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New strategies for a more sustainable fashion industry in an international context.

The fashion start-ups that will shape the global scenario

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Contents

Introduction

The linear model through which the fashion industry is based upon is no longer sustainable, it is one of the most impacting industries worldwide in terms of climate change, water consumption, waste and also social aspects.

Starting from a very interesting lecture «Unraveled. The life and death of a garment» (Bédat, 2021), it is possible to realise that the fashion industry that most of us assume to know is different from what it looks like when we decide to buy a cloth or an accessory.

Even if famous fashion brands (in the luxury but also in the fast fashion segment) are now pursuing some strategies of engagement in the sustainability field, and trends such as circular economy, fair trade, lowsumerism and sharing economy are some of many emerging entrepreneurial ways to address this issue, they are still not engaged into a circular path in this way not having real positive footprint.

Very innovative start-ups and companies are trying to provide some new business models to have a real effect on the nowadays uncontrollable fashion global value chain, aiming to maximising the product's lifecycle throughout different approaches from sourcing to disposal, fostering resale, reusability, reparability, servitisation and resources sharing (Sita Mishra, 2020).

The main object of the current study is to provide a framework of transition from the linear model to the circular model and go in in deep to find the best sustainable business approaches in the fashion value chain. Throughout the combination of a review of literature and insights from the interviews conducted, the objectives of the thesis are addressed by posing the following research questions:

1. Which are the most impacting phases along the fashion value chain?

2. What are the possible new business models that can have a real impact on the shift to sustainability? How the "born- sustainable" start-ups and companies can have an impact on the transition to the sustainability of the worldwide fashion industry?

3. What technological innovations can be applied to enhance the pursue of the UN Sustainable Goals by 2030?

The findings revealed various themes and help to understand the real need to shift from a linear model to a circular model, the importance to support the "sustainable" business models and develop new facilities and improvements as well as the need to adopt Industry 4.0 technologies to make the transition to a more sustainable business agile and quickly. With the help of various example of real cases studies, the thesis shows how as all the actors involved in the supply chain acts immediately it is possible to have a real starting point to pursue new strategies with about zero environmental and social benefits.

Summing up, the structure of the research thesis is divided into three main chapters: first, it provides an overview of the fashion industry underlying some main figures and the impacts along all the phases involved in the worldwide supply chain of the fashion industry. *Chapter 2* divulges insights on the selected innovative business models dividing them into categories and identifying the best practices for each of them. Toward the end, there is a focused toward the upcycling and renewal business model (as it is resulted to be the perfect base to apply tech innovations) and how new technologies and the Industry 4.0 can be introduced to the different steps involved in this sustainable economic approach, identifying strengths, opportunities and the challenges.

Methodology

The methodology of this study follows qualitative research in order to make possible the translation of reality through real case studies of the subject under analysis.
Through some interviews, it has been possible to take different conclusions on how the topic of sustainability is hitting the floor and which are the solutions (in terms of business models) that could shape the actual modus operandi of the fashion industry in an international context. For this purpose, interviews enable to collect many concrete points of view of existing practices to understand which are the best innovative business models that are positively shaping the global scenario since their activities are changing the ways in which a fashion item is created, purchased, disposed and by the end repurposed. Moreover, those interviews allow to draw a "experimental business model" characterised by all the steps involved in the upcycling and renewal economic approaches with the application of innovative technologies and Industry 4.0. In particular, this last step has been supported by a deep literature review and an interview with a start-up that provided many insights about technology application for the path towards a sustainable fashion industry, since it is the front row to the development of a "sustainable service" based on the Artificial Intelligence.

For the success of the interviews, it was firstly important to identify the emergent sustainable business models, identifying strengths, weaknesses and opportunities for each of them and at the same time select which of the different companies and star-ups are having success and are innovative in the activities they performed. After this previous analysis, the choice of the interviewees has been done selecting three samples of companies/start-ups working in different ways in the upcycling and renewal segment which allow to develop then the last chapter focused on the creation of a business model where the sustainability purpose co-work with tech innovations. The interviews were conducted based on a semi-structured format, in particular composed by questions prepared on the topics in object and others coming out during the speech.

Following the research structure, this method was the most appropriate to explore different ways of doing business in a sustainable way and collect the necessary information to explode the different economic approaches analysed with real case

studies. All the interviews were done online between October 2021 and April 2022, recorded in audio format, transcribed in text formats and when needed translated, according to the speech for a deeper content analysis and conclusions (since extra documents have been shared by the interviewees). The average duration of those interviews was of 30 minutes.

1. Fashion as unsustainable business

Fashion has always been part of human society as an expression of people's personality, culture, and life status. The global fashion industry is estimated to worth about $2.5 trillion and around the World people employed in this industry are more than 75 million (UNECE, 2018).

The growing expansion of global markets, the speeding up of production processes and the use of new technologies have allowed for an unprecedented economic development at the international level. This progress, which undoubtedly brought many benefits from the greater availability of consumer goods, has been made possible by an economic model based on the indiscriminate exploitation of natural and human resources. This has led to a progressive deterioration of the environment, whose protection has been marginalised for the sake of growth; for these many reasons the fashion industry can be said to be unsustainable, not only on environmental terms but also by the socio-economic side.

