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CIRCULAR STRATEGIES FOR SUSTAINABLE FASHION

Supervisor: Prof. Francesca Gambarotto

Candidate: Jacqueline Kwakye

Register. number: 2016957

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ABSTRACT

The term fashion encompasses the way people choose to dress and present themselves, often reflecting cultural, societal, and personal influences. Although generally referred to as trend and style in clothing, it is not limited to apparel and footwear. Still, it extends to various forms of self-expression, such as how people decorate their homes or vehicles. The fashion industry includes designers, manufacturers, retailers, and other professionals contributing to its supply and demand chain. The sector and its strategies' consequences hold significant and multifaceted relevance in today's world. The increasing production rate of the apparel and footwear industry has made the sector the second most polluting industry in the world, thereby creating a significant waste crisis largely suffered by sites of developing countries used as dumps. Large quantities of clothing and textiles, often in optimal condition discarded as waste, could be recovered to be recycled or upcycled to create new value. This study addresses some significant problems in the fashion industry: waste, overproduction, labor, and natural resource exploitation. The thesis discusses regenerative solutions for building a resilient circular fashion business model and uses life cycle assessment to analyze the production supply chain.

INTRODUCTION

The Industrial Revolution of the 18th and 19th centuries transitioned society into mass production, urbanization, and rapid resource consumption. This process accelerated humanity's environmental, social, and economic challenges. Sustainability has become increasingly common and relevant in various aspects of society, including industries such as fashion. The thirst for sustainability contributes to the growing awareness of environmental and social issues, increased consumer demand for ethically produced products, and the recognition of the long-term benefits of sustainable practices.

As the World Commission on Environment and Development's 1987 Brundtland report famously stated, we need '*development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*' Sustainable development seeks to reconcile economic development with the protection of social and environmental balance.

The fashion industry, being the second most polluting industry, should be on the frontline for finding regenerative solutions and circular strategies to minimize its ecological footprint; however, fifty-nine percent of the industry brands operate with misleading claims about the environmental benefits of their products and services to appear more environmentally friendly or sustainable than it is.

This dissertation explains the main principles of circular economy using the perspective of key founders such as Herman E. Daly's "The Economics of Life" and Kenneth Boulding's "Earth as a Spaceship," which are significant contributions to reforming the twenty-first century's economy. Highlighted problems within the fashion industry today, which are unethical labor, overproduction, natural resource exploitation, and unsustainable business models, are linked to many factors, including the industry's excessive obsession with economic growth. The implemented strategies of actors in the industry are like we exist on a virtually illimitable plane with unlimited resources. Still, just as Boulding discusses in his work "Earth as a spaceship," the economy should be managed as a spaceship with limited resources where consequences of strategies implemented by economic actors affect all citizens of the spaceship, including the actors themselves. The study mentions the importance of straying from overproduction by discussing the steady-state analogy proposed by

ecological economist Herman E. Daly. In his work "The Economics of Life," he introduced the close similarity of metabolism's basic within-skin life process with the outside-skin life process of economics. Daly advised economic actors to build developmental models based on a steady state analogy, which proposes the optimal point of growth as maintaining its distance from the market equilibrium point by using low entropy matter/energy from the environment.

To practically understand how fashion brands can attain sustainability, this dissertation presents a life cycle assessment of an Italian sustainable fashion brand named Mafric. The Life Cycle Assessment is based on ISO14040 and was assessed using primary data from the brand Mafric and secondary data, which are industry averages sourced from the European Commission's environmental footprint database. The dissertation examines the life cycle processes of producing a blouse, "Top Filli," from Mafric's spring-summer collection 23.

The significance of the dissertation will serve as reference material to Mafric and fashion brands interested in conducting further investigations on sustainable fashion and the transformation of the industry's economic model to a circular one.

CHAPTER 1: PROBLEMS IN THE FASHION INDUSTRY

1.1 Fashion industry: One of the highest polluting industries in the world.

In 2006, a study with a complete focus on social responsibility in the fashion industry was introduced by Dickson and Eckman's publication '*Social Responsibility: The Concept as Defined by Apparel and Textile Scholars*' (Dickson & Eckman, 2006). The emergence of social responsibility in the fashion industry, coupled with other reasons, including the alarming rates of how the fashion industry contributes significantly as a polluting agent on the planet, opens the discussion on measures to transform the fashion industry into a sustainable one.

After Oil and Gas, the fashion industry is the world's second most polluting sector. According to the UN Alliance for Fashion Sustainability, the fashion industry is responsible for an estimated 2-8% of the world's greenhouse gas emissions (UNECE, 2018). It takes almost a thousand and eight hundred gallons of water what one person drinks in about ten years – to make one pair of denim jeans, and these jeans join the twenty-one billion tons of textile that end up in landfills each year. The fashion industry is also the second highest water use worldwide, contributing to twenty percent of global water waste. While the negative impact of the fashion industry is significant today, it is likely to increase further in the future if immediate changes are not made because the average consumer is now purchasing sixty percent more items of clothing compared to the 2000s, according to the UNECE (op.cit.).

Looking at the alarming figures above, the question remains, 'How exactly is the fashion industry causing such environmental pollution and waste?'

Water consumption and pollution is a highlighted issue in the negative environmental impacts of the fashion or apparel industry. A vast quantity of fresh water is used for the dyeing and finishing process for all clothes production. It takes about two hundred tons of fresh water in the dyeing process of one ton of dyed fabric. Dyeing is the process of imparting color to natural or synthetic fibers, yarns, or materials (Tolkar, 2023). Due to the manufacturing process dominantly relying on water and chemicals, wastewater from textile factories contains large quantities of toxic substances such as mercury, lead, arsenic, etc. The untreated contaminated wastewater dumped into rivers causes extreme harm to aquatic life.

In 2018, a group of scientists researched the evaluation of microplastic release caused by textile washing of synthetic fabrics. The findings of this evaluation were that the amount and size of the released microfibrils confirm they could not be totally retained by wastewater treatment plants and potentially affect the aquatic environment. The small aquatic organisms ingest microfibrils from the washing of synthetic fabrics, and along the aquatic food chain, it is gradually introduced to the human food chain (Falco et al., 2018).

The fashion industry generates substantial global greenhouse gas emissions from the energy used during garment production, manufacturing, and transportation. The perception that wearing an item only a handful of times is okay has resulted in an increase in discarded clothing and fuels overconsumption and overproduction. The industry is responsible for ten percent of annual global carbon emissions, more than all international flights and maritime shipping combined. The World Bank reproaches that at this rate, greenhouse gas emissions will surge by more than fifty percent by 2030 if active measures are not taken to minimize the carbon footprint of this industry (Bank, 2019).

Irresponsible consumer practices are a key fostering agent for increasing carbon footprint in the fashion industry. Consumers are often unaware that the rapid disposal of clothing has a higher environmental cost. Clothing was initially made to insulate humankind against cold or hot conditions and, to an extent, provide a hygienic barrier, keeping infectious and toxic materials away from the body. Many years ago, farmers and workers needed durable and long-lasting clothing, thereby caring very little about appearance; specific types of clothing were also required for particular occasions, such as armor for wars, but gradually, as men accumulated wealth, clothing became a status and wealth symbol, indicating a person's social class. To flaunt their wealth, people representing aristocracy and nobility purchased expensive, flamboyant clothes in multiple variants. However, due to fast fashion, one does not need to be flamboyantly rich to afford multiple clothing variants these days.

“Between 1996 and 2018, clothing prices in the EU dropped by over 30 %, relative to inflation. Since 2000, Europeans have purchased more pieces of clothing but spent less money. Fast fashion — the rapid changing of clothing lines and fashion trends promotes increased consumption and reduces the life span of clothing” (Agency, 2019).

The falling clothing prices and rapidly changing fashion trends encourage consumers to purchase more unneeded items. Textile production since 1975 has almost tripled, and sixty percent of it is synthetic textiles. Polyester is the most commonly used synthetic fiber in the market today. Although polyester is primarily used due to its affordability compared to natural fibers, its negative environmental impact during production, use, and disposal raises justifiable concerns.

From a consumer's point of view, polyester is more sustainable because polyester garments are more resistant and durable and require less water, energy, and heat for washing, but consumers are often ignorant of the actual cost of polyester. The synthetic fiber is partly derived from a non-renewable resource. About seventy million gallons of oil are used yearly to make polyester; it is also not biodegradable, meaning a polyester fabric dress bought today will not decompose for twenty years at best and two hundred years at worst. The manufacturing process of polyester fabrics is water-thirsty because it is created through an energy-intensive heating process and requires large quantities of water for cooling; wastewater from polyester textile factories is also very strenuous to treat. Its toxicity causes severe problems to local plants and animal life when it enters the environment.

