refers to those technologies that support the process of collecting, organizing and analyzing large amounts of data ("Big Data") from a variety of different sources (Commission, 2015). These technologies are used to process data whose size is beyond the capacity of the tools traditionally used to store, manage and analyze them. The concept of Big Data is not only related to the

amount of information, but also to the computational capacity of models for real-time data processing (Yin & Kaynak, 2015). They result from the combination of technological innovations in the field of algorithms and predictive models (Schmidt et al., 2015);

8. **Cyber Security.** The growing sharing of data between increasingly connected devices increases the need in the enterprise to protect production systems and network from potential threats (Peressotti, 2016). The main task, therefore, of cyber security is to protect and safeguard businesses from risks arising from the cyberspace, that complex ecosystem of interaction of people, software and services with Internet technologies, devices and networks (Baldoni & Montanari, 2015; Hypponen & Nyman, 2017);
9. **Vertical and horizontal System Integration.** Industry 4.0 requires greater integration of processes along the value chain and those two types of integration can be identified (Mrugalska & Wyrwicka, 2017), thus the integration of data and systems along the entire value chain, whereby all departments and business functions become part of one integrated system (Peressotti, 2016). In particular, horizontal integration refers to network generation of value creation involving the integration of different agents such as business partners and customers, business models and cooperation. Vertical integration, on the other hand, concerns smart production systems e.g. smart factories and products, smart logistics networking, production marketing and services (Mrugalska & Wyrwicka, 2017).

These nine technological pillars will come to help later when talking about trends in the Fashion Industry.

Just as there are multiple definitions of strategic innovation that, however, seem to agree that it takes the form of defining a new business model, there are also multiple definitions of business model. These seem to agree that a business model: *“is used as a conceptual framework to provide a holistic but abstract understanding of the underlying business logic of an organization”* Bagnoli, Massaro, Dal Mas, and Demartini (2018).

In this paragraph, I will mention what is strategic innovation and which are the steps needed to initiate it. As explained by VeniSIA (2024), the strategic innovation is made possible through the creation of Innovative Products, Processes, and Value Chains:

- Innovative products (goods and/or services) to provide a drastically different, even transformational, experience;
- Innovative processes for the manufacturing and/or distribution of new or current items that can result in the acquisition of new client segments;
- Innovative value chains may open up new markets and improve value for both the business and the consumer by eliminating competition.

Initiating strategic innovation begins with providing answers to the following queries regarding the (re)definition of the business model:

- Who are the clients we serve?
- What can we provide them?
- How can we best and efficiently provide it to them?

The “Who” and “What” are frequently defined first, followed by the “How”. This approach carries the danger of not innovating at all and instead beginning with the target market’s identification and, consequently, the demands indicated by present consumers. Because of this, strategic innovation happens more frequently when this analysis is reversed, which is, by developing an outstanding operational model first, followed by defining the “What” and subsequently the “Who” (Bagnoli, Bravin, et al., 2018).

Every strategic aspect has the capacity to impede the creation of radical breakthroughs. According to Bagnoli, Bravin, et al. (2018), the inclusion of users in the venture development process, as recommended by the “Who” dimension, could provide little functional enhancements to product redesign. On the other hand, it is more likely to produce novel results to challenge the “How” dimension (Bagnoli, Bravin, et al., 2018).

A more complicated structure has been created 2.4, building upon the triangular framework 2.3. If, as in the original framework, the “What” is still anchored in the product offering, the “Who” is expanded to include not only customers but also suppliers and society, understood as the collection of corporate stakeholders. The “How” is expressed in the company resources and processes functional to realize the products.



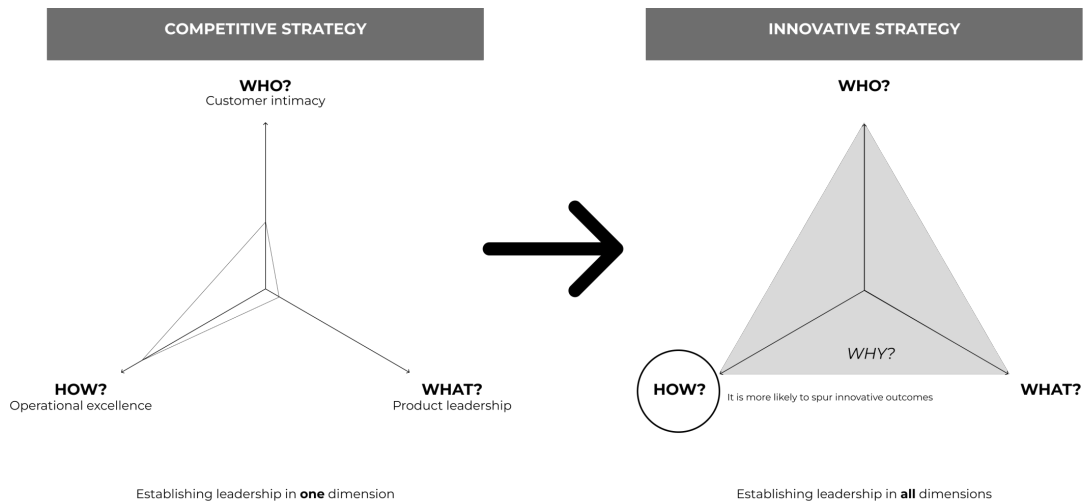


Figure 2.3: From competitive to innovative strategy (Bagnoli, Bravin, et al., 2018)

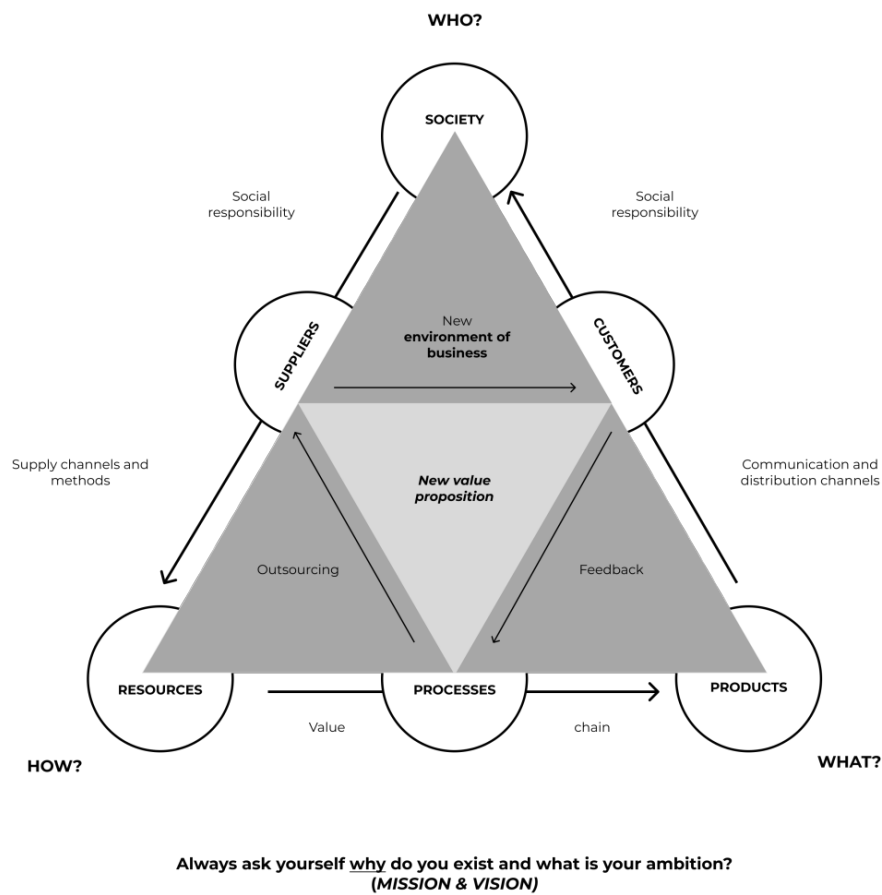


Figure 2.4: The business model framework by Bagnoli, Bravin, et al. (2018)

The business model framework used in the previous figure may be “opened” to create a canvas 2.5, which is a quick and easy visual strategic tool that can be used to map a company’s business model in a thorough and streamlined manner, the first step towards

its redesign. Two more areas, which address the effects of strategic decisions at the level of the cost structure and revenue model, which together make up the profit model, frame the areas directly related to the components of the established business model.

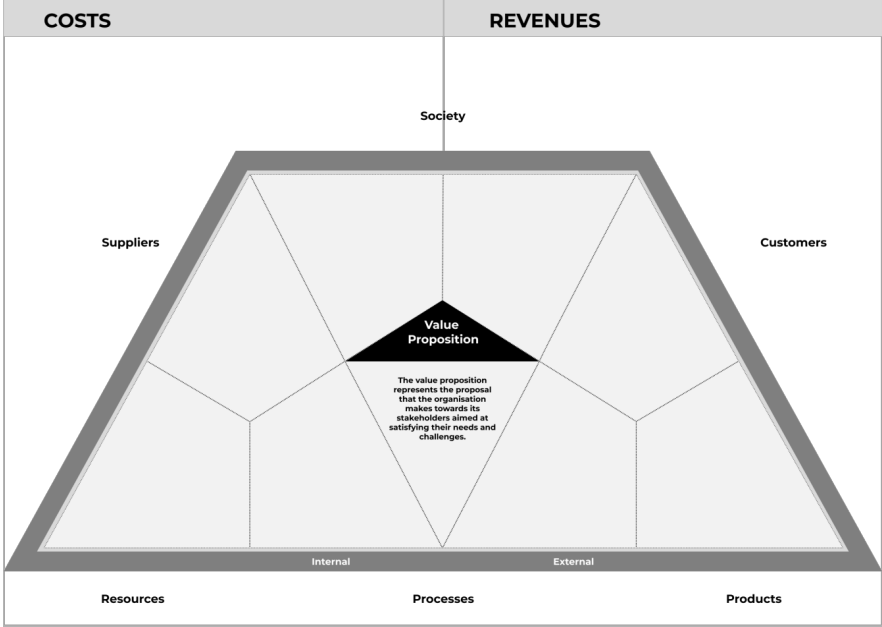


Figure 2.5: The business model canvas by [Bagnoli, Bravin, et al. \(2018\)](#)

The creation of a new business can take place by already established companies operating in adjacent businesses through the launch of re-start-ups. Due to the innovator’s dilemma, however, it is more likely to be done by genuine start-ups ([Christensen & Raynor, 2004](#)). Indeed, it is more often the latter that redefine the established boundaries of traditional businesses by proposing very disruptive solutions made possible by Industry 4.0 enabling technologies. This is to the damage of incumbent companies that tend to focus on the mere improvement of existing products and processes and are therefore doomed to go out of business ([Capgemini Consulting, 2014](#)). Indeed, the industry leaders of the future will be those who seize the opportunities offered by the fourth industrial revolution to develop disruptive business models.

## 2.3 Policies and Circular Economy in the Fashion Industry

There are several fronts on which the European Union is working: Corporate Sustainability Due Diligence Directive (CSDDD) regarding supply chain control, waste management, Eco Design (i.e., design that meets the criteria of durability, repairability, reuse and transparency), Green Claims to limit greenwashing operations, Corporate Sustainability Reporting Directive (CSRD) to regulate companies' reporting on their environmental and social performance, Deforestation-free products to counter the extraction of raw materials that can contribute to the deforestation of the planet. In addition, the EU recently banned the destruction of unsold clothing and accessories, forcing companies to find alternative solutions such as resale, donation, and recycling ([European Commission, 2024](#)).