Taking as explanatory example the European situation, it has been estimated that the purchase of clothes per EU person has increased by 40% between 1996 and 2012 but simultaneously 30% of European consumers' clothes have not been used and once they have been discarded usually are not recycled but exported in low-income countries such as Ghana. As already mentioned, we can address the increase in apparel products consumption to two main reasons:

1. Shrink in garments' prices by 36% in 1996-2012;

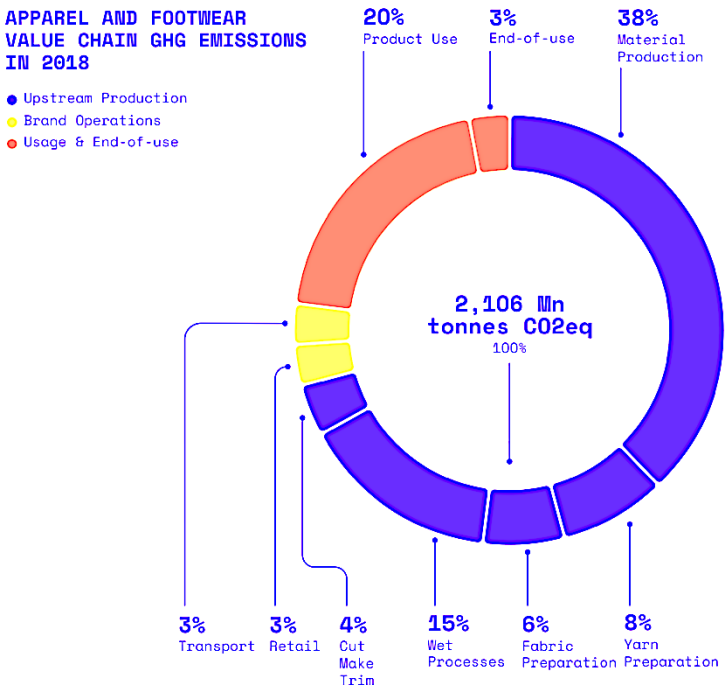
2. The well-known trend of fast fashion that allows consumers to have access to many different collections over a year, as for example European apparel companies has increased the number of available collections per year from two in 2000 to five in 2011. This result can be achieved by multinational retail chains delocalising the sourcing of materials and production, taking advantage of cheap raw materials and labour costs (European Environment Agency, 2014).

The outcome of these two mega-trends is that, at a global level, since 2002, the production of clothes has doubled with an estimated average increase of purchase by 60% and the garment life cycle shrinking by half.

According to many studies conducted, the pollution created by the fashion industry is one of the highest between different world's industry and following the trajectory that it is taking, it has been projected that the use of the world's carbon budget by 2050 will be around 25%.

The fashion industry has been estimated to account for 4% of global greenhouse gas emissions (McKinsey & Company and Global Fashion Agenda, 2020). The activities that have a major impact are the so-called upstream activities such as raw-materials production, yarn preparation, wet processes or fabric preparation for a total of 71% GHG emissions.

Graph 1. Apparel and Footwear Value Chain GHG emissions in 2018



Source: McKinsey & Company and Global Fashion Agenda. (2020). *Fashion on climate. How the Fashion industry can urgently act to reduce its greenhouse gas emissions;* p. 5.

Moreover, the fashion industry is connected with dangerous working conditions due to many factors from unsafe processes and toxic substances involved in the production phase to costs reduction and time pressure imposed along the first phases of the fashion supply chain, and in this way employees are suffering from long working hours and very low wages, and in many cases, evidences show the lack of respect for fundamental principles and rights during labour hours (Bédat, 2021).

The Covid-19 pandemic has underlined the necessity to transform the global fashion industry from a linear model (in which overproduction and where many bad environmental and social impacts are typical) to a circular model (more sustainable and inclusive). Between the most evident environmental impacts along the fashion value chain and as a direct consequence of the "grey rhino" event, it is rise of waste production due to the stricter hygiene standards required and stock accumulation as many orders had been cancelled or fall of fashion products' demand.

To have a better understanding of the major impact of the fashion industry, it seems to be necessary to map the complex value chain that characterize this enormous sector. In the following *Chapter*, it will be analysed the hotspots involved in the creation of a garment (in particular the lifecycle of a pair of jeans) and explaining the different environmental effects for each activity.

1.1. Mapping the complex value chain of the fashion industry

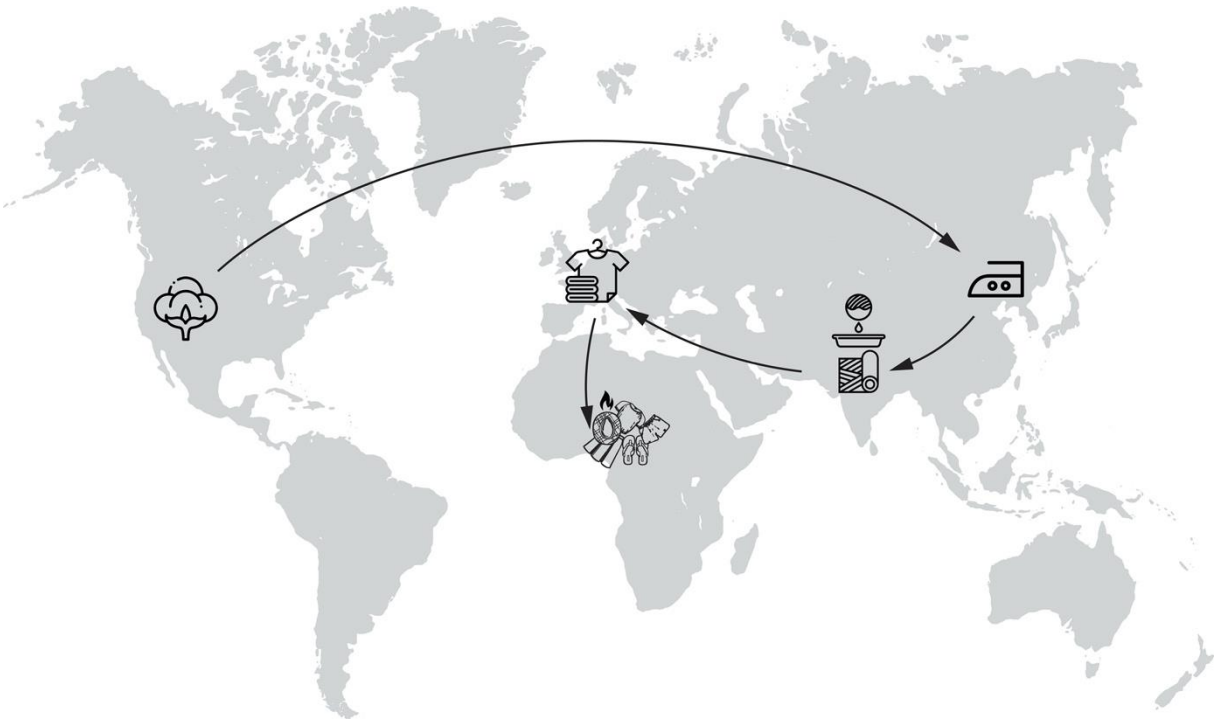
The fashion value chain is truly global since the various steps for a cloth, taking as example the life of a pair of jeans in "Unraveled. The life and death of a garment" (Bédat, 2021), shows how the different spots are situated in various countries around the World.