1.2 Fashion Industry: Labor, Gender, and Inequality

The fashion or apparel industry is closely linked to labor, gender, and poverty issues. Statistics from UNECE show that one in six people on the planet work in a fashion-related job, and eighty percent throughout the supply chain are women (UNECE, 2018). The globalisationGlobalization of the supply chain has led to dangerous exploitation in the fashion industry for garment workers. Child labor, in particular, is a re-appearing issue. Although child labor is forbidden by law in most countries, it is still very present in some of the poorest parts of the world, where cheap labor for fashion takes precedence. In an article published in 2020 by two sustainable fashion advocates, Ayesha Barenblat and Aditi Mayer, they explicitly named Western fashion brands today colonial masters.

“If we look at fast fashion from a macro perspective, it is clear that supply chains for most major clothing brands have the same trade routes from 150 years ago – during the height of

European colonial. That's to say, the fast fashion industry continues to exploit systems in countries still reeling from impacts of colonization” (Mayer & Barenblat, 2020)

Figure 1: A garment worker's hand



Source: Remake

Working conditions of the labor force in unprivileged areas where garment construction occurs are some of the poorest worldwide, with minimal to no health and safety regulations in place to protect workers, particularly women, and children, who are most vulnerable in these cases. Retailers chasing the cheap needle around the planet with lax environmental regulations create socio-economic disadvantages for women workers.

The famous Rana Plaza accident was a wake-up call for international organizations to actively set regulations and monitor the fashion industry's supply chain activities. On 24 April 2013, the collapse of the Rana Plaza building in Dhaka, Bangladesh, which housed five garment factories, killed at least one thousand and a hundred and thirty-two people and injured more than two thousand five hundred people. Many have argued that the industry practices that led to it were far from accidental. Transparent International reports that Rana Plaza was built on unsuitable land, construction rules were flouted, corners were cut in procuring building materials, and officials took bribes to look the other way. The supply chain of fast fashion's rapid demands meant workers had to keep working to meet demand despite cracks appearing in the building. Despite the harsh working conditions, extremely low

wages, and unsafe work environments, employees could not refuse to work because it was the only source of income for the majority of their households (Rahman, 2022).

1.3 Fashion industry: Is Slow fashion enough for sustainability?

As observed from the previous discussion above, diverse challenges in fast fashion hinder sustainability in the industry. Some fashion scholars and experts have suggested that "Slow Fashion" could solve the problems in the fashion industry. "Slow Fashion" was first introduced by a fashion sustainability journalist and researcher named Kate Fletcher 2007. It is a term derived from the slow food movement.

“Slow fashion is a movement that advocates for environmental and social justice in the fashion industry. Its defining point is that it zeroes in on the problem of overproduction and overconsumption” (Vito, 2022).

This movement highlights the importance of fashion designers, producers, and consumers to be aware and educated of the consequences of their actions on the ecosystem and society. Below are some philosophies proposed by the slow fashion movement;

- A shift from quantity to quality, both in production and consumption. It's not hell-bent on constant growth or accumulating more.
- Manufacturing that respects the environment by using low-waste processes and avoiding harmful chemicals.
- Providing workers with a living wage and healthy working conditions.
- Producing collections in small batches or on a pre-order basis to avoid unsold inventory.
- An uncomplicated supply chain where raw materials and labor aren't scattered across the globe. It uses local materials and employs local workers as much as possible.
- Transparency and honesty in its supply chain and practices.
- Using natural fibers, deadstock fabrics, or old textiles for upcycling/recycling.

The slow fashion movement addresses some core issues in the fashion industry and encourages more eco-friendly options for producers and consumers. The last point, for

instance, mentions the importance of using natural fibers, deadstock fabrics, or old textiles for upcycling, which soothes some major ecological problems from the textile industry deriving from synthetic textile production. However, these solutions are still insufficient for the fashion industry's sustainability because they do not sufficiently address its broader environmental and social challenges. Addressing the challenges of the fashion industry requires a systemic approach through policy changes, industry-wide collaborations, and technological innovations. Cooperation from brands, consumers, policymakers, and other stakeholders is needed to promote sustainable practices and create a more sustainable and ethical fashion ecosystem. Solving the problem of overproduction and overconsumption is, therefore, not enough to ensure sustainability in the fashion industry.

1.4 Fashion Industry: Sustainable Development Goals

As mentioned earlier, one in six people work in a fashion-related job, giving it a weighty role to play in achieving the United Nations' Sustainable Development Goals (SDGs). Producers and stakeholders in the fashion industry can contribute to a more sustainable and inclusive future by aligning their practices with the SDGs. Here are a few ways in which the fashion industry can contribute to sustainable development:

UN SDG 8- to promote inclusive and sustainable economic growth, full and productive employment, and decent work for all. Improving the working conditions of fashion workers, promoting policies to regulate fair wages, and ensuring transparency in the manufacturing sector of the industry are coherent to the achievement of this goal.

SDG 12: Ensure Sustainable Consumption and Production Patterns; SDG 12 is structured over eight targets, addressing the use of natural resources, chemical waste, fossil fuels, and the integration of sustainable practices into the production cycles – all the mentioned above are significant categories to the fashion industry.

SDG 6: Ensure Availability and Sustainable Management of Water and Sanitation for All. The fashion industry is among the highest in water consumption and pollution, releasing hazardous chemicals and materials, especially in regions where clean drinking water isn't

easily accessible. Treatment of wastewater and water-use efficiency in apparel production would contribute to reaching this goal.

SDG 14: Conserve and Sustainably Use the Oceans, Seas, and Marine Resources for Sustainable Development; SDG 14 addresses conserving marine life and pollution.

Microfibers and microplastics released into the ocean from washing synthetic fabrics like polyester are a hindrance to reaching this goal. Providing solutions and/or alternatives in fabric production would positively align the fashion industry to do its part in achieving this goal.

SDG 13: Take Urgent Action to Combat Climate Change and its Impacts: Textile production generates more greenhouse gas emissions than all international flights and maritime shipping combined. It contributes to climate change; therefore, urgent action must be taken to minimize the industry's ecological footprint.

SDG 5: Achieve Gender Equality and Empower all Women and Girls. The social dimension of the fashion industry is directly linked to this SDG. Eighty percent of the global garment workforce are women. The informal nature of women's work within the garment sector means that work is defined by precarity, lacking social welfare provisions, and below sustenance-level pay. Ensuring gender equality and empowerment in the industry can contribute to achieving this goal.

SDG 1 End poverty in all its forms everywhere. Paying fair wages to the millions of people working in the apparel industry, particularly in developing countries where many clothing factories are located, could help eradicate poverty.

Further linkages between the fashion industry and the SDGs can be drawn by looking at the health impacts of chemicals used in the production process on workers as well as communities affected by environmental pollution (SDG 3 on **good health and well-being**) or by looking at the recycling of clothing (target six on waste management under SDG 11 on **Sustainable Cities and Communities**). It is also important to note that progress in these areas requires a systemic shift within the fashion industry, involving all stakeholders from design to production to consumption.

CHAPTER 2: CIRCULAR ECONOMY MODEL FOR SUSTAINABLE FASHION

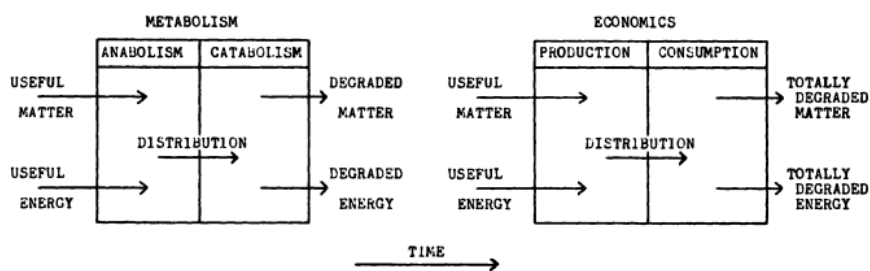
2.1 Circular Fashion: Main Principles of Circular economy

Although presently perceived as a fundamental requirement for sustainability and integrated into academic disciplines and governmental policies, the Circular economy wasn't a widely received concept by mainstream economists in the early twentieth century. Growing concerns regarding climate change, biodiversity loss, and resource scarcity have brought circular economy principles to the forefront and invited scholars and economists to provide new solutions for ecological problems. Founding fathers of circular Economy like Kenneth Boulding, Herman E. Daly, Nicholas Georgescu-Roegen, William Kapp, and others introduced approaches to deliver a new perspective for designing an economic model.

In Herman E. Daly's article "On Economics as a Life Science," He uses biological metaphor to enlighten readers on why a steady state should be preferable to market equilibrium.

"Economics is the part of ecology which studies the outside-skin life process in so far as it is dominated by commodities and their interrelations in what follows the traditional economic(outside skin) and the traditional biological(within skin) views of the total life process will be considered, both in their steady-state aspect and in their evolutionary aspect" (Daly, 1968, pp. 392-406)

Figure 2: The steady-state analogy: Herman E. Daly



Source: *Journal of Political Economy*, 1968

He argues that the process of economics is just like the processes of metabolism, as seen in Figure 2. The **Steady State** should be preferable and not "Market Equilibrium" derived from the linear economic approach. In the traditional economic model, the market equilibrium is the optimal point both producers and consumers are to strive for; classical economists argue that at this optimal point where supply equals demand, the economy is in its best state.