In this context, the integration of technology is essential to encourage a Circular Economy in the Fashion Industry. In fact, the use of digital tools such as digital IDs or blockchain makes it possible to trace the origin, production and recycling of garments throughout the supply chain. This approach promotes transparency and helps companies comply with the Corporate Sustainability Reporting Directive (CSRD), which imposes increasingly stringent standards for environmental and social reporting as mentioned by [Abdelmeguid et al. \(2024\)](#).

As further mentioned in the same article, the adoption of innovative business models, such as clothes rental or product-as-a-service, is a concrete response to the challenges of Sustainability in the Fashion Industry. These models reduce impulsive purchases and promote prolonged use of garments, in line with the European objective of reducing waste and encouraging reuse. Regulations, such as the ban on destruction of unsold garments and the obligation of transparency through Green Claims, actively support the adoption of such practices.

Among Ellen MacArthur Foundation's most recent projects, which was created with the goal of valuing a Circular Economy concept, is The Fashion ReModel. The latter was created to engage companies by providing alternative solutions to classic business models as explained on Vogue Italia by [Di Giamberardino \(2024\)](#). *"When a brand has the ability to innovate by adopting a Circular Economy model, it is up to us consumers not to be skeptical but to believe in it and show participation"*, Magnani, Senior Policy Analyst of the

Ellen MacArthur Foundation, stressed in the interview. *“We want to show that it is not only important to redesign a product from a sustainable perspective, but to change the way it reaches the consumer”*. Magnani goes further by mentioning that it is possible to generate profits not only from the incremental sale of a higher number of pieces, but also from the circulation of a fixed (hence less impactful) number of clothes. Therefore, rental, repair, re-assembly are practices with very high potential that they are trying to explore. *“All of this is true even for the most virtuous realities like Pangaia perhaps: Sustainability cannot come through products alone, it has to be transformed into an economic model for it to be a real success. In fact, if the search for innovative materials has stalled, it is because we do not have the right infrastructure to recycle and dispose of them, so there is little point in proceeding in this direction”*, Magnani stressed. The Senior Policy Analyst concludes the interview by mentioning that, to date, the only real innovation and the only direction in which to push technological progress is precisely Circularity ([Di Giamberardino, 2024](#)).

The creation of suitable infrastructure for material recycling is a prerequisite for the widespread adoption of the Circular Economy in the Fashion Industry. As brought out by [Abdelmeguid et al. \(2024\)](#), currently, many of the innovative materials introduced on the market cannot be efficiently recycled due to the lack of specialised facilities. In this context, the European Union’s Circular Economy Action Plan aims to fill this gap by promoting investment in the necessary infrastructure for recycling and sustainable disposal. Adopted in March 2020 as part of the European Green Deal, the new Circular Economy Action Plan (CEAP) aims to reduce pressure on natural resources, promote sustainable growth and create jobs, while also contributing to climate neutrality by 2050 and the protection of biodiversity. The plan introduces initiatives throughout product life-cycles, promoting sustainable design, circular processes, responsible consumption and waste reduction. The measures focus on resource-intensive sectors including textiles.

On the [European Commission \(n.d\)](#) website there is a section called “How is the EU making Fashion sustainable?” where one can learn about how the EU is ensuring the transition to a more Sustainable Fashion by guaranteeing clothing and textiles that last longer, are easier to repair and are produced ethically. The EU strategy is based on several key phases. The first phase concerns the Sustainable and Circular Textiles Strategy, which aims to transform the entire textile sector by 2030. This strategy focuses on the entire life cycle of products, from origin to waste management, focusing on more durable, repairable

and recyclable garments. Manufacturers will have to take more responsibility for their products, promoting a Circular Economy. Another central step is the creation of design requirements for textiles. Since 80% of a product's environmental impact is determined in its design phase, the EU will set new standards to ensure that garments are more durable and easier to repair and recycle. In addition, minimum requirements will be introduced for the use of recycled materials in textiles, with the aim of reducing the use of virgin raw resources. To tackle the issues of overproduction and overconsumption, the EU strategy also aims to reduce textile waste and limit the export of used clothing to countries outside Europe. Specific measures will be taken to counter the destruction of unsold and returned garments by encouraging their reuse and recycling. In parallel, the EU is working to solve the problem of microplastics released by synthetic fabrics, such as polyester. Microplastics produced when washing clothes account for up to 35% of the total plastics that can be found in the oceans. To tackle this problem, the EU is funding research to reduce this phenomenon and develop concrete solutions to limit the release of microplastics from textiles. Finally, an important part of the EU strategy is the fight against greenwashing, or false environmental claims. As of 2023, companies will have to provide solid evidence to justify their Sustainability claims. The use of misleading labels, such as 'green' or 'eco-friendly', will be prohibited unless they are supported by verifiable data. These measures will provide consumers with greater transparency and help sustainable companies stand out from the competition. In addition, the new rules on Corporate Sustainability Due Diligence will require companies to manage environmental and human rights impacts throughout their supply chain, thus promoting more ethical and responsible behaviour in all Fashion-related sectors.

Summing up, in the past few years, "the rules of the game" have been redefined, but this is just a starting point. In this sense, consumer education plays a key role in promoting Sustainable Fashion. By pushing companies to improve their production practices, European policies, such as environmental labels and transparency regulations, help consumers to make informed and conscious choices. The aim is to create a closer link between consumers and producers, facilitating responsible behaviour throughout the supply chain. To understand how experts and consumers think about Fashion sustainability, in this section I review the literature in order to examine regulators and consumer demand in this area.

## 2.4 Regulatory pressure

Historically, the industry has had a major impact on carbon emissions, both via direct and indirect pollution, but luckily the trend of the Fashion Industry's self-regulating sustainability seems to be coming to an end. Companies finally realised that the social and environmental consequences connected to the Sector are too high to be ignored (Kirpalani, 2022). According to Kent (2024), new regulations ranging from waste management, recycling, the usage of chemicals and the production of textiles are being implemented. Many of these regulations may have a broad effect on Fashion players and consumers in many jurisdictions.

The annual report of Business of Fashion (BOF) 2024 by Bain (2024) also suggests that new rules set to mandate action on Sustainability across the globe may no longer be an option, as governments and international bodies move to address the industry's significant environmental impact.

First of all, regulations are set to shape the design phase of fashion products, emphasizing recyclability, durability, and the reduction of harmful substances.

The EU is leading the way in advancing a vision of a Circular Economy that is free of carbon emissions and separates economic growth from the use of limited resources. The EU's Strategy for Sustainable and Circular Textiles, which was passed already in June 2023, captures the vision of the textile sector. This regulations, as explained by Kent (2024), wants an industry characterized by products that respect social rights and that preserve the environment. This regulation becomes necessary because, up to 80% of a product's environmental impact is determined during its design phase, largely through decisions about materials and dyes, which can be made more consciously.

Moreover, the EU's Ecodesign for Sustainable Products Regulation (ESPR), slated for full implementation by 2025, is a key driver in this regard, setting minimum design standards for products sold within the EU. The use of digital product passports to provide consumers with this information is anticipated to become mandatory, providing consumers with transparent information about a product's environmental footprint. In sourcing and production, efforts to reduce carbon emissions are focused on the upstream supply chain, which contributes the most to emissions in the apparel industry. Decarbonization strategies include improving energy efficiency and transitioning to renewable energy sources. Brands are also seeking sustainable materials and may establish new supplier relationships

or form strategic partnerships (Kent, 2024).

If the ESPR will force manufacturers and brands to step up their efforts to reduce waste and greenhouse gas emissions, the EU Green Claims Directive and similar initiatives aims to ensure that Sustainability-related declarations are specific, evidence-based, and communicated clearly. Carbon labelling requirements, such as those introduced in France, are becoming more common, providing consumers with information about a product's carbon footprint. This Directive is set to put an end to misleading Sustainability.

With less than 1% of Fashion textiles currently recycled, regulators are pushing for extended producer responsibility and improved waste management practices. Amendments to the Waste Framework Directive, along with initiatives such as France's requirement for carbon labelling on clothing, aim to incentivize companies to finance the collection, sorting, and recycling of textile waste. Moreover, bans on the destruction of unsold goods and the implementation of textile collection programs are also on the horizon.

As already stated, Fashion Sustainability encompasses more than just the production of textiles; it examines Fashion from the viewpoints of many different parties, including both current producers and customers as well as future ones. It covers every phase of the life of a clothing item, including how and by whom it is manufactured, and how long it lasts before being thrown away.

Despite the proliferation of ESG disclosures, companies struggle to provide consistent and comprehensive data on their Sustainability practices. The upcoming Corporate Sustainability Reporting Directive (CSRD) aims to address this challenge by requiring companies to report on ESG activities through a standardized framework. Instead, the CSDDD mandates environmental and human rights diligence across the value chain, ensuring greater transparency and accountability. In this context, achieving full supply chain visibility is essential for regulatory compliance, yet many brands still lack reliable data on their suppliers.

Moreover, advances in blockchain and other technologies offer opportunities for more transparent and efficient monitoring of supply chains. Companies like Adidas are already leveraging digital traceability platforms to achieve material traceability at scale, paving the way for greater transparency and accountability.

Furthermore, decarbonizing material and garment production is a key focus area for regulators, with initiatives aimed at reducing emissions and promoting sustainable source-

ing practices. Brands are exploring new materials and suppliers, with some establishing supplier-focused sourcing standards and partnering with innovative start-ups. Collaborations of this kind and innovation are key to driving progress in this area, as brands seek to minimize their environmental impact while maintaining profitability.

Regulations are expected to drive changes in the design process, with a renewed emphasis on longevity, durability, and recyclability. Designers may need to rethink materials and construction techniques to meet circularity requirements, while advancements in 3D sampling and packaging design offer opportunities for more sustainable practices. Creative solutions and innovative partnerships will be essential for meeting regulatory requirements while delivering innovative and desirable products.

Lastly, to minimize waste and promote circularity, new business models are emerging, offering alternatives to traditional linear consumption patterns. Resale, rental, and repair programs are gradually becoming popular, providing consumers with sustainable alternatives to Fast Fashion. Closed-loop recycling technologies, such as Renewcell's fibre-to-fibre recycling factory, offer opportunities for transforming waste into new materials, by ensuring that products are either recycled, repurposed or reused. However, scaling these solutions poses many challenges.

In the last 25 years, the Fashion Industry has not succeeded in reducing its impact on the environment, despite numerous attempts at innovation. As stated by [Kirpalani \(2022\)](#) all efforts are now aiming at lowering the significant carbon footprint by reducing the industry's greenhouse gas emissions from manufacture to transportation. However, the industry's multi-tiered supply chain continues to be opaque and complex ([Pucker, 2022](#)) as few brands own the assets of their upstream factories, and the majority of them outsource final production as a result of trade liberalization, globalization, and persistent cost pressures. According to environmental scientist Linda Greer, in an interview for the journal *Fashionista* by [Cline \(2019\)](#), *“very, very few brands know where their stuff comes from in the supply chain, and even fewer of them have entered into active relationships with those suppliers to reduce their carbon footprint”*.

Nevertheless, the industry is projected to bring in over 2.25 trillion dollars by 2025, up from 1.46 trillion dollars in revenue in 2020. Initiatives and business plans for more environmentally friendly fashion manufacturing and sourcing are becoming more widespread. An alternative known as “Slow Fashion” holds the potential to mitigate the drawbacks



associated with Fast Fashion. Innovative company concepts that are built on ethical and environmental principles, however, also require more capital as suggested by [Kirpalani \(2022\)](#).

Although it is frequently possible to monitor and assess an initiative's environmental impact, there is an ongoing discussion about whether Sustainable Fashion is "good business" in terms of finances. Fashion firms are beginning to understand that it makes financial sense to invest in long-term, creative projects that promote sustainability and social responsibility; in fact, this may be the only course of action that may ensure the industry's survival.