As in the following sections it will be explained the most evident impacts of the global fashion value chain, it seems to be important to map the steps along the journey of a cloth and connect those environmental and socio-economic impacts to the related steps.
Before going into details, it is important to say that the predominant shape of the global fashion industry is linear, made by different phases that are sequential and usually ends

with disposal phase. The main purpose in the following *Chapters* is to identify some ways, especially analysing new business models, to reshape the linear fashion value chain into a circular fashion value chain that could become more sustainable.

Taking as explanatory example the pair of jeans recalled by Bédat that could be replicated for most of the apparel items, *Figure 1* shows how complex is the fashion value chain and how many countries are involved and gives us the idea why the impacts of this huge industry are not limited only to some few states but is a worldwide problem that we need to face and governments, companies and all people should find new solutions to shift to a sustainable as much as possible circular fashion industry.

Figure 1. The complex global fashion value chain



Source: Personal elaboration from Bédat, M. (2021). *Unraveled. The life and death of a garment*. New York: Portfolio/ Penguin and UN Environment Programme. (2020). *Sustainability and Circularity in the Textile Value Chain – Global Stocktaking.* Nairobi, Kenya.

Table 1. Geographical distribution of global fashion industry

	**Fibre creation:** • Raw material production • Material processing & sourcing • Fibre preparation	The most common fibres used in the fashion industry are synthetic (polyester) and cotton. The top three producers' countries worldwide are USA, China, India and European Union.
	**Yarn and textile production:** • Yarn preparation • Weaving, knitting and bonding	The top producers of fabrics, in particular referring to the spinning phase, are China, India and Pakistan, also known as "the world's factory" (Bédat, 2021). In 2018, China represented 64% of the global textile market, followed by India with only 9% of the market. Other minority countries involved in the weaving, knitting and bonding step, other than China and India, are Turkey, Vietnam and Pakistan.
 	**Textile production:** • Bleaching, dyeing and finishing • Assembly	For the textile production, it can be identified four top countries that are specialised in the so-called cut & sew phase. Those leaders are China (44% of the market), Bangladesh (28%), European Union (11%) and Turkey (16%).
	**Consumption:** • Distribution and retail • Use	The consumption step is very fragmented as the final fashion products (clothes, accessories and footwear) are purchased through different channels and by different customers worldwide. The top three consumers are Europe (34% of the total market), North America (23%) and Asia (11%).

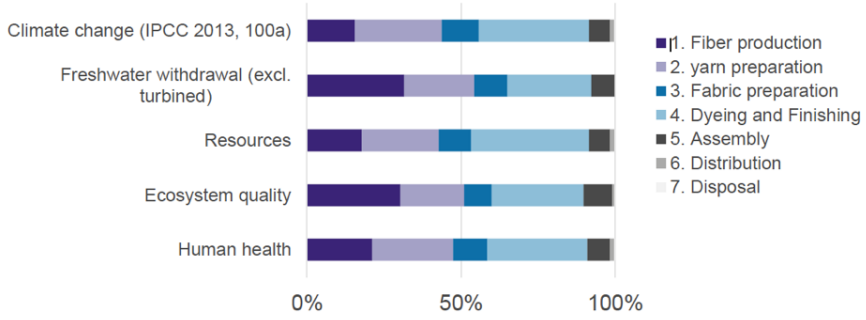
	**End-of-life:** • Collection and sorting • Landfilling and waste to energy	The last step towards the linear fashion value chain is the end-of-life. As already mentioned, once a cloth is dismissed, usually it is incorrectly wasted and ends up in landfills. Ghana, a state of Africa, is one of the countries where million tons of donated low-quality clothing become a nightmare for people living in this area.

Source: Elaboration from Bédat, M. (2021). *Unraveled. The life and death of a garment*. New York: Portfolio/ Penguin and UN Environment Programme. (2020). *Sustainability and Circularity in the Textile Value Chain – Global Stocktaking.* Nairobi, Kenya.

1.2. Major impacts along the value chain

From production of fibres and textile products to distribution and use, and final waste management, the environmental and climate impacts as well as socio-economic footprints are huge problems that characterise the global fashion industry. Water consumption, GHG emissions, toxic substances consumption, waste creation, microplastic pollution and social problems are the key issues that need to be addressed to lead this industry into a circular path. In the following G*raph* it is summarized the contribution of each linear fashion value chain phases by each of the just mention impact indicators.

Graph 2. Contribution of each linear fashion value chain phases by each impact indicators



Source: Quantis. (2018). *Measuring Fashion. Environmental Impact of the Global Apparel and Footwear Industries stud; p.19.*

1.2.1 Environmental footprints: Assessing the unsustainability of our wardrobes

Impacts on water: Rising scarcity and pollution

Taking as baseline data of 2016, it has been estimated that the water consumption of the global apparel industry is about 215 trillion litres per year. Raw material production, yarn and fabric creation, dyeing and finishing as well as the use phase are the biggest contributors to the overconsumptions of freshwater. The most intensive water withdrawal, in terms of fibres, are leather and natural fibres where water consumption for cotton accounts for 43.5% (Quantis, 2018).