However, Daly challenged this theory, explaining that a steady state is a dynamic process that should maintain its distance from the equilibrium point by using low entropy matter/energy from the environment. Daly pointed out;

“Many of the material inputs into metabolism are economic products, and some outputs of metabolism are generally not totally degraded and thus can be further consumed—for example, manure fertilizer, and carbon dioxide. But the ultimate physical output of the economic process is totally degraded matter-energy, in Marx's term, "devil's dust." (E.Daly, 1968)

As classical economist states, the optimum point shouldn't be about supply being equal to demand. Instead, producers and consumers should reuse low-entropy matter/energy from output that is not wholly utilized and still has value for ulterior uses. The concept of circular economy is built on this pillar to completely utilize the matter/energy of a material until it is totally degraded.

Daly mentioned in his article that the dynamic process of a steady state is capable of qualitative change and reorganization over long periods. Due to the growing awareness of sustainability and the global urgency to halt negative environmental changes on the planet, recognizing the systemic approach from the founding fathers is looked up to design new sustainable and resilient economic models for circular fashion. For instance, the circular approach in apparel and footwear production to create a closed-loop system, minimize waste, and maximize the lifespan of clothing items is in line with Daly's steady-state analogy.

Kate Raworth, after decades of studying and analyzing economic theories from past economists, proposed a new economic model that would be able to achieve development within the constraints of the Earth's resources. This model is akin to the principles of Kenneth Boulding's Spaceship analogy. Boulding's article “Earth as a Spaceship” in 1965 made revelatory arguments on the differences between what he named the “Cowboy Economy” and the “Spaceship Economy” (Boulding, 1966). In his work, he explains the cowboy economy, which is a metaphor for linear economics as a place of infinite resources where exploitation, appropriation, and accumulation are regular and productive. In the cowboy economy, actors are unconcerned with pollution or scarcity of resources as cowboys exploit a territory and move on to the next after its depletion. Meanwhile, the spaceship economy is a closed system

The questioning factor of this diagram (Figure 3) is the things the classical economist Samuelson leaves invisible. As John Sterman states

“The most important assumptions of a model are not in the equations, but what’s not in them; not in the documentation, but unstated; not in the variables on the computer screen, but in the blank spaces around them” (Raworth, 2017, p. 66)

From Samuelson's diagram, we observe two significant factors of circulation that significantly impact the economy were not mentioned; thus, **energy** and **materials** the economic activity depended on and, secondly, the **society** in which this activity takes place. The significance of these two is why Raworth designs the embedded economy (figure 4)

The embedded economy nests the economy within society and the living world while recognizing the diverse ways in which it can meet people's needs and wants. From Kate Raworth's analysis, we first see from the diagram the circular "Earth," which is the living world powered by the energy from the sun. Within the Earth is human society, and within the society is the economic activity that includes the households, the market, the commons, and the state. These are all important realms of provisioning for human wants and needs and are enabled by financial flows. She gives a breakdown of each actor in the embedded economy diagram and how we are to relate and work with it (Raworth, 2017)

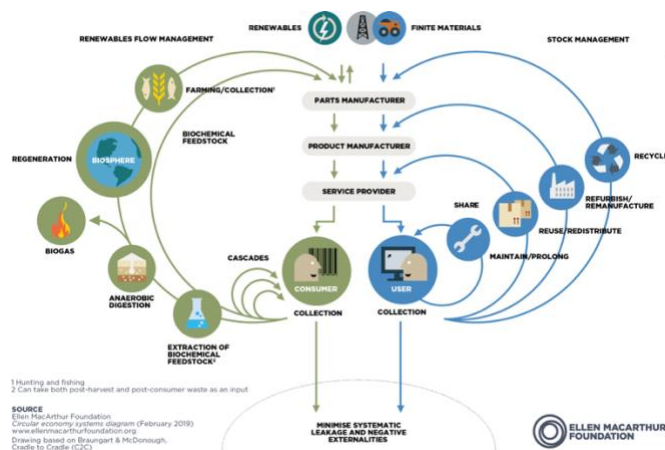
- Earth, which is life-giving, so respect its boundaries.
- Society, which is foundational, nurtures its connections.
- The diverse economy supports all of its systems.
- The household, which is core, values its contribution.
- The market is powerful, so embed it wisely.
- The Commons, which are creative, unleash their potential.
- The state is essential, so make it accountable.
- Finance, which is a service, serves society.
- Business, which is innovative, gives it a purpose.
- Trade, which is double-edged, so make it fair.
- Power is pervasive, so check its abuse.

The embedded economy, therefore, ends the myth of a self-contained, self-sustained market and opens an analysis of the economy, highlighting the fact that household, market, common, and state are all embedded within and dependent upon society, which in turn is embedded within the living world. It changes our focus from thinking of increasing economic activity to how the content and structure of that activity might be shaping society, politics, power, and the ecosystem. Given the ecological and societal ceilings and interdependence with other variables, we evaluate how best an industry can produce and consume. The fashion industry operating with a classical economic model like that of Samuelson, although it would observe economic growth, will be highly unsustainable because it would ignore the planetary boundaries of the Earth, would not take into consideration the consequences of its activities on the society and would not consider investing in building a resilient ecosystem. Kate Raworth's doughnut economic principle educates all industries in the economy not to a tunnel vision in solving the challenges in the economy but to observe the circular flow from diverse sectors. Circular fashion must, therefore, choose growth that is regenerative by design, restoring, and renewing.

2.2 Circular Fashion: Regenerative Solutions for Fashion Industry

For a circular Economy to take flight, industry actors must move from the cradle-to-grave mentality, the linear economic model, to a cradle-to-cradle one. The cradle-to-cradle mentality in the fashion industry implies that products must first be designed to be restored and thus go through repair, reuse, refurbishment, and recycling principles.

Figure 5: The butterfly economy



Source: Ellen MacArthur Foundation

Ellen MacArthur Foundation, the inventor of the Butterfly Economy, explains how the butterfly illustration is synonymous with the circular model. The butterfly insinuates a continuous flow of materials in an economy with two primary cycles: the biological cycle and the technical cycle. In the technological cycle, products and materials are kept in circulation through processes such as reuse, repair, remanufacture, and recycling. In the biological cycle, the nutrients from biodegradable materials are returned to the Earth to regenerate nature (Foundation, 2019).

Implementing the butterfly illustration to the fashion economy means all materials in the industry, including biological materials such as wool or cotton, should first be cycled through the technical loops of reusing, repairing, remaking, and recycling, which is on the right side of the image (figure 5) above. Ellen MacArthur Foundation, in the published research study *Vision of a Circular Economy for Fashion*, explains that

“circulation of materials is enabled by keeping different technical materials separate or easily separable (as not doing so can hinder recycling), as well as keeping biological materials and technical materials separate or easily separable (as not doing so can hinder recycling and composting)” (Foundation, 2020).

The Vision for circular fashion comprises the concepts needed to provide regenerative solutions for the industry by creating circular products. The three key drivers are; Fashion products (apparel, footwear and accessories) must be:

- Used More
- Made to be made again and
- Made from safe and recycled or renewable inputs.

Used More: *“In a circular economy, products and materials are kept in use at their highest value at all times. Reuse is the preferred option wherever relevant”*(op.cit.).

This first principle explains that products must be more **durable** and remain functional and relevant over time. Apparel, footwear, and accessories should be made in a way that could be **reused**, often involving cleaning, **repairs**, or even minor modifications so they can pass through the hands of multiple users.

Made to be made again: *“From the outset, products are designed and manufactured so that they can be reused, remade, recycled, and - where relevant, and after maximum use and cycling - safely composted”* (Foundation, 2020).

This principle, almost similar to the previous, is not equal; here, it is explained that products must be designed with a cradle-to-cradle perspective in mind right from the genesis. The design principle should be built on the ability to **disassemble**, allowing components and materials to be reused, remade, or **recycled**. High energy, labor intensity, and increased resources go into textile production, whereas **composting** them adds little to no nutrients to enrich the soil. Therefore, it should be a priority to keep longer life cycles of garments before considering composting.

Made from safe and recycled or renewable inputs: *“In a circular economy, substances that are hazardous to health or the environment are designed to allow safe material circulation and ensure that no pollutants are released into the environment”*(op.cit.).

Last but not least, the principle highlights the importance of drastically reducing the need for virgin inputs and sourcing the remaining pure inputs from renewable materials using regenerative practices for apparel, footwear, and accessory production.

A circular model focuses on designing, producing, and consuming fashion items to minimize waste, reduce environmental impact, and promote sustainability. Bruna Villa Todeschini discussed the underlying factors of a circular economy model tailored to fashion businesses (et al., 2017); in addition to the proposed principles by the Ellen MacArthur Foundation, these factors are not product-focused but present a wholistic perspective in the fashion economy and its interrelation with the ecosystem. The three main factors are:

- Upcycling
- Recycling
- Vegan.

Upcycling

“Upcycling refers to the use of waste materials to generate new goods of equal or higher perceived value, utility, and/or quality than the original products” (Singh et al., 2019).