## 2.5 Consumers' demands

The Fashion Industry is known for its capacity to establish trends influencing society and the purchasing behaviours of consumers. Sustainability is currently the most fashionable "trend" and the most environmental aware customers are pressuring the Fashion Industry to consider its environmental impact and asking for its regulation.

According to a survey conducted by McKinsey in 2020 ([Granskog, Lee, Magnus, & Sawers, 2020](#)) "67 percent [of respondents] consider the use of sustainable materials to be an important purchasing factor, and 63 percent consider a brand's promotion of sustainability in the same way".

A Bain & Company research from 2022 carried out by [D'Arpizio et al. \(2022\)](#), showed that approximately 15% of consumers of Fashion worldwide are already very concerned about sustainability and often choose products that will reduce their impact. But given that more consumers are becoming interested in sustainable practices, that figure may rise to more than 50% in the upcoming years. From the research it emerged that shoppers are concerned about Sustainability but lack the knowledge to take appropriate action. About 65% of them are concerned about the environment but only a small percentage consistently consider sustainability a priority when they shop. From the research it further emerged that Sustainability, being one of the top six buying reasons, is clearly a lower priority than other, more concrete aspects. When it comes to fashion purchases, people prioritize product quality over factors like price, fit, and style. Quality has a constant, universal appeal because it is the primary deciding factor for purchases in every nation

that participated in the poll. Consistently across nations, durability holds the fourth position among the most important aspects when making a purchase. However, even though consumers may not realize it, Sustainability is strongly linked to quality and durability.

While consumers might still have a vague, subjective, or even abstract idea of sustainability, the term has gained momentum. Younger generations are increasingly concerned about it. Brands may gain a competitive edge and capture a sizable portion of a quickly expanding market by exhibiting leadership and implementing sustainable practices (D'Arpizio et al., 2022).

After gathering information from different sources, it becomes clear that customers of today are increasingly aware of how their purchases will affect society and the environment. Nowadays, customers look for businesses that share their beliefs and place a high priority on Sustainability. As reported by Zajac, Kotlarek, and Dlutowska (2021), a big acceleration was caused by the pandemic, which led shoppers to rethink some of their practices, including their spending habits. Customers are buying fewer products overall, exercising greater selectivity, and choosing well-known brands that they can relate to and trust. Additionally, people are requiring companies to behave with a distinct mission and vision that they can support and identify with. This change in customer behaviour highlights the need for clothing shops to implement sustainable practices and provide eco-friendly design alternatives.

The change is led by Generation Z, also called the “sustainable generation”. As mentioned by Hope (2022), 62% of Gen Zers prefer to buy from sustainable firms and are prepared to pay extra for products made responsibly. This generation’s need is the reason behind the growth of resale websites like Vestiaire Collective, Rebag, StockX, and The RealReal. Being ‘green’ has become a genuine social movement, and not simply a temporary trend.

Moreover, the term “Sustainability” is creating a real buzz. In accordance with data from Launchmetrics (2021), which examined the amount of media discussion around the term “Sustainability” generated across several sectors, the Media Impact Value (MIV) for Sustainability increased by 54% in the first semester of 2022 compared to the same period in 2021, accounting for \$ 2 billion and \$ 1.3 billion in value, respectively. The term “Media Impact Value” refers to an algorithm that Launchmetrics (2022) developed. Its

main purpose is to measure and evaluate media mentions and placements across many platforms in the Fashion, Luxury, and Beauty industries in a comparative manner. This process makes it easier to assess the return on investment (ROI) of different marketing initiatives and the public perception of a brand, making it possible to compare the impact of media across a variety of channels, such as print, web, and social media. As evidenced by the comparison between the industry's placements and the expanding MIV, consumers are beginning to make changes. "Making Sense of Sustainability", the sustainability report published by [Launchmetrics \(2023\)](#) in collaboration with Camera Nazionale della Moda Italiana states that during the first semester of 2022, Fashion accounted for \$ 618 million in MIV. (The analysis examined information from several platforms from January 2022 to October 2022.)

In conclusion, the Fashion Industry in 2024 is at a pivotal point in its history, juggling the demands of innovation and sustainability with changing consumer tastes and legislative frameworks. It takes strategic thinking, flexibility, and a dedication to both environmental care and technology innovation to successfully navigate this complicated terrain ([Loboda, 2024](#)). This context is fertile ground for start-ups free of business preconceptions and skilled at harnessing technology with an eye on Sustainability-related issues.

# Chapter 3

## Emerging trends in the Fashion Industry: a manual analysis

As mentioned in the previous chapter, the Fashion Industry stands at a pivotal point as it deals with the complexities of 2024.

The expert viewpoint of Business of Fashion and McKinsey & Company's report "The State of Fashion 2024" by [Amed and Berg \(2023\)](#) provides insights that, when viewed through the lens of recent times, help us predict the trends and obstacles that will determine the course of the sector in the upcoming years. The industry showed strong economic growth in 2022 despite lasting and growing problems in 2023, highlighting its capacity for adaptation and development. However, executives in the Fashion Industry are bracing themselves for more challenges, with the term "uncertainty" resounding loudly in conversations. Geopolitical developments, faltering economies, and the lingering effects of high interest rates are all reasons for concerns. Furthermore, the necessity for Fashion firms to increase their resilience to climate impacts has been highlighted by extreme weather events that occurred in 2023.

As anticipated, regulatory constraints with a focus on Sustainability, force a reevaluation of supply chain procedures and business models. Therefore, manufacturers and brands will have to update their business strategies to reflect the impending changes. In this context key trends shaping the future of Sustainable Fashion are emerging. Their focus is on regulatory developments and their implications for product design, marketing, waste management, reporting, traceability, sourcing and production, design, and end-of-life waste.

## 3.1 Macro-Trends in the Fashion Industry

The annual report of Business of Fashion (BOF) in collaboration with [Bain \(2024\)](#) brings out the state of Fashion in 2024. The Fashion landscape is characterized by 5 main macro-trends, where Fast and Sustainable Fashion are both part of the 2024 Fashion system.

The five trends are summed up here briefly:

1. **Gen AI's Creative Crossroad:** Generative artificial intelligence (GenAI) is emerging as an important tool in the Fashion Industry, used for creativity, design and product development. With 73% of Fashion executives considering it a priority for 2024, companies in the industry are expected to invest more in this technology to enhance human creativity and improve process efficiency. According to the McKinsey analysis by [Amed and Berg \(2023\)](#), as much as one-fourth of Generative AI's potential value in fashion may be driven by use cases in design and product development. Code writing, design support, and sales team empowerment are just a few of the Fashion Industry tasks that GenAI has the ability to enhance, speed up, and automate. Executive teams can learn best by acting, even while there are hazards associated with GenAI. It has become clear that the quick learners will create a blueprint for achieving financial gains.
2. **Competitive Strategies for Fast Fashion:** competition in the fast Fashion Industry is set to intensify, with companies like Shein and Temu revolutionising pricing, customer experience and speed strategies. The ability to adapt quickly to consumer preferences and navigate new regulations will be crucial to success for both disruptors and incumbents. Customers' attention has been drawn to the third generation of Fast-Fashion retailers. As explained in the report, within the last year, 40% of US and 26% of UK customers have shopped at Shein or Temu. Many operational model advances, such as flexible manufacturer-to-consumer supply chains and data-driven product design, are what underpin the success of a large portion of the third generation and make Fashion faster and more affordable than before. However, Fast Fashion has recently encountered some difficulties as consumers' awareness and regulatory standards have changed ([Amed & Berg, 2023](#)).
3. **The Rebirth of Brand Marketing:** the return of brand marketing is another

significant trend, as consumers' emotional connection with brands is becoming increasingly vital. Fashion companies are shifting their focus from performance marketing to long-term brand building, seeking to create authentic and lasting brand stories. As per the BoF-McKinsey State of Fashion 2024 Executive Survey ([Amed & Berg, 2023](#)), 71% of fashion executives aim to increase their budget for brand marketing in 2024 compared to the previous year, and 46% want to increase their budget for performance marketing.

4. **Sustainability Rules - Regulations and New Business Models:** Sustainability regulations are becoming increasingly rigorous, pushing fashion brands to review their business models. With the introduction of new laws in Europe and the US, companies need to adapt quickly to reduce greenhouse gas emissions and waste, and to develop models that protect and conserve natural resources. In the EU alone, as late as 2023, up to 16 pieces of legislation pertaining to textiles and fashion were being discussed; with the first coming into force in 2024. The laws will affect consumers and businesses worldwide and include the whole Fashion value chain, from product design to marketing ([Amed & Berg, 2023](#)).
5. **Bullwhip Effect and Supply Chain Dynamics:** changes in consumer demand have caused the so-called 'whiplash effect' along the Fashion supply chain, creating volatility and uncertainty. To adapt to these fluctuations and prevent overcapacity, brands need to focus on transparency and strengthen strategic partnerships. This last one represents more a growing challenge than a trend for the Fashion Industry that requires new strategic and operational approaches to manage supply chains more efficiently and resiliently. In order to survive and prosper in a changing environment, the implications of this trend drive the adoption of new technologies, the reorganisation of operations, and the development of collaborative Sustainability-related strategies ([Amed & Berg, 2023](#)).

The next paragraph will focus only on Technology Trends.

## 3.2 Technology Trends in the Fashion Industry

In recent years, the Fashion Industry has witnessed a rapid transformation driven by the adoption of new technologies. In an increasingly competitive and unstable market, technology is no longer an option but a strategic prerequisite for Fashion companies that are seeking to differentiate themselves and respond to changing consumer needs. The current challenge is being sustainable. However, developing new sustainable practices requires technological advancements. In this regard, the report published by the organisation [Force for Good \(2023\)](#), explored the role of technology in achieving the Sustainable Development Goals (SDGs).

Innovative start-ups are changing the global landscape of Fashion creation, marketing, and consumption and [StartUs Insights \(2023\)](#) identified eight Fashion Technology Trends that emerged during the year of 2023.

- **Artificial Reality (AR) and Virtual Reality (VR):** the Fashion Industry is moving from a physical to a digital realm thanks to technology. Virtual Fashion solutions offer limitless creative space and use AR or VR to bypass physical limits. Through sensors and the ability to recognise objects through cameras, the AR scans the surrounding environment adding virtual objects and other non-real features which in most cases are interactive and follow the user's movements or gestures. AR is able to augment perceptions of reality in terms of both visual and auditory features, making it a unique interactive experience. AR technology is often associated with VR, but the differences are many as explained by [Yong-Chin \(2021\)](#). VR technology, in fact, immerses the user in a completely artificial digital environment, as is the case in gaming and entertainment. The experience of AR is not at all disorienting and can be easily used through smartphones or tablets in the retail sector “to entertain, educate costumers, help them evaluate product fit and enhance the post-purchase consumption experience” ([Yong-Chin, 2021](#)).
- **Blockchain:** transparency and data security are pivotal considering growing digitization. Authenticity is guaranteed for both digital and physical Fashion goods using blockchain-based solutions. Product digital passports, which verify transactions and deter counterfeiting, and traceability systems, improve supply chain traceability. Non-fungible tokens (NFTs) are another blockchain-based technology

that establishes ownership of an item ([StartUs Insights, 2023](#)). NFTs for the Fashion Metaverse are also being released by designers and fashion brands. They are an opportunity to test new products and play with AR, proving to be the right medium for the creative industry of Luxury.