According to where the water-intensive fashion value chain steps take place, it is not a surprise that China, India an USA are most impacted countries referring to water scarcity footprint. In details, China accounts for the biggest share of this total natural resource scarcity with 34% mainly since it is one of the counties with the most extensive cotton plants and at the same time with the highest numbers of firms specialized in the yarn and textile production, followed by India with 12% and USA with 5%. The problem is that China and India are placed in areas that are already characterised by high levels of water shortage and because of the increasing demand for fashion products by 63% in the next few years, those levels of scarcity are assumed to rise significantly around. The water consumption for fashion uses has been projected to increase from 79 billion cubic meters

in 2015 to 118 billion cubic meters in 2030, with a +50% (Global Fashion Agenda (GFA) & The Boston Consulting Group (BCG), 2017).

Table 2. Freshwater consumptions along the fashion value chain

Fashion value chain stages	**Impact's weight**	**Key reasons**
Fibre creation	High	High water uses due to the massive amount of water needed to grow cotton
Yarn and textile production	High	Water use in dyeing, cleaning, rinsing of fibres
Textile production	Medium	Use of water during garment finishing phase
Consumption	Medium	Water used in washing, tumble drying and ironing by consumers
End-of-life	Medium	Frequent change of consumers' closets leading to unnecessary resource waste

Source: Elaboration from UN Environment Programme. (2020). *Sustainability and Circularity in the Textile Value Chain – Global Stocktaking.* Nairobi, Kenya and GFA & BCG. (2017). *Pulse of the Fashion Industry,* Chapter 2*.*

Impacts on climate change: Relying on the use of fossil fuels

Yarn and textile production stage accounts for the largest part of climate change impacts of all the fashion industry, this is due to the fact that a consistent amount of GHGs is emitted as a direct result of apparel's reliance on fossil fuels to generate electricity and heat required in this phase. As already mentioned, Asian countries, as China, India and

Bangladesh, account for the largest global manufacturers but also, they rely predominantly on coal-based energy mixes.

In the following *Figure*, it is possible to appreciate how dyeing and finishing steps (part of the yarn and textile production) contribute in percentage to the use of hard coal and natural gas.

Figure 2. Energy use for dyeing and finishing stages

	DYEING	FINISHING
Hard coal (electricity)	17%	7%
Hard coal (heat)	28%	22%
Natural gas (heat)	16%	40%
Other	39%	31%

Source: Quantis. (2018). *Measuring fashion. Environmental Impact of the Global Apparel and Footwear Industries Study; p.22.*

Consumption phase, that includes distribution and use, has a contribution to climate impact of fashion products. The main reasons related to the distribution step is the choice of transportation methods. It has been estimated that the climate change impacts of transportation of fashion industry's products accounts for only 3%, but this percentage will increase significantly if companies decide to switch from road to air transport modes (Quantis, 2018).

For what regards the use phase, the level of contribution to climate change is connected with the amount of electricity used for wash and dry clothes.

Table 3. Climate impact across the global apparel value chain

Fashion value chain stages	**Impact's weight**	**Key reasons**
Fibre creation	High	Production of synthetic fibres, e.g., oil as input for polyester
Yarn and textile production	Very high	Synthetic fibres, the most common fibres use for apparel products, associated with high non-renewable resource use and climate emissions
Textile production	Medium	Greenhouse gases emissions from burning fossil fuels, e.g. coal, to generate the heat and electricity for this phase
Consumption	Medium	Electricity consumption in washing, drying and ironing Excessive use of energy in transport modes (airplanes)
End-of-life	Medium	Frequent change of consumers' closets leading to unnecessary resource waste

Source: Elaboration from UN Environment Programme. (2020). *Sustainability and Circularity in the Textile Value Chain – Global Stocktaking.* Nairobi, Kenya and GFA & BCG. (2017). *Pulse of the Fashion Industry,* Chapter 2.

Impacts on land: Toxic substances and waste management

The fashion industry is known for its impact on water and land pollution since many chemicals are used along the value chain, especially during the dyeing and treatment of textiles. This industry accounts for up to one-fifth of industrial water pollution and the most impacting countries are China and Bangladesh, not only because are the two biggest producers of apparel products but also due to the lack of national norms that regulate the management of these substances (Un environment programme, 2018). It has been found that China is the largest consumer of textile chemicals, as surfactants (that include dye additives, antistatic agents and softeners), sizing chemicals and lubricants, that account for about 40% of global consumption.

Of course, these toxic substances have a high impact on the environment but also on people health as a lot of these chemicals are dispose into rivers, streams and ocean and fashion employees are exposed to toxic chemicals that can be linked to different types of illness, such as cancers and disruption of hormonal systems.

It is possible to observe, in *Table 4*, that the fibre creation phase has also a high impact since the global cotton cultivation needs about 200 tonnes of pesticides and 8 tonnes of fertilizers per year, therefore the soil is highly polluted by these chemicals.