Upcycling is an elevated version of the concept we are often used to, thus "Downcycling," where the second life of a product is given a reduced value compared to the original value. A

typical example of downcycling would be using your old shower towels as rugs for cleaning surfaces at home. Upcycling provides a second life or even multiple lives by creating a new product of **higher quality** or value from discarded or old materials and garments. It offers an alternative to traditional manufacturing practices and encourages a shift towards a more environmentally conscious and socially responsible fashion landscape.

Upcycling is built on the core of collaboration and community building within the fashion industry. Designers, craftsmen, artisans, retailers, and consumers of products need to work together to share knowledge and resources to create upcycled pieces. This collaborative approach promotes sustainable practices by tackling all areas of the value chain, which enables the transformation of the linear model of the industry to transition to a more circular one. A group of authors researched standard vs. upcycled design and production in the garment industry. Findings from this study demonstrate that there are significant differences between upcycled and standard fashion and design, production, and research processes. (Li-Chou Han, et al., 2017)

Standard Design versus Upcycling Design

Figure 6: Standard vs. Upcycled Fashion Design and Production



Source: Han et al. 2017

The main differences between the standard design process and the upcycling process were internalized in the design brief set. Upcycling design embodies the sustainable design strategy of 'design for waste minimization'; therefore, this sector's fashion collections use post-consumer and post-industrial textile waste as the source materials.

The results of their analysis showed that utilizing textile waste in designs is an integral part of upcycling brands, and, in contrast to standard fashion, design and production are linked to trends and consumer and market data. Upcycling thereby provides a circular alternative in fashion that minimizes waste and promotes sustainability, creativity, and resourcefulness within the industry.

Christabel Parung and fellow scholars also conducted a comparative study on the Upcycling Design Process versus the Standard Design Process using local designers. Their analysis observed that design thinking is an iterative upcycling process. The process of upcycling old garments by local designers was projected into the five stages of the upcycling and design process: Empathize, Define, Ideate, Prototype, and Test. A comparison of upcycling local fashion designers and standard local fashion designers was conducted, and the scholars noticed key variations in their processes (Parung et al., 2022).

Figure 7: The Comparison of the Upcycling Design Process and Standard Fashion Design Process

No	Upcycling Design Process (2 Upcycle Fashion Designers/Brand)		Standard Design Process (2 Local Designers/Brand)	
	Process	Description	Process	Description
1	Collecting used garments (random)	The garments are collected from variable resources (families and friends' discarded clothing and secondhand-shop / thrift shop)	Creative inspiration search	Creating inspirations from the trend research, market testing, and any other inspiration sources.
2	Sourcing materials and textiles	Checking the type of materials available from upcycled clothes to create a concept	Moodboard creation	From the inspiration, designers need to make a moodboard containing color plan, mood, texture, and inspiration/theme pictures
3	Creative inspiration search	Creating inspirations from the materials that are available.	Raw sketches, Details and Fabric planning	This process includes the creation of fashion sketches of collection planning, including the details and fabrics to use.
4	Moodboard creation	From the materials available, designers need to make a moodboard containing color plan, mood, texture, and inspiration/theme pictures.	Materials and textile sourcing	Materials and textile are set based on the garment types, designer preferences, and the inspiration.
5	Collection creation (sketches)	From the materials and the type of the garments, designers create a 'brand new' design that has the elements of the used material.	Collection creation	The detailed collection is made based on the inspiration and mood board.
6	Production process	The production process of the garment.	Production process	The production process of the garment (Can be mass produced or limited product)

Source: *Upcycling Design Process and Classification of Upcycling Method as Innovation to Extend Product Lifecycle*

The standard fashion designing process usually starts by making creative inspiration and mood boards before determining the textile materials used. In contrast, with the upcycling process, the materials used are old garments with defects. The upcycling process, therefore, requires designers to adjust their design and create inspiration based on the old clothes and textiles available. The upcycled garment is unique in the production process, making it impossible to create the same clothes because defects and old garments come in varied forms. On the other hand, the production in the standard design process can be mass-produced and replicated severally.

The conducted study provides the four methods in the production process of upcycling, which are the subtraction method, Deconstruction method, Addition method, and Refunction method. She explains that subtraction is the easiest method to use since it does not require any special tools (except laser cutting), and the Addition method is the richest since it applies many creative techniques to the garment. The various techniques of the upcycling process prove that the life cycle of garments can be extended, and further research in this area can include consumers' contribution to creating unique products by minimizing the standard design process to elevate upcycling in the garment industry.

Recycling

Recycling simply means converting materials from existing products to create different products. It is an alternative to reducing waste and conserving resources; however, it is considered the last option among the three R's, thus **reduce**, **reuse**, and **recycle**, because recycling entails high energy processes. A high-profile example of an innovative business model based on recycling is that of Adidas and Parley for the Oceans. On Earth Day in 2015, Parley announced their first partnership with Adidas. The companies developed shoes made of yarns and filaments reclaimed and recycled from ocean waste and illegal deep-sea gillnets (Parley, 2015).

With tons of textile waste created each year and figures estimated to increase because consumers are purchasing six times more compared to the year 2000, recycling the waste accrued significantly positively impacts the ecosystem. In the clothing industry, there are two types of recycling;

- **Pre-consumer** refers to recycling materials or products that do not meet quality standards, are production cut-offs, or any other byproducts generated during the manufacturing or production process before they reach the consumer.
- **Post-consumer:** It involves the collection, sorting, processing, and reprocessing of products or materials used by consumers and discarded as waste. A typical example of post-consumer recycling is collected plastic waste recycled to make textiles for garments.

Both recycling types require collaboration from diverse actors in the production value chain to make it possible. For instance, pre-consumer recycling involves collaboration between manufacturers, recycling facilities, and other stakeholders in the supply chain because one's facility waste could be recycled and used as input by another facility. Post-consumer recycling also requires raising consumer awareness about the impact of clothing waste and educating them on how they can contribute to post-consumer recycling. Pre-consumer and Post-consumer recycling are vital in reducing waste and promoting a circular economy in the fashion industry.

Vegan

According to Todeschini, "*Vegan refers to an approach to fashion production that deliberately refrains from using raw materials of animal origin*" (et al., 2017). Vegan fashion aims to reduce overall energy consumption within the whole system, as extracting and processing animal material requires high energy.

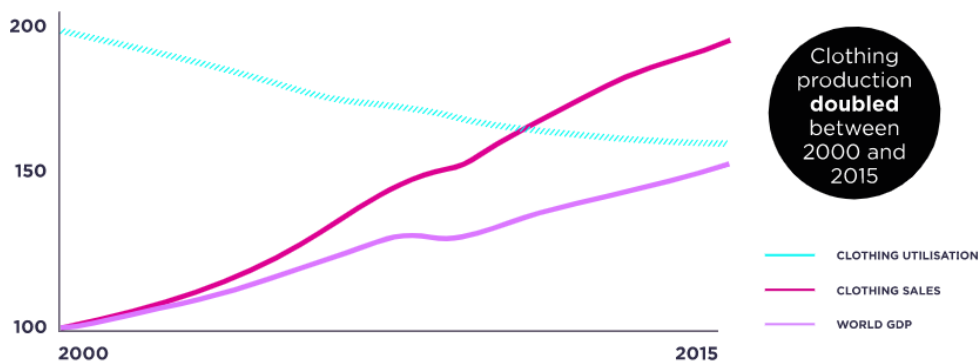
Stella McCartney, a pioneer in promoting cruelty-free fashion, has been a vocal advocate for animal rights and sustainability in the fashion industry since she launched her brand in 2001 and has never wavered in her commitment to ethical practices in the fashion industry. Stella has been at the forefront of incorporating vegan materials into high-end fashion and uses alternative materials to leather, fur, and other animal products.

According to sustainable fashion experts, recycled cotton, organic linen, and organic hemp are today's most eco-friendly fabrics. These are all plant-based materials and thus vegan-friendly. The second category of vegan alternatives is recycled plastic, such as recycled PET (plastic bottles). As veganism and ethical consumerism continue to gain momentum, the

availability of vegan fashion options has increased. Many fashion brands now offer vegan collections or have entirely transitioned to producing only vegan products, but it is essential to clarify that using vegan alternatives does not equate to sustainable production. The environmental footprint derived from the life cycle assessment of products and human costs, such as child labor and indecent working conditions, is still predominant in ensuring that fashion becomes fully circular.

2.3 Circular Fashion: Producers and Consumers Role in Circular Fashion

Figure 7: Growth of clothing sales and decline in clothing utilization since 2000



Source: Ellen MacArthur Foundation Circular business models.

The graph above (Figure 7) shows a decline in cloth utilization as cloth production and sales surged. The economic growth in apparel production is apparent, but as discussed in the first chapter, overproduction comes at a high price; therefore, new business models that consider the society and ecosystem must be explored in the fashion industry. Ellen MacArthur Foundation proposes circular business models that allow companies in the fashion industry to make revenue without making new clothes. Implementing these models can reduce considerable amounts of greenhouse gas emissions, pollution, and biodiversity impact caused by the fashion industry.