- **Artificial Intelligence (AI):** by incorporating AI, Fashion firms are redefining how they approach the design and production of new products. The technology predicts trends in fashion to assist brands in being adaptable to shifting consumer needs. By integrating AI into the buying process, brands can guarantee that clients receive a customized experience. Additionally, AI streamlines wardrobe planning by providing tailored buying suggestions based on previous purchases. Synthetic media, sometimes referred to as AI-generated media, is helping Fashion firms come up with more innovative ways to improve the customer relationship and better address market demand ([StartUs Insights, 2023](#)).
- **Circular Tech:** start-ups are creating Circular Fashion solutions with the goal of making the Fashion sector carbon neutral. These solutions give consumers and brands an alternative to fast-production items by manufacturing clothing from eco-fabrics and recycled materials. Reusing worn-out textile components or post-consumer waste to create new products is another method. Moreover, less water is used when linen, hemp, and recycled fibres are used. Sustainable substitutes for traditional textiles include various materials like vegan leather and other engineered materials as explained by [StartUs Insights \(2023\)](#).
- **Smart Product:** start-ups are introducing smart clothing to address the demand for it. Smart products can be constantly monitored remotely and they gather, store, and share the wearer's physical and biometric information. This enhances performance and makes applications for fitness and health possible. The Internet of Things (IoT) is advancing the design of smart clothes, for example by regulating the temperature to the user's needs in an unstable environment. The smart product business model involves harnessing digital technologies to integrate the physical world with the digital world through the creation of cyber-physical systems (CPS): 'smart' finished products, as well as 'smart' machines and production facilities that underpin the realisation of the 'smart' factory ([Bagnoli, Bravin, et al., 2018](#)).



- **Additive Manufacturing, i.e. 3D Printing:** refers to the production of objects in three dimensions from virtual models. Additive manufacturing leads to the digitisation of production, starting from the idea to its materialisation, from the prototype to the finished product ([The Boston Consulting Group, 2015](#)). Fashion brands are increasingly using customization to produce unique designs and provide tailored solutions. By using additive manufacturing, businesses may create eco-friendly and sustainable solutions for the Fashion sector while still responding to consumer demands. It also makes demand-driven production possible, which in turn helps to avoid overproduction. In order to improve personalisation, engage younger consumers more, and offer shoppable Virtual Fashion assets and real clothing, start-ups are now creating Fashion gaming solutions.
- **Big Data & Analytics:** brands can use data to plan and develop new designs by utilizing big data and analytics. Additionally, it enables marketers to make data-driven decisions that streamline collection planning and inventory management. Data analytics is being used by fashion businesses and retailers to enhance their product offers and outreach to their target market. It boosts sales and profitability by providing customisation. The technology also recognizes damaged goods for future repairs and forecasts manufacturing hazards ([StartUs Insights, 2023](#)).
- **Live Streaming:** consumers are spending more time on digital media as a result of the growing trend of digitization. For this reason, live streaming is being used by Fashion firms to provide their target consumers with digital content. The advantages of social media and at-home purchasing are combined in the live shopping trend that gives users an immersive and engaging experience and encourages a feeling of community among its users. Advancements in technology, like 5G, are enhancing live streaming quality and encouraging more interactive content along with practical e-Commerce features ([StartUs Insights, 2023](#)).

Figure (3.1) sums up the Fashion technology trends and innovation of 2023.

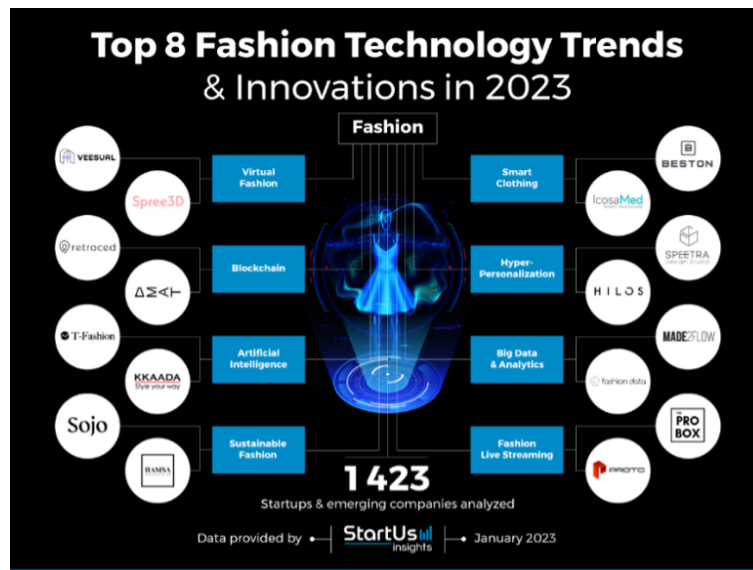


Figure 3.1: Top 8 Fashion Technology Trends and Innovations in 2023 (StartUs Insights, 2023)

Sustainable and technological trends are often complementing each other, but among the 8 trends highlighted above, not all of them also have a sustainable focus. Likewise, low technological innovations can also contribute to Sustainability. To better separate and isolate sustainable trends, in the next paragraph I delve deeper into the most established ones.

### 3.3 Sustainability Trends in the Fashion Industry

To identify sustainable trends in the Fashion Industry, I conducted an in-depth meta-analysis. For this, I manually examined and synthesised 8 leading articles focusing on providing a comprehensive and detailed view of emerging trends. In order to obtain a final list of trends redefining the Sustainable Fashion landscape that are common across the articles, I followed these steps. The starting point was the “Article Trend”, that is a specific label accredited to the trend in the article. Since these labels were highly heterogeneous across articles, even when identifying the same trend, I used a first sub-grouping, in which “Article Trend” from the same or different articles are merged together. This ensures a degree of homogeneity that was absent in the original articles. The second step consisted in merging different “sub-group 1” trends into seven final trends. The merging choice is justified by the similarities among the sub-groups and the necessity to have a final classification at the macro level and not extremely granular.

The table in Figure (3.2) displays the meta-analysis highlighting the different steps.

Article Trend	Article	Sub-group 1	Final Trend
Garment Disassembly Technology	SmartUS Insights (2021)		
Textile Material Recovery	SmartUS Insights (2021)	Garment recycling	
Clothes from Recycled Fibers	SmartUS Insights (2021)		
Upcycled Fabrics	SmartUS Insights (2021)		Circular fashion: garment recycling and upcycling
Advanced Fiber Recycling Technology and Systems	Gripenberg (2024), Chan (2023)		
Circular Economy and Upcycling	Loboda (2024), Awear(2023), Priyanka (2024), Chan (2023)	Circular and upcycling	
Circular Fashion Initiatives	Priyanka (2024), ApparelMagic (2023)		
Ethical and Transparent Supply Chains	Loboda (2024), Priyanka (2024), Pathak (2023)		
Efficient Supply Chain	Awear(2023)		
Sustainable Sourcing	Awear(2023)	Transparent Supply Chains	Ethical & Transparent Supply Chains
Gender Fluidity Plus Sustainable Practices	ApparelMagic (2023)		
Just transition for workers	Chan (2023)		
Innovative Sustainable Materials	Loboda (2024), Pathak (2023)		
Novel Materials from Food Waste, Algae, and Mushrooms	Gripenberg (2024)		
The Rise of Vegan Fashion	Gripenberg (2024), Pathak (2023)		
Vegan Leather Dominance	Priyanka (2024)	Sustainable Materials	Sustainable materials and the rise of vegan fashion
Biodegradable Fabrics	Priyanka (2024)		
Use of Biotechnology	ApparelMagic (2023)		
Seaweed is the material	Chan (2023)		
Reversible Colouring Technology	SmartUS Insights (2021)		
Waterless Dyeing Techniques	Priyanka (2024)	Sustainable Colouring Technologies	
Eco-Friendly Dyes	Chan (2023), Phatak (2023)		
Tech-Enhanced Textiles and Design	Loboda (2024), Pathak (2023)		
Adoption of E-Textiles	Loboda (2024), Pathak (2023)		
Digital Fabric Printing	Awear(2023)	Tech-enhanced Textile	Tech-Enhanced Textiles & Design
Smart Fabrics	ApparelMagic (2023)		
3D Printing	ApparelMagic (2023)		
Circular Design Software	SmartUS Insights (2021)		
Use of Robotics in Production	ApparelMagic (2023)	Design Software and Robotics	
Digitization and Virtual Fittings	Loboda (2024), Awear (2023), Pathak (2023)		
Virtual Showrooms and Fashion Shows	Awear(2023)		
Fashion Metaverse	ApparelMagic (2023)	Immersive Fashion Tech	Immersive Fashion Tech: Digitization & Virtual Fittings
Immersive Fashion Technologies	ApparelMagic (2023)		
Merchandise Management Platform	SmartUS Insights (2021)		
Reduced Physical Production	Awear(2023)		
Sustainable Design Evolution	Awear(2023)		
E-Commerce and Reduced Packaging	Awear(2023)	Reduced Production / Merchandise Management	
On-demand fashion	Gripenberg (2024), Chan (2023), Phatak (2023)		
Sustainable Clothing	ApparelMagic (2023)		On demand fashion and merchandise management platform
Use of Artificial Intelligence	ApparelMagic (2023)		
Technology Such As ERP and PLM	ApparelMagic (2023)		
Slow Fashion and Minimalism	Loboda (2024), Priyanka (2024), Pathak (2023)		
Multipurpose Pieces	Priyanka (2024)	Slow Fashion and Minimalism	
Rental and Clothing Swaps	Priyanka (2024)		
EU Legislation: Enforcing Accountability and Responsibility	Gripenberg (2024), Chan (2023), Phatak (2023)	SDGs and ESG Legislation Compliance	SDGs and ESG Legislation Compliance

Figure 3.2: Sustainability Trends in the Fashion Industry.

These trends represent the most relevant practices, innovations and directions in which the industry is moving. Here is a description of the identified trends:

- **Circular Fashion: Garment Recycling and Upcycling.** The requirement to quickly dismantle vast quantities of clothes is one of the obstacles limiting the recycling of used clothing. For this reason, clothing disassembly technologies are being developed by start-ups and scale-ups, making it easier to recycle and reuse textiles. Moreover, reusing resources to create new products is made possible by technologies that enable the recovery of materials from discarded textiles. A Fast-Fashion clothing problem is that garments typically lose their colour and shape quickly, impacting on the environment. Growing businesses are prepared to provide the more sustainable solutions that environmentally concerned consumers are demanding by creating durable, stylish clothing out of repurposed materials. In this case, dead-stock or excess fabrics make much more sense for garment production than wasted ones that require water and other valuable natural resources to produce. Around the world, start-ups are saving textiles from being thrown away to make fewer impacting clothes as mentioned by [StartUs Insights \(2021\)](#).
- **Ethical & Transparent Supply Chains.** In a world where everything is connected digitally, transparency is king. Digital platforms enable companies to track labour and commodities down to ethical and sustainable sources, promoting responsibility and accountable behaviours. They also provide a comprehensive picture of the supply chain. Moreover, efficient supply chains result from the smooth coordination and communication made possible by digital tools. This increased efficiency results in less waste, less surplus inventory, and a smaller carbon footprint due to emissions from transportation as explained by [Awear \(2023\)](#).
- **Sustainable Materials and the Rise of Vegan Fashion.** The Fashion sector is focused on finding sustainable materials. Fashion designers continue to find great value in food waste, as textiles made from fruits, vegetables, and other organic waste are becoming more and more fashionable. For example, due to their special qualities, algae and mushrooms are drawing the interest of designers as renewable and biodegradable substitutes for conventional textiles. Veganism has also grown popular. The demand for cruelty-free substitutes has increased as a result of ethical

concerns about the source of conventional materials like wool ([Gripenberg, 2024](#)).