Table 4. Chemicals use in the fashion industry

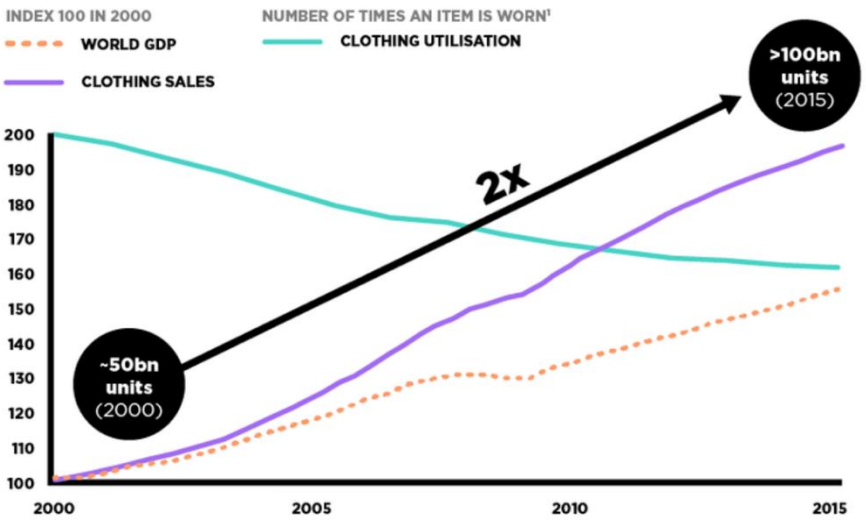
Fashion value chain stages	**Impact's weight**	**Key reasons**
Fibre creation	High	Use of pesticides and fertilizers for cotton cultivation
Yarn and textile production	High	Choice of colours in the dyeing phase
Textile production	Very high	Lack of water waste treatment (release of toxic chemicals)

		Toxicity of materials used for prints
Consumption	Low	Toxicity of detergents use to clean clothes Pollution of wastewater (e.g., chemical processing residues)
End-of-life	Medium	Leachate of chemicals as textiles degrade in landfills Incineration of clothes lead to harmful emissions

Source: Elaboration from UN Environment Programme. (2020). *Sustainability and Circularity in the Textile Value Chain – Global Stocktaking.* Nairobi, Kenya and GFA & BCG. (2017). *Pulse of the Fashion Industry,* Chapter 2*.*

Waste is another problem related to the unsustainable fashion industry due to many reasons as identified in *Table 5*. It is important to underline that the end-of-life phase is the most impacting when we refer to the issue of fashion products' waste. In fact, In UK and EU27, it has been estimated that 80% of clothes end up to ultimate disposal and in details 30% are incinerated and 70% goes to the landfill. At the same time, only 20% of clothes that are throw away are collected and sorted: 40% of these clothes are reused and 50% are recycled (Global Fashion Agenda (GFA) & The Boston Consulting Group (BCG), 2017). The waste of clothes at the end of the fashion value chain is primary for the decreasing rate of clothing utilisation in the last 15 years, as it is possible to appreciate in *Figure 3*.

Figure 3. Decrease of clothes utilisation (200-2015)



Source: Ellen MacArthur Foundation, (2017). *A new textile economy: Redesigning fashion's futur.*; p.18.

However, the pre-consumption phases have some impacts in terms of waste and especially the textile production where hundreds of thousands of different types of fabrics are wasted. Surplus from cutting patterns, stock or items that are mistaken represent a huge problem of scraps that result to make the fashion industry even more unsustainable. For example, in 2016, in UK 800000 tonnes of fabrics have been wasted in the pre-consumption phases (Wrap, 2017).

Table 5. The problem of waste management in the fashion industry

Fashion value chain stages	**Impact's weight**	**Key reasons**
Fibre creation	Very low	No hotspots identified
Yarn and textile production	Medium	Waste of fibres or fabrics (e.g., roll ends, off-cuts, samples)
Textile production	Medium	Cut and sew waste

Consumption	Medium	Waste generated through packaging, pallet use, tags, hangers, bags
End-of-life	Very high	Disposal of products generating waste (e.g., non-renewable resources depletion)

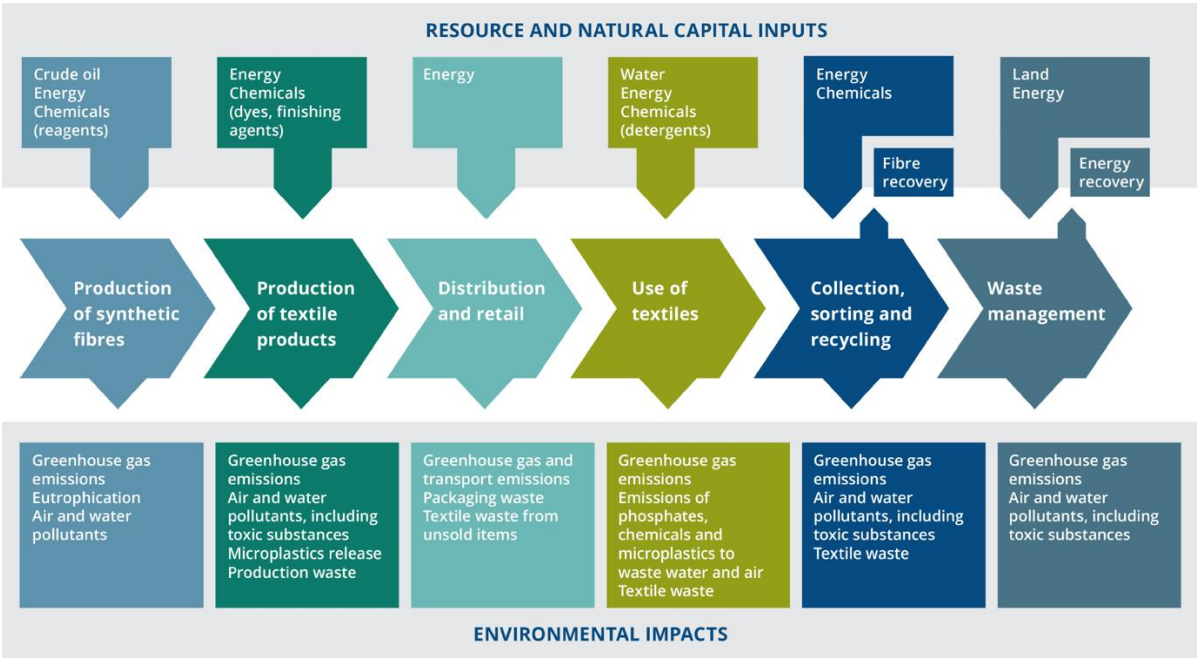
Source: GFA & BCG. (2017). *Pulse of the Fashion Industry, Chapter 2.*

Microplastic pollution: A direct relationship with synthetic fibres

Fashion industry has been declared to be one of the major contributors to microplastic pollution of the ocean. As already seen, polyester is the most used fibres in the fashion industry because clothes are designed to last forever and also it costs less than other materials such as cotton. However, the synthetic fibres utilization poses many risks in terms of pollutions, climate change and dangerous effects on aquatic life, birds and the human health.