Circularity in the industry depends on the active collaboration of both the producers and consumers to ensure its sustainability. Ellen MacArthur explains the approach producers could take thus “*by decoupling revenues from raw material production – through business models such as resale, rental, repair and remakin.*” Circular business models in this industry can be created by combining these three categories:

- **More use per user:** Business models could be designed to make products physically and emotionally durable, provide services to support long-term use, and empower consumers to use their products more and for more extended periods (e.g., H&M customizations services and publishing tips and guidance for customized items, also their M,IN.T care initiative which provides repair, mending, and washing services).
- **More users per product:** Business models can be designed to facilitate the movement of products from user to user after only wearing or moving products after a significant amount of use. (e.g., GANNI is a platform for combining the rental, remaking, and resale of products)
- **Beyond physical products,** Business models in this category move entirely away from using physical products and can include alternatives like digital clothing or services that replace, enhance, and complement customers' fashion needs and aspirations. Producing one digital product vs. one physical product eliminates material waste. It reduces greenhouse gas emissions by ninety-seven percent while, on average, using three thousand three hundred fewer liters of water. It also eliminates the physical transport of clothing, resulting in additional greenhouse gas emissions savings. (e.g., The Fabricant collaborates with physical brands such as Napapijri and Tommy Hilfiger to digitize their marketing campaigns and collections so that products don't need to be made for them)

Beyond the environmental benefits that could be attained from these three categories, brands can also utilize this medium to improve their stock management and increase customer loyalty and their revenue potential. The three proposed categories by the Ellen MacArthur Foundation enable consumers to get the value out of their own wardrobe by utilizing peer-to-peer re-commerce and rental platforms (Foundation, 2021).

Most products currently in the fashion industry are not designed for circularity. At the end of their use by the first user, an overwhelming majority of them end up in landfills or incineration. Meanwhile, a large percentage of these materials could be reused, recovered,

and recycled into new materials for the textile industry to use as new feedstock. Some key data from PWC global survey on consumers suggest that (Rinaldi, 2019):

- Thirty-five percent of respondents said they choose sustainable products to help protect the environment;
- Thirty-seven percent look for products with environmentally friendly packaging;
- Forty-one percent avoid the use of plastic when they can;
- Two-thirds of respondents were willing to pay for locally produced food items;
- Forty-two percent said they will pay more for sustainably produced non-food items.

From the provided data, it is clear consumers, even though largely uneducated about the production procedures by producers, care about the sustainability of the product and would be willing to play an active role in the supply chain. Francesca Romana Rinaldi, in her book *Fashion Industry 2030*, suggests it is better to describe consumers or neo-consumers as a "consum-actor" or "consum-author" because the consumer assumes the final stage of the transaction as a mere process of purchasing and consuming, while the prior two describe a user who is an active part of the complex consumption dynamics (Rinaldi, 2019). For the fashion industry to be fully circular, consumers should be involved in the role of producer-designer-client because they can gain knowledge and awareness from the product and translate it into developing goods and services.

2.4 Circular Fashion: Transparency and Traceability in the Fashion Industry

In her book *Fashion Industry 2030*, Francesca Rinaldi suggests Transparency and Traceability as the main drivers of chain to sustainability in the fashion industry. Transparency and traceability in the fashion industry, broken down to the simplest definition, means that producers share details of each component of their supply chain, and consumers can track the whole process for individual products and batches. These two concepts, coupled with circularity and collaborative consumption, are reshaping the rules of fashion company success (Rinaldi, 2019).

Traceability of value chains enables enterprises to track materials, products, and the conditions in which they were produced and transformed through the entire value chain.

Transparency is relevant information being made available to all elements of the value chain in a standardized way, which allows common understanding, accessibility, clarity, and comparison. Active implementation of traceability and transparency in the fashion industry implies that all materials, practices, and conditions along its value chain are unconcealed, giving room for all the activities to be assessed and transformed towards a more sustainable path.

As important as these concepts are vital in the industry's transition to sustainability, research conducted by Deloitte has shown that sixty-five percent of procurement leaders across sectors have limited or no visibility beyond their tier-1 suppliers. And only six percent of procurement leaders say they have full transparency of their entire supply chain (Deloitte, 2018). If procurement leaders need to be made aware of the activities behind the curtains of their procurement processes, how could the industry be holistically transformed into sustainability? One can only improve what they can measure. A fundamental benefit of embarking into traceability and transparency is the opportunity to gain complete visibility of the value chain, identify all suppliers and actors up to raw material providers, and proactively engage with them to prevent and mitigate environmental and social risks and impacts. It allows producers, brands, consumers, governments, and regulators to have the full range of information and to tackle the complexity of current supply chains in the garment and footwear industry.

In UNECE's attempt to provide solutions for the issues regarding transparency, traceability, and circularity in the fashion industry, a pledge was launched named The Sustainability Pledge. In January 2021, the United Nations launched this platform, built on three core values: **“Track it, Trace it, and Wear it.”** They have worked together with hundreds of experts, policymakers, businesses, academics, and NGOs to come up with a workable and verifiable way of ensuring sustainability in the garment and footwear sector. The platform is effectively preparing stakeholders, governments, and all actors in the apparel industry to take up traceability and transparency with the support of advanced technologies. The platform does not only offer a series of policy recommendations, guidelines, and standards for fashion industry actors to authenticate their sustainability claim but also provides a toolbox including opensource blockchain and DNA tracking to develop an immutable fingerprint for any item of clothing or pair of shoes (UNECE, 2021). The blockchain pilot has been tested in twenty-one countries with more than seventy partners in thirteen use cases. They have shown

reliable information's importance in identifying, preventing, and mitigating adverse impacts on people and the planet. Some companies submitting pledges or signing on as partners include Inditex, Mulberry, Scottish Leather Group, and Vivienne Westwood.

Companies mentioned above and others on the path of transitioning to sustainability are influenced mainly by the emergence of consumers' concerns about the ethical and environmental impacts of their purchases. Transparency and traceability enhance the connection between producers, firms, brands, and retailers by providing a rigorous way of collecting information related to operations and products along the value chain. It helps companies build consumer trust and fosters a solid network with their clients and suppliers.

Agreeing with Francesca Rinaldi's book *Fashion Industry 2030*, sustainability cannot be achieved only within the boundaries of a company's operation. This is because for garments or footwear to be produced, it involves numerous production phases, the interaction of multiple economic actors exchanging raw materials, semi-finished goods, and components of finished goods. Improving traceability and transparency is essential to investigate and collect most of the data needed to quantitatively and qualitatively assess environmental and social sustainability in the fashion industry.

Transparency and traceability systems unveil the dependencies and risks in the supply chain. It enables procurement leaders, suppliers, and consumers to observe the Environmental, Social, and Governance measures implemented in the product life cycle. Tracing a garment means to know where it is in every moment. To be able to recognize it among other products makes it possible to mark it.

Fabbrica Futuro explains: *"A product is traced if it is possible to reconstruct the whole production cycle, starting from the origin of single elements that compose it to the single production phases, ending with the passage to the consumer"* (Dotti et al. 2012)

The modern solution or tool advised for transparency and traceability is blockchain technology. Blockchain is a distributed database that maintains a continuously growing list of ordered records called blocks. These blocks "are linked using cryptography. Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data (Synopsys, 2023). Transparency and traceability using blockchain have two key objectives:

- To provide transparency by enabling consumers to inspect the sustainability and ethical claims of a product.
- to provide traceability by enabling the verification of a product's authenticity and ownership.

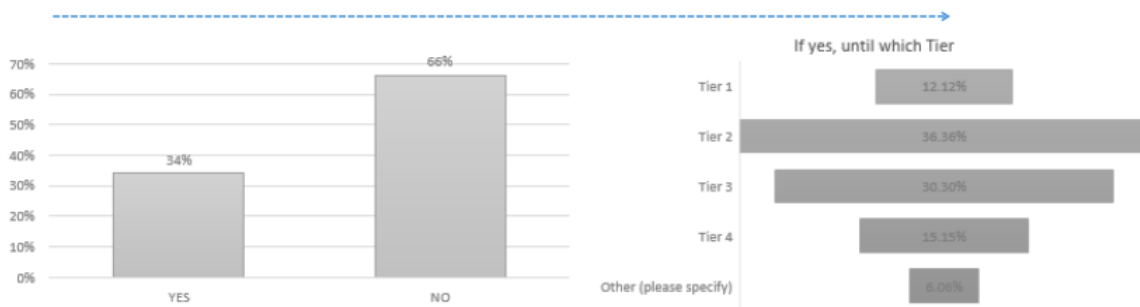
One of the first instances blockchain was used for transparency in the fashion industry was in 2017. The fashion designer Martine Jarlgaard partnered with a blockchain company, Provenance, for a pilot program that tracked raw materials through the supply chain to the completed garment. Each item of clothing was allocated a unique digital token, allowing for the verification of every step of its production. Customers could also access the information on the Provenance application when they scan the item's QR codes. The unique digital identity for the product, thus a digital twin, enables tracking the product's lifecycle from its raw material stage to design, its sale, resale, and then recycling. Through this program, consumers could easily learn where the cotton or silk in their garment came from, where it was manufactured, and how to recycle it. The unique token identity is also a medium for brands to protect and authenticate their products and reassure consumers that they are buying a genuine article (Agency, 2023).