- **Tech-Enhanced Textiles & Design.** Brands require knowledge about circular materials and ideal designs to create durable clothing that can be recycled and reused. Software solutions that furnish this information are being developed by start-ups, thereby facilitating circular design in apparel. Reusing manufactured clothing is encouraged by technologies that enable fabrics to be continuously recoloured without the need of harmful additives. This lessens the need for fresh raw materials while also extending the life of clothing ([StartUs Insights, 2021](#)). The transition to Tech-Enhanced Textiles is being driven by smart fabrics, which integrate technology like flexible electronics, sensors, and actuators into textiles directly. Fabrics infused with graphene adjust to the body's temperature, and materials that change color in response to outside stimuli both provide exciting new opportunities for Fashion. Beyond just being aesthetically pleasing, these advancements offer practical advantages like improved safety and health tracking, indicating a move toward clothing that is interactive and environment-responsive ([Awear, 2023](#)).
- **Immersive Fashion Tech: Digitization & Virtual Fittings.** The Fashion Metaverse is becoming a key trend in the fast-evolving field of Fashion and digital technology integration. Users can dress their avatars in distinctive Virtual Fashion by creating, customizing, and trading clothing in this virtual environment. By merging virtual and real-world Fashion experiences and expanding the parameters of style, interactivity, and personalization, gamification introduces a fresh perspective to Fashion expression as well as consumer involvement. Virtual platforms are also gaining momentum, bringing an eco-conscious shift to the world of Fashion displays and events. The transition to virtual events, for example, reduces the carbon emissions that come with holding live events, such as transportation and complex set construction ([ApparelMagic, 2023](#)).
- **On-demand Fashion and Merchandise Management Platform.** Virtual design, prototyping, and sampling made possible by digital tools have sparked a creative revolution. This move into the virtual world drastically reduces the requirement for tangible materials and samples, which is a major change with far-reaching effects on waste reduction and resource conservation. Digitalization opens the door

to a more effective and ecologically conscious design process by removing the excesses associated with traditional physical prototyping and leading to Slow Fashion (Awear, 2023). From the buyers' side, minimalism is part of this trend: conscientious buyers are increasingly drawn to multipurpose items. Quality is becoming more important to consumers than quantity (Phatak, 2024).

- **SDGs and ESG Legislation Compliance.** A distinguishing feature of both firms and start-ups is whether they possess or not a certification proving their sustainable efforts. The increasing significance of certification and compliance in the Fashion Industry's Sustainability endeavours is highlighted by a regulatory trend. Whether certified or not, businesses and start-ups must manage these new regulations in order to comply with the more general objectives of environmental and social responsibility.

A clear trend surfacing is the anti Fast Fashion trend. The European Union adopted the Corporate Sustainability Due Diligence Directive (CSDD), a regulation that obliges companies to monitor, manage and reduce their negative impact on the environment and human rights. The directive, approved by the European Parliament and the Council of the European Union, marks a significant step towards sustainability, despite amendments that have watered down its scope as mentioned by Mauri (2024). The directive requires companies to map and assess the environmental and social risks of their production chains, integrate monitoring systems into their corporate policies and procedures, and develop reporting to ensure transparency and continuous improvement. In particular, the Fashion Industry will be heavily impacted, requiring strict monitoring of suppliers and production processes. Companies will have to prevent and mitigate negative impacts on human rights and the environment throughout the value chain. Information on their due diligence policies will be available on the European Single Access Point (ESAP) to facilitate access to investors and other stakeholders, promoting greater transparency. As a consequence, non-compliant companies will be subject to audits, administrative sanctions and civil liability, with fines of up to 5% of their worldwide net turnover. In addition, people harmed by violations of human rights or environmental standards will be able to sue for compensation.

Furthermore, the directive also applies to companies based outside the EU with a net turnover of more than EUR 450 million. The implementation of the obligations

will be gradual, starting in 2027 for larger European companies and completing by 2029 ([European Commission, 2024](#)). In response, some Fast Fashion companies are adopting Sustainability policies, while ultra fast fashion companies may find it difficult to adapt due to their high-impact business models. In addition, France is considering a tax on Fast Fashion based on the principle of Extended Producer Responsibility (EPR), which taxes products according to their environmental impact. A further novelty will be the digital product passport, planned for 2027, which will collect and communicate detailed information on the Sustainability of textile and clothing products.

The Figure (3.3) includes seven examples of start-ups that are representative of the trends identified in this chapter.

Now that I have a list of manually identified trends I will move to automatic trend classification and scouting.

STARTUP	DESCRIPTION	YEAR	TREND
<b>TEREFORM</b>	Decarbonizing chemical manufacturing through molecular recycling - Tereform is developing novel deconstruction processes to transform waste materials, with a particular focus on end-of-life textiles, into pristine chemical building blocks. These products can then be used to rebuild the plastics they are derived from to enable circularity, circumventing the need for petroleum-based inputs. What if waste textiles could be broken down and reassembled into new materials, even if they contain challenging additives such as spandex? Tereform makes it possible. By using oxidation, polyester-based textiles can be deconstructed and reconstructed in a fully circular fashion helping turn textile-to-textile recycling into reality.	2022	Circular Fashion
<b>THE FITTING ROOM</b>	The Fitting Rooms complete virtual try-on solution empowers end-consumers to create hyper-realistic 3D avatar with just their smartphone and then visualize the fit and drape of the garment	2020	Immersive Fashion Tech: Digitization and Virtual Fittings
<b>TEXTILE GENESIS</b>	TextileGenesis <sup>®</sup> is a pioneering traceability platform custom built for the apparel ecosystem. The platform is an outcome of intensive discussions with the entire apparel supply chain from fiber producers, fabric mills, dyeing house, cut & sew, to retail brands. It's custom-built for the premium and sustainable textiles such as wood-based fibers, premium cotton, specialty filaments, silk, wool and cashmere. The vision is two fold: creating radical transparency from fiber-to-retail, and ensuring authenticity & provenance of sustainable textiles against generics. Using the power of blockchain technology, Textile Genesis tracks and verifies the use of sustainable fibres all the way from fibre to garment. Their digital fibercoin ensures transparency and reliability throughout the entire production line and beyond."	-	Ethical Supply Chain
<b>AZOLLA</b>	Azolla is an environmental agency specialised in consultancy and carbon removal projects. As part of our consultancy services we help companies make meaningful changes to become more sustainable and reach net-zero	2021	ESG Compliance
<b>UNBUYIST</b>	Unbuyist is committed to making an impact on the fashion industry's supply chain footprint by solving the problem of overproduction. The platform provides demand forecasting and assortment optimization using AI and Big Data technology. The software predicts demand for each SKU and optimizes for quantity, size, and color by effectively analyzing omnichannel data, including product attributes, website traffic, historical sales, and social media trends. The results of our pilot program have shown significant time reduction in assortment planning, cost reduction in inventory, and accuracy improvement on demand prediction.	2020	On-demand Fashion and Merchandise Management Platform
<b>MYCORIUM BIOTECH</b>	Mycorium Biotech is a biotechnology startup committed to creating sustainable and eco-friendly materials for the fashion industry, among others. Our primary focus is on mycelium-based leather, a revolutionary alternative to traditional leather. It is a sustainable, cruelty-free, scalable, and innovative material that has the potential to revolutionize the fashion industry, among others.	2022	Sustainable Materials and Vegan Fashion
<b>SXD</b>	This pivotal AI solution is prompted with design concepts and fabric information from brands or manufacturers. Then, it generates a 100% efficient design that saves fabric and puts every millimetre of it to use. The output? Iconic designs with zero fabric waste.	2023	Tech-Enhanced Textiles and Design

Figure 3.3: Examples of start-ups in the database



# Chapter 4

## Emerging trends in the Fashion

### Industry: an automatic classification

In this chapter, I am going to explore various methods of automatic trend classification, starting from “traditional” machine learning techniques in the form of Natural Language Processing (NLP) and moving towards more recent technologies in the form of Generative AI. In order to validate and evaluate these two approaches, I use a benchmark dataset which is described hereafter.

#### 4.1 Data

The original database was produced by VeniSIA for a business project. VeniSIA is a Venture Builder that specializes in Deep Tech. It is located in Venice and focuses on the growth and expansion of technology, start-ups, and creative organizations. The project was carried out in partnership with OVS SpA, the leading company in Italy’s market for women’s, men’s, and children’s clothes.

The database contains start-ups operating in multiple industries, including Fashion, circular and sharing economy, biotech, data management, and packaging. The database includes a total of 279 start-ups. The information includes the name of the start-up and, among others, a short description, the nation of registration and establishment year.

In order to have at least 10 start-ups for each of the identified trends, I manually scouted start-ups until the quota was met. In order to use a procedure which could later on be automated in a simple way, the scouting was done by using the query “sustainable

start-ups in Fashion” on Google and by focusing only on the first page of the Search Engine Result Page. The final dataset contains 309 start-ups which are categorised into the identified trends by human expertise according to Table (4.1).

Table 4.1: Manual Trend Classification

<b>Trend</b>	<b>Count</b>
Sustainable Materials & the Rise of Vegan Fashion	85
Circular Fashion: Garment Recycling & Upcycling	84
On-demand Fashion & Merchandise Management Platform	76
Tech-enhanced Textile & Design	21
None of the Above (NoA)	14
SDGs and ESGs Legislation Compliance	13
Ethical and Transparent Supply Chains	10
Immersive Fashion Tech: Digitalization & Virtual Fittings	6

With respect to the identified trends, I added another category, namely None of the Above (NoA). The choice of keeping start-ups not belonging to any of the identified trends is motivated by the future use of the database. Since the final objective is that of automatic classification, it is desirable to have some examples of start-ups that should not be included into any of the categories. This allows the machine learning algorithms I will use to see negative examples and be able to properly discriminate, instead of forcibly assigning a trend to every start-up.

Moreover, I inspected the 14 elements belonging to this category and tried to assign those start-ups a possible new trend not included in the first classification. The start-ups can be traced back to: Reward system for virtuous behaviors (2), Laboratory for R&D, Platform for Networking, No innovation (4), Analytics solution to profile shoppers, Non fashion Recycling (2), Education, Reward system for non virtuous behaviors, and lastly, Logistic Automation. It is clear that the start-ups in this section represent a variety of innovative approaches that do not fit into the trends already identified. However, considering the details of the start-ups included in ‘NoA’, some reflections can be made.

- Reward system for virtuous behaviour: include start-ups that seem to be moving towards business models that incentivise sustainable practices or responsible behaviour. A possible new trend could be defined as ‘Incentivised Circular Economy’, where initiatives are designed to reward ecologically responsible behaviour.
- R&D Labs: this category suggests a specific focus on research and development in

the Fashion Industry, potentially oriented towards technological or process innovation.

- Platform for Networking: in an increasingly interconnected industry, platforms that facilitate networking and collaboration may be crucial to stimulate innovation. A possible trend here could be ‘Collaborative Ecosystems and Networking Platforms’.
- No innovation: the presence of start-ups with no innovation suggests that there are realities that replicate existing models without introducing significant differentiation. This might lead one to reflect on the need for more stringent criteria to define what constitutes an ‘innovative start-up’.
- Analytics to profile consumers: this area is clearly related to marketing and personalisation. A specific trend could be ‘Data-Driven Fashion Marketing’, focusing on data analysis solutions to understand and predict consumer behaviour.
- Non-fashion-related recycling: these start-ups could be considered under a broader trend related to Sustainability, but in sectors different from Fashion.
- Education: education-oriented start-ups suggest the emergence of a trend related to education and awareness-raising in the Fashion Industry.
- Reward system for non-virtuous behaviour: this is an unusual and seemingly counterintuitive category, which might require further investigation to better understand the context and rationale.
- Logistics Automation: with automation becoming more and more relevant, a category for ‘Supply Chain Automation in Fashion’ could be created, covering both logistics optimisation and automation of production processes.