In *Figure 4*, it is possible to observe the major impacts of synthetic fibres production (polyester, nylon, acrylic, elastane) along all the chain, from the production of the synthetic textiles to the waste management.

Figure 4. Major impacts of synthetic fibres production



Source: European Environmental Agency. (2021). *Resource efficiency. Plastic in textiles: towards a circular economy for synthetic textiles in Europe; p.6.*

For microplastics, it is generally referred to tiny particles of plastic fragment that have a size of less than about 5 millimetres and it has been found that the major source of the release of these micro-particles is the domestic washing of garments (35% of total primary microplastics found in the oceans) because they are not retained and filtered during this process (Fashion Revolution, 2019). It has been estimated that the washing of textiles is the cause of the yearly release of about 500000 tonnes of microplastic fibres and if the fashion industry continues following this path, the release of these fibres will increase up to 700000 tonnes per year by 2050 (Ellen Macarthur Foundation, 2017).
The leakage of these plastic microfibres is a real important problem that the fashion industry needs to solve, promoting for example the use of sustainable fibres, the control of microplastic emissions as well as the improvement of waste management with separate collection campaigns, reuse and recycle.

1.2.2. Socio-economic footprints: Fashion factories as a cage

The fashion industry employs 75 million workers worldwide, for the majority women (85% of the total) and provides different opportunities for developing countries. Despite that, the working conditions that characterize this global industry are unsustainable and unethical. As explained in *Table 6*, many social risks are prevalent along the fashion value chain and the most common ones are the presence of child labour, the absence of fixed schedules, under minimum level wages, gender inequality and abusive practices.

The phases that seem to have the highest relevance for what regards the unsustainable labour practices are yarn and textile production because these steps take place in underdeveloped countries as India, Pakistan and Bangladesh or in China where there are no protections for workers. For example, it has been recorded that in the mentioned countries where yarn and textile production phases happen, "the fashion workers" gain less than five times of the minimum wage. This leads to an overexploitation of workers that are often forced to work from fourteen to sixteen hours per day, seven days a week (Sustain Your style, 2020).

Another evident problem connected to social risks is child labour; estimates shows that about 170 millions of children are engaged in the production of textiles and garment for the satisfaction of most European and USA costumers. This high number of child workers is a direct consequence of demand for low prices clothes and also because the requirement of low-skilled labour (ILO, 2013).

Table 6. Unsustainable labour practices across the fashion value chain

Fashion value chain stages	**Impact's weight**	**Key reasons**
Fibre creation	Medium	Prevalence of child labour, forced labour and excessive working time Low level of wages

		Gender inequality and conflict
Yarn and textile production	Very high	Prevalence of child labour, forced labour and excessive working time Low level of wages, non-compliance to minimum wages Gender inequality
Textile production	Very high	Prevalence of child labour, forced labour and excessive working time Low level of wages, non-compliance to minimum wages Gender inequality
Consumption	Medium	Non-compliance to contract terms (due to sub-contracting) Excessive working hours Low level of wages, non-compliance to minimum wages Limited social security, temporary employment

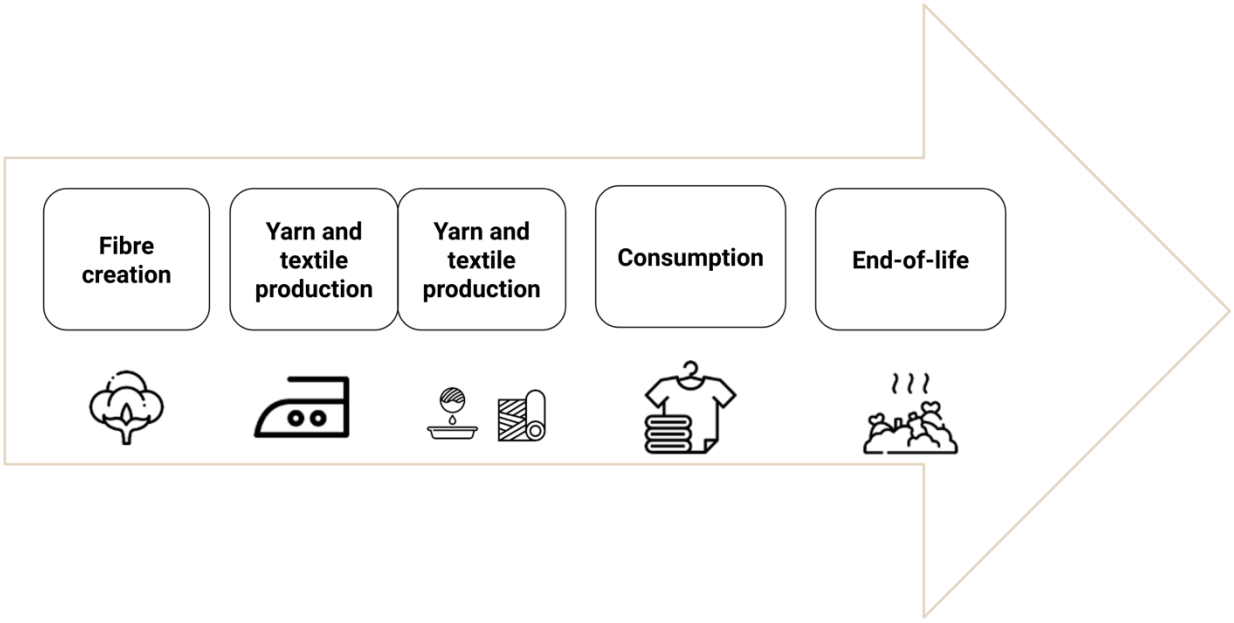
End-of-life	Very low	No hotspots identified