In a brief summary, transparency and traceability in the fashion industry results in the following advantages;

- Enabler for transitioning to sustainability
- The certainty that the product has been really produced in the specified place.
- Clear information on the production processes of products
- Reduction of child labor

Traceability and transparency in the life cycle of products is still a refrained concept because there are key challenges with tracking and tracing the value chain. A survey conducted in 2017 by UNECE to assess the tracking and traceability of the value chain of the garment and footwear sector depicts that only a minimum of thirty-four percent of the sample track and trace their value chain. The respondents of the survey shared certain key challenges in achieving value chain transparency and traceability (Rinaldi, 2019).

Figure 8: Source: UNECE 2017 and UN/CEFACT Plenary, April 2019



Note in the right-hand graph 'Other refers to chemical suppliers.

- The Fragmentation and Complexity of the Business Network:** About sixty-nine percent of the respondents to the survey declared that it is difficult for companies in the fashion industry to track the value chain because multiple actors are often in different countries and continents with diverse requirements and systems of production. In certain areas, the supply chain is rather opaque, making it difficult for companies to track product history and features.
- Privacy of Data and Data Security:** Fifty percent of the respondents shared in the survey that they are willing to share information about specialized providers; however, privacy of data and specific data regulations prohibit them from doing so.
- The Costs Associated with Necessary Resources and Technologies:** Implementing systems and schemes for tracking the value chain of products implies an upfront cost. Forty-nine percent of respondents disclosed that traceability requires substantial investment in sophisticated technology and processes to verify products, parts, and all components stages of the value chain.
- Technological Barriers:** Lastly, technological advances such as blockchain, tracing chips, bar codes, etc., offer a good opportunity for traceability and transparency in the garment and footwear industry; however, mastering these technologies is a challenge due to uncertainty of perceived legal risks, data protection laws and other blurry technological law codes across diverse territories. Twenty-nine percent of respondents from SMEs and non-vertically integrated companies mentioned that a widespread collaborative effort by leadership to minimize the costs involved in technological

advancement would be an attractive offer for many garment and footwear companies to pursue traceability.

2.5 EU Initiatives for circular economy and how it applies to the Fashion Industry

Experts and scholars in the discussion of sustainability argue that Europe cannot achieve sustainability without a circular model. In 2020, the European Union approved the European Green Deal, which presents a roadmap for making the EU's Economy sustainable by turning climate and environmental challenges into opportunities across all policy areas and making the transition just and inclusive for all. Its objective is to augment the efficient use of resources by moving to a clean, circular economy and stopping climate change, reducing biodiversity loss, and reducing pollution.

The initiative introduces a new set of regulations for eco-design requirements and sustainable products. The criteria for eco-design of products are:

- Product durability, reusability, upgradability, and reparability
- Presence of substances that inhibit circularity
- Energy and resource efficiency
- Recycled content
- Rem, manufacturing, and recycling
- Carbon and environmental footprints
- Information requirements, including a Digital Product Passport
- Footprints of products throughout their life cycle.

The Eco-design framework proposed by the EU aims at creating a digital product passport to regulate all products in the EU area, make it easier to repair or recycle products, and facilitate tracking substances of concern along the supply chain. The digital product passport will be created for all products and a significant enabler for circularity in the fashion industry because traceability and transparency will be enhanced. Transparency and traceability will compel industry actors in the fashion industry to stray away from greenwashing and integrate circularity principles in its business model to minimize its environmental footprint. The commission's long-term plan for the textile industry is to successfully achieve green and digital transitions to sustainability and make the ecosystem more resilient (Commission, 2022)

CHAPTER 3: LIFE CYCLE ASSESSMENT on MAFRIC

3.1 About Mafric

Sustainability is a concept that cannot exclude innovability. Transitioning towards sustainable paths implies finding alternative ways to utilize resources and minimize ecological footprint. Mafric is an Italian fashion brand founded in 2019 by Giovanni Lucchesi after returning from a transformational volunteering experience in Zambia. Its mission is to promote the employment of people in fragile situations while conveying a message of multiculturalism, inclusion, and sustainability through fashion. Mafric's network comprises a dozen social tailor shops in Milan and Como and a chain of about 100 shops in 50 Italian cities in ten regions. The brand aims to be able to support more people in fragile situations by involving them in the production network of tailor shops around Italy. Mafric adopts circular economy dynamics through the use of recovered fabrics, recycling, and upcycling processes thanks to collaborations with organizations working in these fields for years. The organization's founder believes that ethical and sustainable fashion is not only possible but a necessary requirement for the fashion industry's future.

Mafric's project stems from the awareness that the current production and consumer system, mainly linked to fast fashion, contributes to the industry's significance as a polluting agent of the planet. Therefore, the business model of Mafric adopts fundamental principles of ethics and sustainability while combining quality sartorial production with a profound social commitment. The brand's innovation lies precisely in uniting the two realities, profit and non-profit, by creating and managing with an entrepreneurial approach.

“According to the Greening Europe's Economy study, conducted by the European Network for Sustainable Consulting in 2015, the main reason why green startups fail is essentially due to their inadequate business models” (School, 2018)

Giovanni Lucchesi understood that social sectors, mainly small/medium-sized isolated non-profit territorial realities, are often characterized by poor coordination and a visceral refusal to be part of market dynamics. Poor coordination can hinder the longevity and sustainability of their good cause.

The garments in the collections are made exclusively by social tailors located in the Milan and Como areas, where people from highly vulnerable backgrounds, especially women and migrants but also ex-convicts and people with mental and physical disabilities, learn the trade of professional tailors. In this way, Mafric is personally committed to making up for the lack of social vocation on the territory that characterizes most fashion companies in Italy.

3.2 Mafric and Local Territory.

Green startups like MAFRIC find their natural application in fields related to waste management, pollution, renewable energy, sustainable tourism, and cultural and creative industries. When these areas are well curated and innovative sustainable strategies for territorialization are implemented, green startups in local areas can become a significant bridge for local regeneration.

Not only the state but other actors attempt to exercise power over space and build territory through a territorialization process. Neil Brenner, in his article, calls the *'territory effect the articulations of power which are revealed in the process of territorialization'* (Brenner, 2004). A territory is more than just an empty space; the distinction between space and territory was first made by Alain Faure;

'The first transformation occurred in the 1980s and 1990s with the growing role played by analyses of the conditions for implementing public policies at the local level in government action studies. The second, more contemporary change stems from the growing empowerment of local communities. It is characterized by the evolution of the language used by scientists and experts to describe the public action surrounding the derived term "territorialization" and descriptors such as "territorial" and "territorialized." These changes are undoubtedly symptoms of the crisis of the French administrative model, in the sense that, in relation to theory, they reveal the totally new political issues of "territoriality" associated with the general process of decentralization in all national political systems' (Translated from French) (Faure, 2004)

There are three acts of the process of territorialization, which are dependent on what rationality is guiding an actor's action in a definite time and place. The three acts are:

Denomination, Reification, and Structuring (Turco, 1988)

From Turco, we understand that territories are not fixed, and through the sequence of processes, the local environment or actors can influence territorial development by reshaping a territorial context. For instance, in the case of migration, local authorities and actors can play a significant role in integrating migrants into their territories. Although migration policies are set nationally, migration integration policies are generally implemented on a subnational level. Therefore, active local actors must be considered partners in the reshaping of territories for development. There are three major international documents: the Agenda for Sustainable Development, the Global Compact for Safe, Orderly, and Regular Migration (GCM), and the Global Compact on Refugees (GCR), which recognizes the potential of migration to promote sustainable development in both sending and receiving societies (Gonçalves d'Albuquerque & UNON publication services, 2020)

Mafric, an ethical local fashion company with a strong message of social and environmental sustainability, involves fragile migrants who have lost identity in their new territories and local tailors in the suburbs, predominantly in the Milan area, to produce its collections. The initiative of Mafric ensures sustainable fashion and provides social network and economic stability to migrant tailors and vulnerable people in localities to build back their territories.

3.3 Circular Strategies Implemented at MAFRIC

The textile and apparel industry consists of several actors along the supply chain of a garment or footwear production. In order to implement circular strategies to foster sustainability, there must be transparency and active administration of circularity across all actors. The actors in the textile industry include (Polanía Giese, 2022):

- **Raw material producers:** They can either be local or multinational companies, producing raw material for the textile value chain based on natural/botanic or synthetic raw materials via manufacturing processes.
- **Suppliers:** Fabric and yarn producers which create the textile materials that will form the basis of the garment.

- **Garment manufacturers:** Both on a local (EU or even country) scale and on a global scale (multinational companies), companies that transform the textile into garments that will be sold to consumers.
- **Retailers:** These include major (multinational) fashion brands as well as smaller, more boutique brands and specialized brands, such as active lifestyle and sportswear brands, which sell the garments to consumers.
- **Logistics:** Companies responsible for collection points and return/take-back procedures.
- **Recyclers:** Companies specializing in sorting and transforming waste, bringing secondary raw materials back into the loop.