In conclusion, the NoA group offers an interesting cue to broaden the picture of emerging trends in the Fashion Industry by considering new categories that better reflect the nuances of current innovation.

The dataset is accompanied by metadata of the country and year in which the start-up was founded. Figure 4.1 offers a bar plot of these two variables. In the left panel, I included only the top 20 nations for the number of start-ups in the database. The

distribution reflects the overall ability of a country to foster innovation, with the USA having the most cases. According to the article published in StartupBlink by [Sengul \(2023\)](#), the United States is regularly confirmed as the leading country in terms of the number of start-ups, hosting more start-ups than any other nation. In 2023, the United States maintained its dominant position in the global startup ecosystem, with a significant advantage over other countries in terms of total number of start-ups, quality of start-up ecosystems, and overall innovation capacity. As mentioned by [Startup Genome \(2023\)](#), this is the consequence of U.S. start-up ecosystems, such as Silicon Valley, New York City and Los Angeles, that continue to top global rankings, driving innovation in various fields, particularly in technology. Italy is the second country represented, which is most likely the result of the scouting being conducted by an Italian team. However, in the ranking by [Sengul \(2023\)](#), Italy is listed in the top 20 Countries by Total Start-ups in 2023. It is important to mention that some start-ups in this country have an Italian description. I decided to leave the original instead of translating the description in English in order not to alter the semantic value. This choice is also motivated by the fact that the Generative AI algorithm I will later use is multilingual and can therefore deal with data in different languages. The right panel represents the distribution of the start-ups in the database over the years. It is important to notice that the peak is in 2021 with less data in 2022 and 2023, and no start-ups in 2024. This is a desirable feature of the database since it will be used as a benchmark training ground for the automatic scouting. In this way it is less likely that when scouting for new start-ups the algorithm will encounter an entry which was already classified.

## 4.2 Topic Identification with Latent Dirichlet Allocation

The first step I take towards an automatic scouting of start-ups, is that of automatic classification of the trends in the dataset.

The first method I use is Latent Dirichlet Allocation (LDA), a generative probabilistic model developed by [Blei, Ng, and Jordan \(2003\)](#). LDA is mainly used for topic modeling, a data analysis method that identifies latent topics within a set of documents. In practice, LDA represents each document as a combination of several topics, and each topic as a

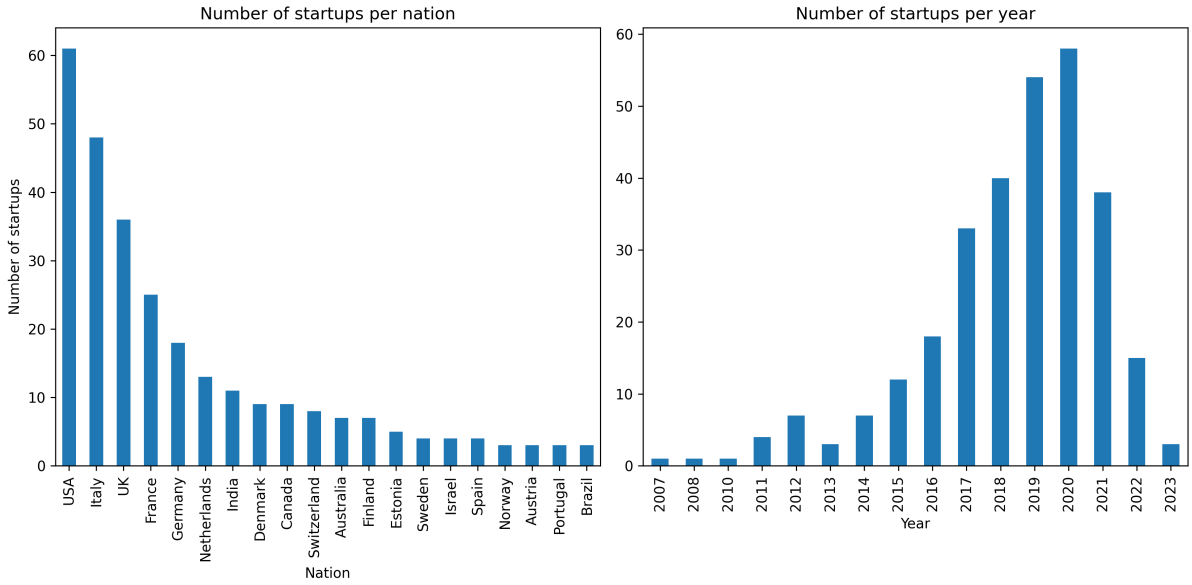


Figure 4.1: Metadata

distribution of words. The idea underlying is that documents are composed of words that belong to different topics, and that LDA can determine the probability with which each topic appears in a document and the probability with which each word is associated with a topic.

For my specific application, I collect all the descriptions of the start-ups in the database into a unique corpus, and then proceed to remove common English and Italian stopwords. Moreover, given the specific nature of the dataset, I remove additional words without a proper semantic valence allowing for the attribution to a specific trend. The list is reported below.

(	una	di	company	la	also	first	perfect	women	grazie
	italy	100	offers	help	uses	end	sviluppare	brands	brand
	high	low	allows	use	marchi	startup	innovative	clothes	clothing
	bags	allows	single	need	new	create	make	brand	sustainable
	fashion	products	product	design	designs	designer	designers		

I then select the number of topics to be equal to 8, giving to the algorithm the theoretical possibility to identify the trends and the NoA category.

In order to visualise the result of the algorithm, I plot a network in Figure 4.2. Each node represents a central word from the vocabulary, that is words that are the most

occurring in the overall vocabulary and in the individual topics. Edges between nodes indicate a significant co-occurrence of these words within the same topic, as determined by the LDA model.

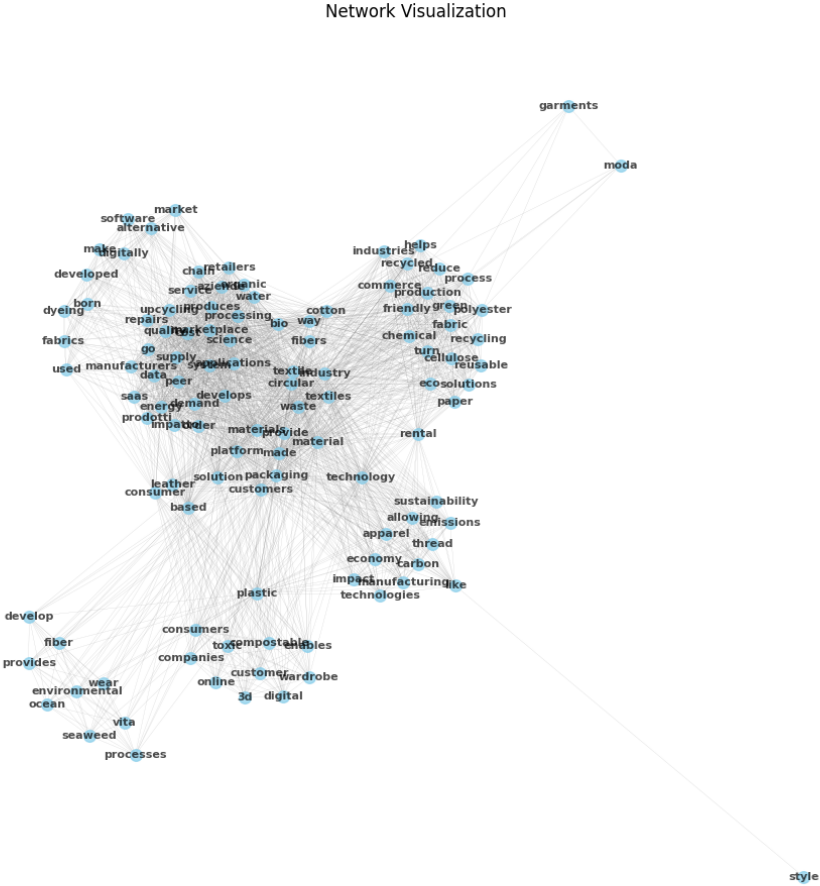


Figure 4.2: Network Visualization

The figure suggests that the identified topics are highly correlated among each other and that the algorithm fails to represent topics which are less popular in the dataset. In order to corroborate this insight, I plot a word cloud for each of the 8 topics identified by the LDA in Figure (4.3). This shows the most frequent words in the text, represented graphically, with font size correlated to the number of occurrences.



Figure 4.3: Word Clouds for each Topic

Visual inspections reveal that all topics can be re-conducted to three of the trends I identified from the literature. Specifically topics 0, 1 and 7 could be classified as *On-demand Fashion & Merchandise Management Platform*, 2, 5 and 6 as *Sustainable Materials & the rise of Vegan Fashion* and 3 and 4 as *Circular Fashion: Garment Recycling & Upcycling*. I can then evaluate the performance of the LDA in classifying the topics in the database, by computing the accuracy as the ratio between the correct predictions and the number of entries in the database. The accuracy achieved is 0.36 a value which although significantly better than a random prediction is far from being satisfactory. There are two main reasons for this result. The first is that as highlighted by both the network visualisation and the word clouds figure the topics are highly correlated in the words used and therefore discerning among them is extremely challenging. The second is that the classes in the dataset are unbalanced. As shown in Table (4.1), these are the top 3 represented Trends in the database: Sustainable Materials & the Rise of Vegan Fashion (85); Circular Fashion: Garment Recycling & Upcycling (84); On-demand Fashion & Merchandise Management Platform (76).

Multiple methods have been suggested in the literature to overcome this hurdle, see Wang, Han, Li, Zhang, and Cheng (2021) for a recent review, but their application is outside the scope of this thesis. The way in which I will deal with this problem is that of resorting to a Large Language Model (LLM) in the form of the popular ChatGPT for the classification.

## 4.3 Overview of Chat GPT

I start by perhaps the most important question: what is Chat GPT?

The first term is easy but contains already an important clue. As per the Italian Wikipedia page, a chat is defined as “a telecommunication service between two or more *people*”. The italic which is absent in the original page, is added to stress an important point to keep in mind: Chat GPT strives to replicate human-like interactions through its responses. Its purpose goes beyond merely providing information; it endeavors to engage users in conversations that are so convincingly human-like that distinguishing between an AI and another human can pose a challenge (Nov, Singh, & Mann, 2023).

I now focus on the part that often remains enigmatic for the majority of users: the acronym “GPT”. GPT stands for Generative Pre-trained Transformer. Its significance becomes clearer as I delve into its components:

- it is able to **generate** coherent text based on the relevant context;
- it is **pre-trained** on a large dataset to learn structure and patterns of human language;
- it is based on a model architecture which is called **Transformer**.

For the purpose of the current report, I will only provide a high level overview of what this model is. A Transformer model is a type of deep learning architecture that has revolutionized various tasks in natural language processing (NLP). Introduced in Vaswani et al. (2017), it is renowned for its ability to capture long-range dependencies and contextual relationships in sequences of data, making it particularly well-suited for tasks involving language understanding and generation.

The key component of a Transformer is its attention mechanism, which allows the model to selectively focus on different parts of the input sequence when processing each element. The Transformer architecture consists of two main components: an encoder and a decoder. The encoder processes the input sequence, encoding the information into a series of hidden representations. The decoder, in turn, generates the output sequence by attending to the encoder’s representations and progressively predicting the next elements. The model used in GPT (Brown et al., 2020) although based on this architecture, presents unique features.



In traditional approaches, fine-tuning on specific tasks requires substantial amounts of task-specific data. In contrast, humans can often learn and perform new language tasks with only a few examples or simple instructions, something that base NLP systems struggle to achieve. GPT overcomes this limitation by scaling up the language model. In particular they use 175 billion parameters, which is ten times more than any previous non-sparse language model.