Source: Elaboration from UN Environment Programme. (2020). *Sustainability and Circularity in the Textile Value Chain – Global Stocktaking.* Nairobi, Kenya and GFA & BCG. (2017). *Pulse of the Fashion Industry,* Chapter 2*.*

2. Sustainable business models: innovative chances to a greener approach

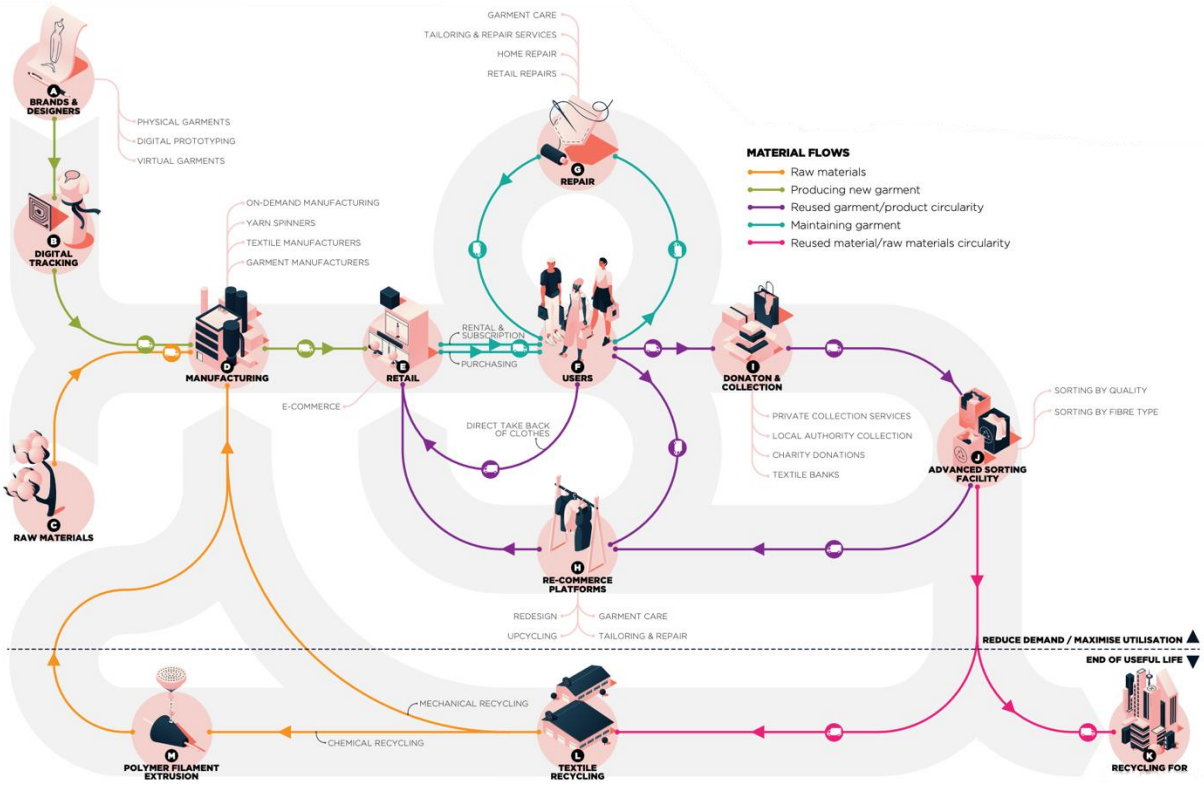
The fashion industry, as explored in *Chapter 1*, is based on four main phases: take-make-use-waste (*Figure 5*). This path has been shown to be unsustainable for many different reasons, from the environmental to the socio-economic ones, but in the last few years some companies, associations and governments are striving to make this worldwide industry more sustainable. All these institutions want to achieve what it is known as circular economy following the scheme represented in *Figure 6*.

Figure 5. The fashion value chain: As is



Source: Elaboration from Bédat, M. (2021). Unraveled. The life and death of a garment. New York: Portfolio/ Penguin

Figure 6. The circular fashion industry



Source: Institute of positive fashion (2021). *The circular fashion ecosystem. A blueprint for the future; p.23.*

A circular model is characterized by a regenerative factor in which the main purposes are the minimisation of waste and resources and connected to that, six main economic approaches seem to ride the wave in the last few years thanks to the more attention on the environment and the sustainability field in general. Resale, renting, recycling, co-creation, upcycling and repairing business models are becoming predominant in the ways in which the fashion industry is evolving.