In the case of Mafric, materials and fabrics used for the production are chosen by multinational suppliers. A higher percentage of textiles used for the production of garments are recovered fabrics in optimal condition destined for waste. Mafric incorporates wax textiles in the accessories and garments it produces. Wax is a colored printed cotton fabric, generally with bright colors and very colorful patterns. The wax fabric owes its name to the resins and waxes used in processing the raw material, which is white cotton. Through numerous processing steps, these waxes are gradually removed so that the repeated infiltrations of colors remain imprinted on the fabric.

Although it is considered the quintessential African fabric, wax was invented by the Dutch in India 150 years ago to create a fabric that could compete with the famous Javan batik. However, the operation took longer than expected and failed to rival the local fabrics. To find a new market, the Dutch contacted some Scottish missionaries who told them of batik's great success among the Gold Coast population (present-day Ghana). The Europeans decided to transfer the industrial production of wax print to the continent of Africa, and this is how the spread of wax print in the African continent began. It symbolizes the encounter and collaboration between distant cultures, which is also finding its way onto the catwalks of international high fashion.

Figure 9: A tailor working on an African wax print



Source: Mafric

The principles of Mafric are based on circular and slow fashion; therefore, their innovative ideas by fashion designers are produced sustainably through social garment manufacturers. Production is entirely handcrafted, minimizing the negative environmental impact of the mechanical output. All clothing and accessories are designed as unique pieces by carefully studying the materials and patterns used to reduce waste. To ensure circular strategies are implemented in each production phase, Mafric provides teachers in every tailor's shop with a solid foundation for making high-quality, sustainable products.

Recycling and upcycling production processes are essential for sustainability in the fashion industry; ensuring careful recycling of materials and upcycling methods for garment production must be implemented to minimize waste production and establish a virtuous circle that is good for the environment. At Mafric, production involves reusing everything that can be reused so that even the last supply chain feeds back into the productive one to eliminate waste. Regarding retail, Mafric works with pre-order models, implying they only remake what has already been sold and supply to diverse boutique shops around Italy.

3.4 Life Cycle Assessment of Mafric

Measuring the impact of an industry's progress towards sustainability can be complex, particularly in industry sectors such as footwear and apparel, where standards and measuring metrics to gauge effectiveness are complicated. Some fashion brands unwilling to go through the complexity involved in measuring circularity result in misinformation and greenwashing because sustainability is currently the selling point in the industry. All vague and inflated claims have appeared across advertising, marketing, media, packaging, and beyond.

“The European Union (EU) finds there are currently more than 200 types of eco-labels in the EU market, for instance, many of which are unverified and misleading. In the UK, the Competition & Markets Authority (CMA) is specifically reviewing the fashion retail sector due to widespread concern for the way in which certain items of clothing are touted as better for the environment, promoted as using recycled materials, or branded as sustainable” ((UNEP), 2023)

Promoting garments with vague language such as ethical, eco, or green does not necessarily make it an environmentally or socially friendly product. Instead, there is a need for analytical information and circular measures taken to back the sustainability claim. The ultimate requirement is a holistic, accurate account of the life cycle assessment of products and services. This process can help identify significant environmental challenges from a lifecycle perspective and the relevant trade-offs.

The European Union has developed a Product Environmental Footprint (PEF) Category Rules for apparel and footwear. PEF is a detailed set of rules to assess the environmental performance of products throughout their life cycle (accounting for all the upstream supply chain and downstream activities), following an LCA-based methodology. It offers a science-based, standardized framework with the aim to help the entire industry speak the same language when talking about environmental impacts. With the EU's agenda to achieve the objectives of the European Green Deal, the commission established the PEF methodology to support and help meet this goal.

The International Standard Organisation provides the guidelines for conducting an LCA study. According to the ISO4040 environmental management, Life Cycle Assessment is a

compilation of inputs, outputs, and potential environmental impacts of a product system throughout its life cycle, thus from the cradle to the grave, to avoid a shift of the potential effects among life cycle stages. To determine an accurate measure of the environmental footprint of the producers in the fashion industry, it is advised to use the scientifically validated methodology ISO4040. The International Standard is, however, not intended for contractual or regulatory purposes or registration and certification.

The procedure of LCA consists of four key steps:

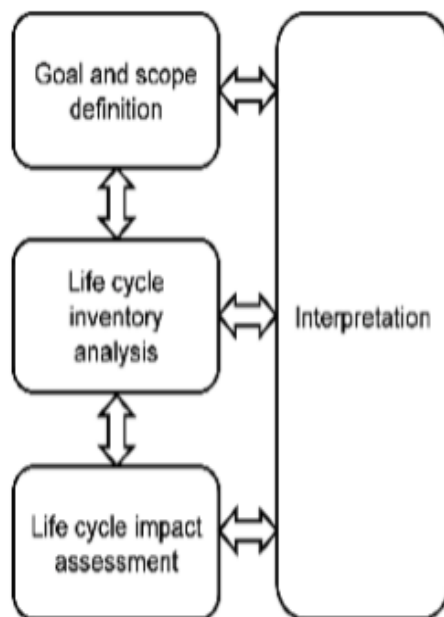
Goal and scope definition

Life cycle inventory analyses

Life cycle impact assessment

Interpretation

Figure 10: Procedures of LCA



Goal and Scope: The aim of the assessment, the functional unit, and the product life cycle are defined, including boundaries to other product systems and the environment. In this LCA, the goal of the study is to track the environmental performance of a blouse (Top Fili) from Mafric's spring-summer collection 2023. The intended audience of the study is my academic professors and the organization Mafric. The LCA carried out is not intended for comparative assertion with other products. The consolidation method chosen is the financial control approach because Mafric has no investors with equity exceeding five percent. It is a relatively

small fashion brand, so the equity share and control approaches will have the same result. The reference year for the study is 2022/2023 because the production of the summer collection was in this period. The study is conducted with both primary data from Mafric and secondary data, which are published production data that are not directly collected, measured, or estimated by Mafric but are generic datasets sourced from the European Commission environmental footprint database (LCA, 2023).

System Boundaries: It identifies which Life Cycle Assessment processes should be included in the metric system. Three main approaches can be considered for the study:

Gate to gate→Only production processes are considered.

Cradle to gate → from raw materials to the output of a specific life cycle stage, such as production.

Cradle to grave→encompasses the entire life cycle of the products, including what happens after the use stage.

The cradle-to-gate approach would be taken for this LCA study because data was not accessible from the use and after-use stage of the consumers of the product.

Basic data for the garments in this study

Garment	Mass (g)	Material type	Key raw materials by mass
Top Fili	100	Non-woven	Recycled cotton Viscose Wax print

Life cycle processes of producing Top fili

Raw material extraction

Dyeing

Spinning & Knitting

Wet treatment

Transportation of fabrics to Mafric

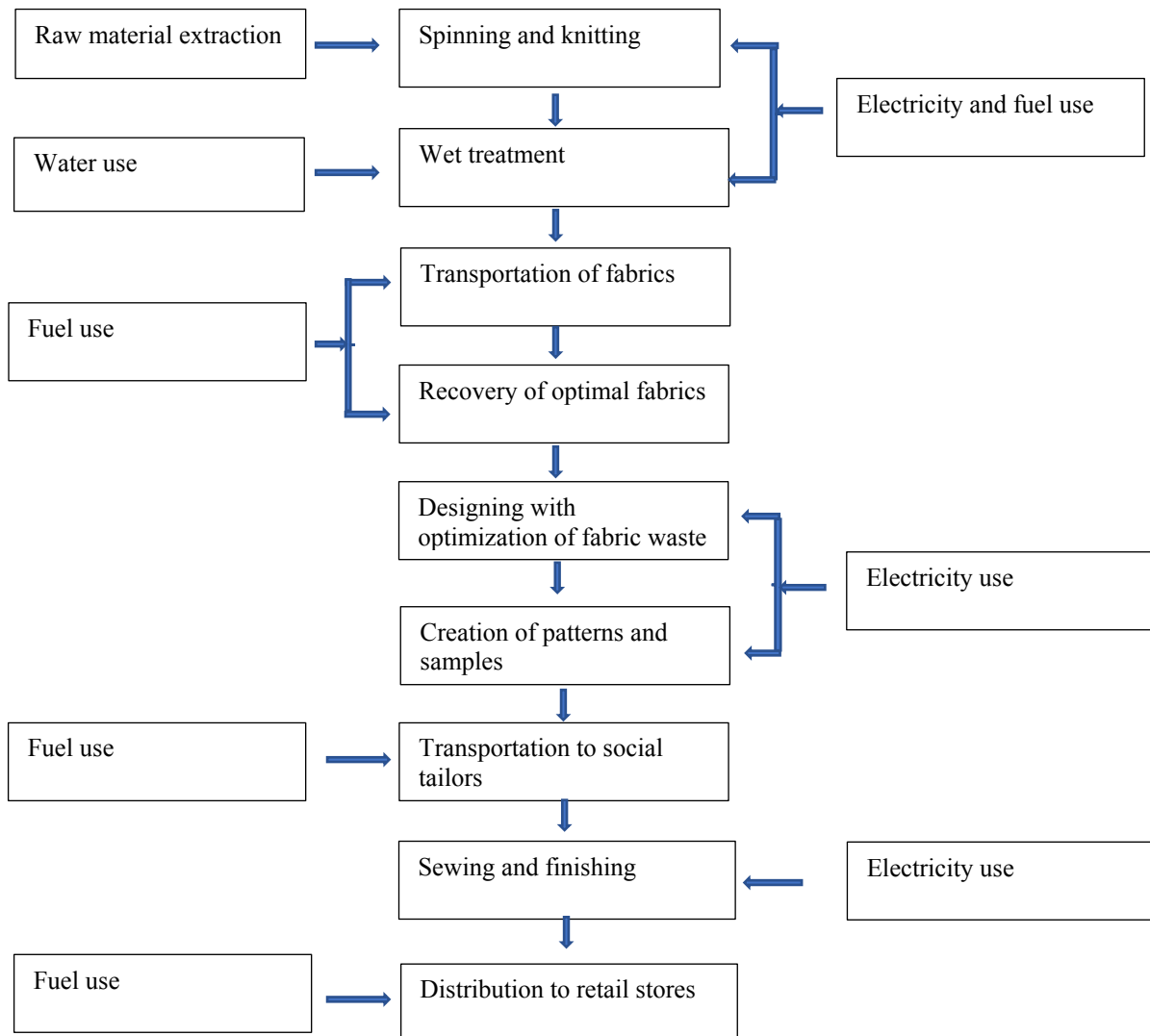
Recovery of optimally conditioned fabrics destined for waste