While the base Transformer model typically requires task-specific fine-tuning datasets of thousands or tens of thousands of examples, GPT relies on a task-agnostic, few-shot learning approach. This approach is the core element of the GPT architecture allowing these models to demonstrate remarkable flexibility and adaptability across various language tasks without explicit fine-tuning. This feature is particularly appealing for the current application since the training of the model is done on different data, I can use the dataset for validation rather than training, circumventing completely the problem of unbalanced classes. Moreover, the use of a model designed specifically to imitate human communication is of particular interest since my aim is to obtain an automatic classification as close as possible to the manual one.

## 4.4 Topic Identification with Chat GPT

The specific version of GPT that I use is Chat GPT-4o (“o” for “omni”). This version is, according to OpenAI, a *step towards much more natural human-computer interaction—it accepts as input any combination of text, audio, image, and video and generates any combination of text, audio, and image outputs.*

Moreover, this version can directly run Python code in its console and interact with Excel files. In order to systematically classify the start-ups in the database I upload the file to Chat GPT-4o with the following prompt:

```
I want you to classify the start-ups in the database according to their
description in column B: 'description' into one of the following trends:
- Circular Fashion: Garment Recycling and Upcycling
- Ethical and Transparent Supply Chain
- Sustainable Materials and the Rise of Vegan Fashion
- Tech-Enhanced Textile and Design
- Immersive Fashion Tech: Digitalization and Virtual Fittings
- On-demand Fashion and Merchandise Management Platform
- SDGs and ESG Legislation Compliance
- NoA (None of the Above)
Then add the name into the corresponding line in column
```

After the classification I compute again the accuracy as before. In this baseline case the accuracy achieved is 0.25, significantly worse than the LDA. The reason for this is that Chat GPT is actually using a simple Python script to execute the task. In the script, which is reported in Appendix (A.1) one can see that the classification is obtained in a naive way. Specifically GPT has decided to assign certain words to each trend and then classify the start-up to the trend if any of the words is matched in the description. This is essentially a simplified version of the LDA algorithm I used, based instead on a rule of thumb. In order to overcome this naive approach and have a classification based on the full capabilities of GPT, I rely on its API interface provided by OpenAI. For this experiment I use the general version of Chat GPT gpt-3.5-turbo-0125 and set the temperature parameter, regulating the ‘creativity’ of the AI response to 0, since I am interested in a deterministic response. To systematically perform the categorization, I use the following prompt passed to Chat GPT:

You are a start-up scouter. Your aim is to categorize start-ups based on their main innovation component into different trends, based on a start-up description. The possible trends into which a start-up can be classified are:

- Circular Fashion: Garment Recycling and Upcycling
- Ethical and Trasparent Supply Chain
- Sustainable Materials and the Rise of Vegan Fashion
- Tech-Enhanced Textile and Designn
- On-demand Fashion and Merchandise Management Platform
- SDGs and ESG Legislation Compliance
- NoA (None of the Above)

Do not add any text or explanation. Just provide the required classification.

The accuracy achieved in this case is 0.57. In order to improve this benchmark I then rely on better prompting by offering Chat GPT a more accurate description. Specifically, I use the following set of instruction:

You are a start-up scouter. Your aim is to categorize start-ups based on their main innovation component into different trends, based on a start-up description. The possible trends into which a start-up can be classified are the following:

- Circular Fashion: Garment Recycling and Upcycling
- Ethical and Transparent Supply Chain
- Sustainable Materials and the Rise of Vegan Fashion
- Tech-Enhanced Textile and Design
- On-demand Fashion and Merchandise Management Platform
- Immersive Fashion Tech: Digitization and Virtual Fittings
- SDGs and ESG Legislation Compliance
- NoA (None of the Above)

To help you, here is short description of each trend:

- Circular Fashion: garment recycling and upcycling -> Circular Fashion focuses on creating sustainable clothing by recycling and repurposing textiles, using deadstock or excess fabrics to produce durable garments that meet the demands of eco-conscious consumers.
- Ethical and Transparent Supply Chain -> In a digitally connected world, transparency is crucial. Digital platforms allow companies to trace labor and materials to ethical sources, ensuring accountability, while also improving supply chain efficiency, reducing waste, surplus inventory, and transportation emissions.

- Sustainable materials and the rise of vegan Fashion -> The Fashion Industry is increasingly turning to sustainable materials, with designers using food waste and exploring algae and mushrooms as renewable, biodegradable alternatives to traditional textiles. The rise of veganism and ethical concerns about traditional materials like wool are driving demand for cruelty-free options.

- Tech-Enhanced Textile and Design -> Brands are using software to design durable, recyclable clothing, while technologies that recolor fabrics without harmful additives extend garment life. The rise of Tech-Enhanced Textiles, featuring smart fabrics with integrated electronics, offers innovative, interactive Fashion that adapts to the environment.

- On demand Fashion and merchandise management platform -> The rise of virtual design tools in Fashion reduces material waste and supports sustainability, while consumer demand for high-quality, multipurpose items over quantity aligns with the minimalist trend.

- Immersive Fashion Tech: Digitization and Virtual Fittings -> The Fashion metaverse is blending digital technology with Fashion, allowing users to create, customize, and trade virtual clothing for their avatars, enhancing personalization and engagement through gamification. This virtual shift also supports sustainability by reducing carbon emissions associated with traditional Fashion events like live shows and set constructions.

- SDGs and ESG Legislation Compliance -> Sustainability certification is increasingly crucial for Fashion businesses, as regulatory trends push firms and start-ups to meet environmental and social responsibility standards, certified or not.

Do not add any text or explanation. Just provide the required classification.

The result is an improved accuracy of 0.60. Table 4.2 summarizes the results across the different model, as well as reporting the accuracy one would obtain with a random allocation, as a benchmark.

Table 4.2: Accuracy comparison across automatic models

Random	LDA	GPT base	GPT prompting
0.12	0.36	0.57	0.60

While the result might seem not extremely impressive at first, one must acknowledge that the task at hand is particularly prone to a non perfect accuracy given the subjectivity in the classification task. It is likely that even comparing the classification of two humans, the result would not be a perfect match. As such the result obtained by the most refined GPT version is a promising starting point to move to the automatic scouting in the next chapter.

# Chapter 5

## Automatic Scouting

In this chapter, I am going to introduce the automatic scouting system based on Chat GPT 4o and evaluate its performance. To achieve this object, I used the Assistant Functionality of Open AI via its Application Programming Interface (API). Specifically, I created a “Fashion Start-up Scouter”, as shown in Figure (5.1), with the instructions specified in the previous chapter, including the trends’ descriptions.

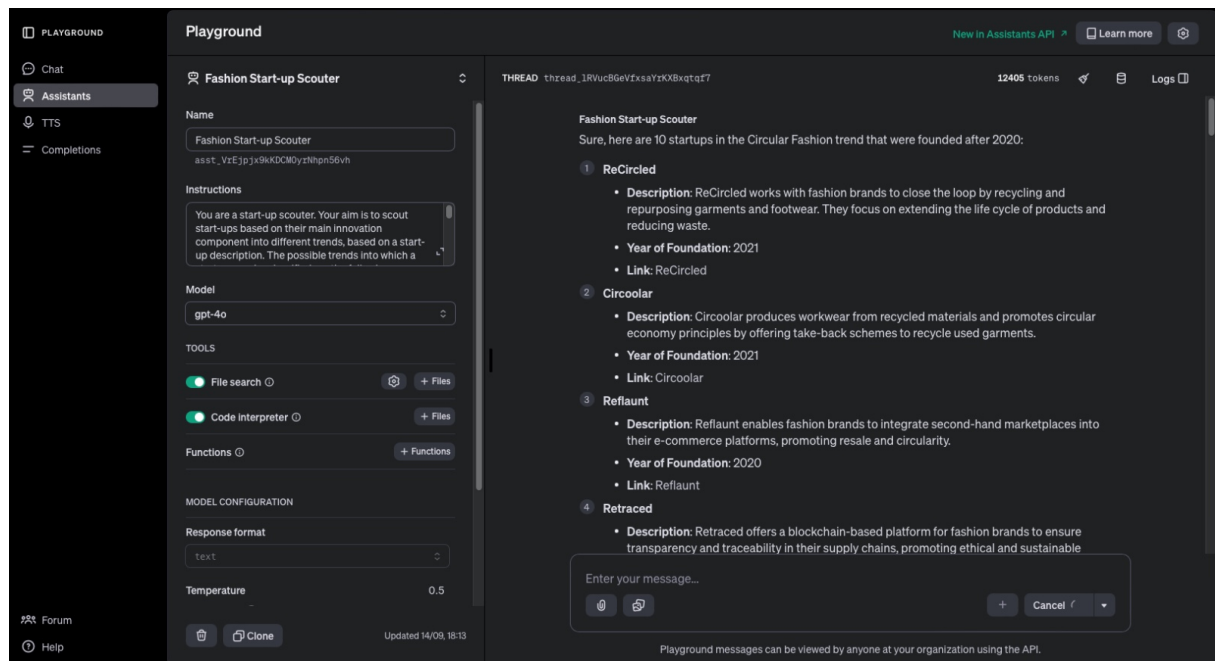


Figure 5.1: Fashion Start-up Scouter Interface

After this step, I had an Assistant to interact with via prompts and I experimented with multiple different interactions.

I asked the Assistant to give me some start-ups for each trend previously classified, that were founded after 2019. The year 2019 was chosen for a reason: 5 years is the

time span for which companies can be considered start-ups. As mentioned by [Moraca \(2016\)](#), for the Italian law, the five-year time limit was introduced by Article 4 of Decree 3/2015, which extended by one year the time frame in which an innovative start-up can take advantage of the benefits provided by the law.

An important point to observe is that when asking the Assistant a specific number of start-ups, its answer was that not having access to real time information, it could not provide me with a specific number. Instead, I had to repeat the same prompt multiple times and then collect the result myself. Another interesting aspect is that although I explicitly requested unique entries, after a while the start-ups suggested included duplicates. This is not a surprise. Even though, the AI is capable of analysing large amounts of data, it may have difficulty understanding the context in which the information is presented. As explained by [Fontana \(2023\)](#), this can lead to incorrect or fanciful interpretations of the data, resulting in ‘hallucinations’ in the output generated. To mitigate hallucinations in AI, it is essential to adopt rigorous training and verification approaches, and develop appropriate control mechanisms to detect and correct distorted or implausible representations. Above all, the most important awareness is to know that any output can be hallucinated, therefore approaching the machine with critical awareness is essential. This is why, in order to validate the results, I had to make sure that the start-ups suggested by the Assistant were actually real and belonging to the right trend. Overall, over multiple prompts and after removing duplicates the Assistant gave me a database of 406 start-ups divided into the trends according to [Table 5.1](#).