Ennobling of fabrics with original prints

Preparation of design to optimize fabric waste

Creation of patterns and samples
 Transportation of fabrics and patterns to social tailors
 Sewing and finishing
 Distribution to retail stores.

System Boundary Diagram



Inventory analyses: Life cycle inventory data describes the physical and energetic flows between processes within the life cycle of a system. In the case of the product, the systems under study are described in the system boundary diagram above.

Cotton production from its cultivation, knitting, and dyeing process makes it a highly consuming water product. However, Mafrić's "Top Fili," a cotton blend with natural fiber

viscose, makes it a preferable alternative. The product is being produced with recovered fabrics in optimal condition destined for waste. The fabrics are ennobled with just the original prints, and no further chemical or mechanical work is done. With Mafric's aim of minimizing its ecological footprint, all collections, including "Top Fili," right from the designing stage, are made with the optimization of textiles and fabric waste to be included in production.

Materiality analyses: It is a process that enables a business to identify its most important areas and prioritize ESG issues that are most critical to its organization. Based on the life cycle processes listed in the system diagram, the ESG issues critical to Mafric, and the significant activities observed, these areas are of most concern for the production of Top Fili.

Global warming: Due to fuel usage

Freshwater acidification: Due to the production process of cotton, viscose, and wax print

Impact assessment is a step for evaluating potential environmental impacts by selecting materiality analyses into specific impact indicators. Impact assessment indicators can be selected from the EU Product Environmental Footprint Category Rules Guidance, which are:

Climate change

Ozone depletion

Human toxicity

Particulate matter

Ionizing radiation, human health

Photochemical ozone formation, human health

Acidification

Land use

Water use

Resource use, minerals, and metals

Resource use fossils

The EU product environmental footprint category rules for apparel and footwear are a useful instrument to assist with conducting a thorough study. Impact assessment is necessary to understand which areas of the life cycle process contribute primarily to a negative footprint and how the overall ecological footprint could be minimized. From the life cycle processes of producing Top filli, fuel and electricity usage runs through its life cycle processes;

Fuel use	Electricity use
<ul style="list-style-type: none"> • Spinning and knitting • Wet treatment • Transportation of fabric • Recovery of optimal fabric • Transportation to social tailors • Distribution to retail stores • 	<ul style="list-style-type: none"> • Spinning and knitting • Designing with optimization of fabric waste • Creation of patterns and samples • Sewing and finishing

Using recovered fabrics and upcycling fabric waste are some circular strategies that minimize the ecological impact of producing Top fill. However, high electricity and fuel consumption negatively affect its sustainability. Electricity is primarily derived from diverse energy sources; therefore, its environmental impact depends on the source. It can be generated from nuclear power, renewable energy sources, hydropower, biomass plants, geothermal energy, and fossil fuels. According to the International Energy Agency, fossil fuels account for over sixty percent of global electricity generation. Burning fossil fuels in power plants releases carbon dioxide (CO₂) and other greenhouse gases into the atmosphere, contributing to global warming and climate change.

Renewable sources and nuclear power have fewer direct emissions, but their environmental challenges are not. The transition to cleaner and more sustainable sources of electricity is essential to mitigate the harmful effects of fuel consumption on the planet. To minimize the ecological footprint of the production of Top Fili, efforts must be made to transition towards cleaner and more sustainable energy sources, promote energy efficiency, and develop alternative transportation options, such as electric vehicles and public transportation. To improve upon the circular strategies, a further impact assessment with quantified details from processes will generate an accurate measure of the impact indicators.

CONCLUSION

In recent years, the United Nations and individual states have mainly promoted environmental awareness due to the depletion of natural resources, waste production, climate change, and core environmental constraints humanity can no longer escape. In this study, we understand the relevance of an immediate transition from the traditional economic linear model to a circular one, which will gear the economy toward a sustainable path.

The study focuses on the fashion industry and how it can attain sustainability by implementing the pillars of circularity in all sectors of operation. The word sustainability, as discussed, is quickly thrown about and advertised by both emerging and long-existing brands in the fashion industry, but according to a report conducted by Changing Market Foundation, fifty-nine percent of green claims made by European and UK fashion brands are misleading (Foundation, 2022). The research focused on policies and processes fashion brands must go through to authenticate their claim to sustainability and contribute positively to the ecosystem.

For a complete theoretical background, we discussed the problems in the fashion industry, the concept of circular fashion, and regenerative solutions to revolutionize the footwear and apparel industry. We introduced the EU initiatives for circular fashion, some ethical concerns in the fashion industry regarding unfair wages, fashion colonialism, child labor, and concerns for women garment workers. We presented circular strategies such as implementing transparency and traceability along the supply chain, moving away from the standard design to an upcycled design, and enacting a model based on the three R's (Reduce, Reuse, and Recycle), which aims at reducing waste.

The research presented a life cycle assessment of a fashion brand named Maftric. The procedure was to unveil and communicate why it is vital to assess all product processes to discover unsustainable practices and how to tackle them effectively. This process reveals the impact of the activities carried out by industry and how electricity and fuel consumption contribute to air pollution and climate change.

Using an LCA procedure reveals that the sustainable fashion of brands entails more than using upcycling models, natural fibers, or even recycled textiles because the whole processes

along the supply chain contribute to the viability of the product being sustainable or not. Increasing energy usage from electricity and fuel is directly linked to increased emissions of air pollutants and greenhouse gases, which significantly contribute to climate change.

Improving circular strategies, Mafric could implement in its production process.

- Green alternative options like solar energy, electric vehicles, and car-sharing would minimize greenhouse gas emissions.
- Ensuring transparency and traceability in all stages of its life cycle processes.
- Investing in digitalized patterns and product designs to minimize sample waste.
- Consumer involvement in production could be used to create products with their old garment (Upcycling), which would minimize the standard design process and create unique sentimental pieces.
- involving its consumers for waste recovery optimization, including shared use options in its business model and providing second-hand clothing resale options

The company Mafric aims to minimize its ecological footprint; therefore, performing an organizational life cycle assessment (OLCA) would enable it to create target-focused strategies.

RECOMMENDATION FOR FUTURE RESEARCH

LCA is an evolving discipline, and although it analyses all production procedures, it does not cover all sustainability-related issues. Other social concerns are not addressed in the life cycle assessment; therefore, it must be accompanied by methods to assess and mitigate social impacts, especially in the apparel and footwear industry, where ethical concerns like child labor, women exploitation, and poor labor conditions are predominant.

Consumer understanding of sustainability refers to individuals' awareness and knowledge regarding the environmental, social, and economic impacts of their consumption choices. Producers are to educate consumers on how products and services are produced, distributed, used, and disposed of and the implications of these actions on the planet and society. Further research can be conducted to measure the impact of educating consumers about sustainability and circular fashion. Consumer knowledge on the end of life of products could also be a helpful bridge in designing LCA's.

My last but not least recommendation is on how local communities can invest in the fashion industry to prevent exploitative labor practices and exploitation of its natural resources by foreign companies. Communities from the global south suffer consequences from the global fast fashion industry, leaving them vulnerable to the fashion industry's negative impact, such as climate change and water and air pollution. Inhabitants of the local territory can promote sustainable and ethical fashion practices, support local artisans and craftspeople, and ensure fair labor conditions that can help mitigate negative impacts and promote positive contributions to local development.

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