Table 5.1: Assistant Gathered Database

<b>Trend</b>	<b>Count</b>
Sustainable Materials & the Rise of Vegan Fashion	178
Circular Fashion: Garment Recycling & Upcycling	98
On-demand Fashion & Merchandise Management Platform	8
Tech-enhanced Textile & Design	14
None of the Above (NoA)	14
SDGs and ESGs Legislation Compliance	10
Ethical and Transparent Supply Chains	90
Immersive Fashion Tech: Digitalization & Virtual Fittings	8



## 5.1 Analysis of Results

I manually checked whether the link that the Assistant gave me was actually a link associated with the start-up. In some cases, those links were wrong. For example, <https://retraced.co/> was the link that the Assistant gave me, which is not completely made up, but missing a letter at the end. The correct link would be: <https://retraced.com/>. After checking all the links, I calculated the average number of true links as the ratio between the number of correct links and the total links. Overall, the Assistant was able to provide 252 correct links, for an average of 0.62 correct links. Then I checked whether the start-ups were correctly classified. For this check I rely on the version of Chat GPT used for classification in chapter 4 prompted with the description of the different trends, that is the best automatic classifier that I have available. On average the assistant and the classifier agree 82% of the times. This result confirms, on one hand, the self consistency between different versions of GPT and, on the other, the difficulty of the task. As I remarked it is likely that also two different humans would not agree on all classifications. I then analyse the geographical and time dimensions of the dataset by the accompanying metadata of the country and year in which the startup was founded. Figure 5.2 offers a bar plot of these two variables. In the left panel, I included only the top 20 countries by number of start-ups in the database. Again, the distribution reflects a country's overall capacity to foster innovation, with the United States remaining the country with the highest number of cases, counting more than 175 start-ups. The second position is occupied by the United Kingdom, with less than 75 start-ups. It is followed by Australia, Germany, the Netherlands, Canada and France, with between 25 and 20 start-ups each. In this case, Italy is the 10th country, confirming that the result of the previous chapter, in which Italy was the second country represented, was most likely the result of a manual scouting conducted by an Italian team.

Moreover, an important role might be played by the training data used by the Chat GPT model, which is heavily represented by information from anglosaxones countries. As for the year of foundation, 2020 represents the year with the highest number of start-ups, followed by 2023, while 2019 represents the year with the lowest number of start-ups. The difference between 2020 and 2019 might be a result of the Covid-19 pandemic which might have delayed the foundation of the start-up until after the restrictive measures were removed.

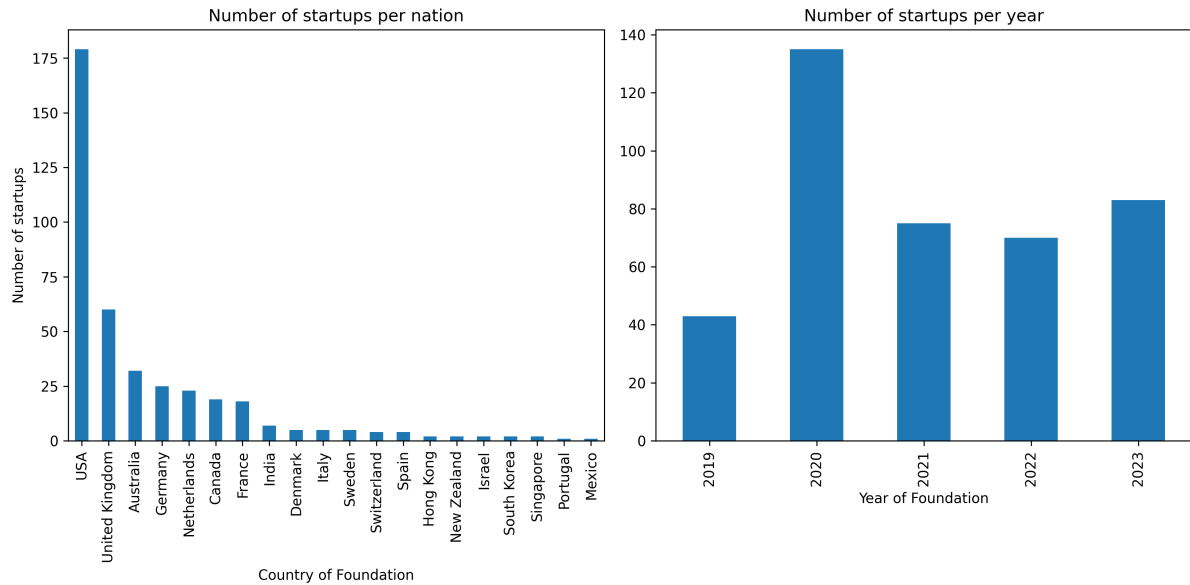


Figure 5.2: Metadata for the Assistant-gathered Database

## 5.2 Challenges and Opportunities

This type of analysis presents some limits. As we can see from the Figure 5.2, there are no start-ups for the year 2024. This is due to the overall training dataset of the GPT model I am using, which contains information until 2023. Since this model can access the web, but not in Assistant mode, a possible solution is to use it in a chat. However, even in this case the most it can do is looking up for information which is already available to a public audience such as articles, websites or news that can be found by a simple Google query. Therefore, although this automatic scouting offers a good starting point, it is not well suited for an organization whose goal is to have access to potentially interesting startups before its competitors. In order to achieve this, one would have to integrate the GPT model described above into a flow engineering, whose first components should consist of a web scraper. One possible solution is offered by the use of FlowiseAI or Langflow, open source low-code tools for developers to build customized LLM orchestration flows & AI agents. The flow designed should consist of the following components:

1. A web scraper module, to automate the research of new start-ups on websites such as LinkedIn, Crunchbase and Orbis with the criterion of belonging to the Fashion Industry. The output of this research should be organised in a database organised with the Name, Description, Country of Origin and Year of Foundation.

2. This database can then be fed to the GPT classifier that I described in chapter 4 to obtain the trend of each entries and to filter out the start-ups with the None of the Above classification.
3. The final database can be provided to a human analyst for a final check and for the selection of a few sample of promising start-ups to be contacted.

The realisation of this flow and the evaluation of its performance is something that I leave to further research.

# Chapter 6

## Conclusions

This thesis explores the use of GenAI for the purpose of trend scouting in the Fashion Industry, in a context where innovation and Sustainability are becoming key pillars for the future of the industry. With the increase in the number of sustainable and innovative start-ups, the need to quickly identify new trends has become crucial for companies wishing to maintain a competitive advantage.

The objective of this thesis is to address three main challenges: firstly, to identify the most recent sustainability-related trends through manual trend scouting and a subsequent meta-analysis; secondly, to investigate methods to automatically identify start-ups related to these trends by examining NLP algorithms, up to the most recent forms represented by Generative AI, in particular ChatGPT; and thirdly, activate a scouting process for sustainability-related trends in the Fashion Industry, exploiting the use of GenAI.

The Fashion Industry, historically associated with high levels of pollution and resource consumption, provides an ideal context for exploring these innovations. The first chapter explores the Fashion Industry context and identifies the relevance of Sustainability and more specifically of Sustainable Fashion. This topic is further explored in the second chapter, which delves into sustainable business models and discusses the Business Model Canvas for Industry 4.0. The chapter also seeks to highlight the legislative pressures, in particular those of the European Union, that are pushing the industry towards a Circular Economy.

One of the central aspects of the industry's transformation are consumers' preferences, especially younger generations such as Generation Z, who demand ethically and environmentally responsible Fashion. This cultural shift is pushing companies to review not only

their production practices, but also their marketing models and customer relations. The overview of the five macro-trends explored in chapter three shows that the industry is already taking the first steps towards more sustainable solutions. However, it remains clear that new technological innovations will be crucial to further accelerate this process and create sustainable practices on a large scale. Hence, technological innovation is an essential element in meeting environmental challenges. The use of technologies such as artificial intelligence, blockchain and augmented reality is profoundly transforming the industry, offering new opportunities to improve transparency, reduce waste and promote the adoption of circular business models. Companies that are able to seize these opportunities and integrate them into their processes will have a competitive advantage in a rapidly changing market. Finally, after a thorough meta-analysis of the most influential articles, I identify seven sustainable trends. The fourth chapter explores the automatic classification of start-ups related to these trends, moving from traditional machine learning methods to the use of the latest Generative AI technologies. The database created for this study, which includes 279 start-ups, is then used for an in-depth analysis of the most promising trends in the field of Sustainable Fashion. In the fifth chapter, the focus shifts to the use of Open AI's Application Programming Interface (API) Assistant Functionality to automate the scouting process, enabling a more efficient classification and analysis of the identified start-ups. After creating the final database, each start-up is examined to ensure that the output is accurate and follows the expected pattern.

As highlighted in the thesis, the future of the Industry will be characterised by a close integration of Sustainability, technology and new business models. Only through the adoption of innovative and responsible solutions it will be possible to ensure a prosperous future for the industry, in line with consumer expectations and increasingly stringent regulatory requirements. An essential step is represented by the transformation towards Circular Economy.

The integration of automation using GenAI, explored in the final chapter, offers an interesting and promising analysis, but also presents significant technical challenges. The Fashion Start-up Scouter created using the OpenAI API demonstrates how artificial intelligence can be harnessed to simplify the scouting process, in particular by identifying emerging start-ups related to sustainability trends in the Fashion Industry. However, the implementation of the system has shown obvious limitations, such as the possibility of

the AI generating incorrect or inaccurate information, commonly referred to as ‘hallucinations’. These errors result from the model’s difficulty in correctly interpreting the context of the data presented, leading to results that require manual human validation.

The analysis of the results shows that although the Assistant provided useful insights, the percentage of correct links was rather low at around 62%. This underlines the importance of approaching such tools with caution and critical awareness, implementing control and verification mechanisms to avoid biased interpretations. In addition, the validation process required manual checking not only of the links, but also of the affiliation of the start-ups to the identified trends. This aspect, although unavoidable, reduces the effectiveness of the automated system and confirms the need for close human monitoring.

Another major challenge concerns the absence of up-to-date data up to 2024, a problem due to the time limit of the dataset on which the GPT-4 model is based. This represents an obstacle for those who want to be at a competitive advantage, as it is not possible to identify emerging start-ups with more recent information than the model’s database. The proposed solution, i.e. the integration of an engineering flow with a web scraper, suggests a way to overcome this limitation by collecting real-time information from the web. However, this solution requires additional technological development and implementation complexity.

Despite these limitations, the use of Generative AI for automatic scouting represents an innovative opportunity. When combined with monitoring technologies such as web scraping and human verification, the system could significantly improve its effectiveness and offer a real competitive advantage to companies in the Fashion Industry. Indeed, the automation of scouting can speed up processes that would otherwise require a great deal of manual effort and time.

In conclusion, this chapter highlights how the combination of Generative AI and automation systems can be an effective starting point for improving the efficiency of trend scouting in Sustainable Fashion. However, it remains clear that human supervision is essential to ensure the accuracy and relevance of the results. To make this system truly competitive, further development of complementary technologies and greater integration between AI capabilities and dynamic search tools, such as web scrapers, will be necessary.

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# Appendix A

## Code

### A.1 Code used by GPT-4o

```
# Define keywords or phrases associated with each trend for  
classification  
  
trend_keywords = {  
    "Circular Fashion": ["recycling", "upcycling", "circular"],  
    "Ethical \& Trasparent Supply Chain": ["ethical", "transparency", "  
        supply chain"],  
    "Sustainable Materials and the rise of vegan Fashion": ["sustainable  
        materials", "vegan", "bio-based",  
        ", "plant-based"],  
    "Tech-Enhanced Textile \& Design": ["tech-enhanced", "technology", "  
        innovation", "design"],  
    "On-demand Fashion and merchandise management platform": ["on demand  
        ", "merchandise management", "  
        platform"],  
    "ESG compliance": ["ESG", "compliance", "sustainability"],  
    "NoA": []  
}  
  
def classify_description(description):  
    for trend, keywords in trend_keywords.items():  
        if any(keyword.lower() in description.lower() for keyword in  
            keywords):  
            return trend  
    return "NoA"
```

```
# Apply the classification function to each description
df_new['Manual Classification'] = df_new['Description'].apply(
    classify_description)

# Save the updated DataFrame back to an Excel file
output_path_new = "/mnt/data/Manual_Classified_Updated.xlsx"
df_new.to_excel(output_path_new, index=False)

output_path_new
```