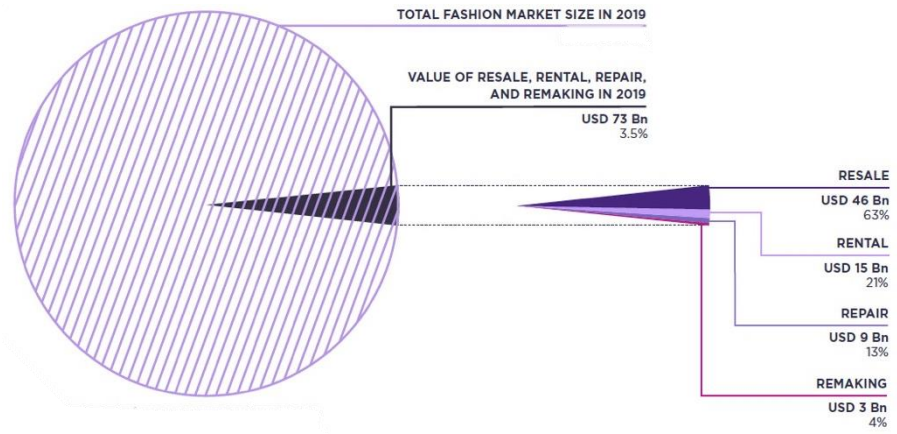
Besides these very innovative business models, there is the need of change in the ways in which consumers purchase fashion products and the need of new innovations as technological innovations including the use of Artificial Intelligence (AI), Internet of Things (IoT), Data platforms, Blockchain and also innovative robotics machines.

2.1. The innovative circular business models in the fashion industry

As a result of the unsustainability explained in the previous part, some circular business models have raised in fashion industry and nowadays represent the opportunity and one of the most significant ways for a better fashion industry.

In the last decade, six circular business models in the fashion industries have emerged and are having more success as the to shift to a more sustainable World: resale, renting, recycling, co-creation, upcycling and repair are now booming. It has been estimated that these innovative economic approaches represent $73 billion market on the total $2.5 trillion in 2019: 63% is taken by resale, 20% by the rental BM, 17% is represented by recycling, upcycling and repair. The co-creation business model remains marginal, but it is presumed to grow increasingly not only for the environmental and economic benefits but also for other important reasons as body and gender inclusivity (Ellen Macarthur Foundation, 2021).

Graph 3. Value share of the sustainable business model in the fashion industry in 2019[1]

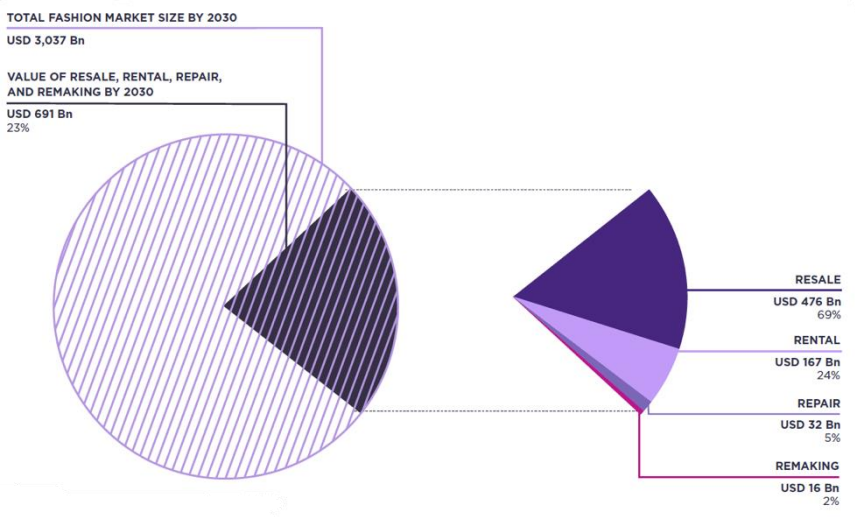


Source: Ellen Macarthur Foundation (2021). *Circular business models: redefining growth for a thriving fashion industry; p.15.*

[1] In Graph 3 and in Graph 4, remaking refers to the BM where companies and start-up from existing products or components create new wearable items. Following this concept, recycling, downcycling and upcycling go all under the remake umbrella.

The potential growth of these business models is assumed to be around 20% of the total global fashion market by 2030, driven mainly by North America and Europe and marginally by the Asian Pacific regions, Middle East, Africa and Latin America, as customers' motivations such as affordability, empowerment, convenience and environmental awareness value more than in the past and they continue to become more the centre of decision in the fashion products' purchase choices.

Graph 4. Economic value of the sustainable business model in the fashion industry by 2030



Source: Ellen Macarthur Foundation (2021). *Circular business models: redefining growth for a thriving fashion industry; p.16.*

In the following sections, it will be discovered what are the main pros of the sustainable fashion business models, in terms of how they can have a good environmental impact, and what are the points that need to be improved as well as the limitations faced by the born sustainable companies of the fashion industry.

2.2. Resale business model: Expanding the vintage concept

The resale business model is having its momentum as its marketshare in the second-hand scenario has grown from 4% in 2010 to 9% in 2020 and it has been estimated to reach 18% in 2030 (ThredUp, 2020); Vinted and Vinokilo are two of the most popular marketplaces in which second-hand clothes can be sold and bought.

In general resale in the fashion industry comprehends networks' sales of second-hand items (both online or in stores), third-party marketplaces and brands which decide to re-commerce and take-back their own clothes. This type of fashion economic approach is driving sustainability in different ways:

- *It reduces the environmental impact of the traditional linear model of the industry.* Estimates say that in the production and the end-of-use phases the decrease of CO2 emissions states at -67% as in the first case the realization of clothes decreases. Overall, the fall in the CO2 emissions is about 50% thanks to the resale business model. Not only, with the resale business model it is possible to save energy demand and water use that as explained in the previous chapter represented a very huge waste for this the fashion industry.

- *It increases the inclusivity.* Every wallet and everybody can have access to clothes that if they were new cannot in many cases been bought. In fact, as the fashion items are resold the prices are lower and this is translated in more affordability.

- *It is a way to communicate transparency around a fashion item.* Usually, consumers can have the possibility to have information about the clothes and ho sell them.

2.2.1. Matching resale business model shapes to case studies

In *Table 7* are enclosed some of the most worldwide known resale networks of fashion second-hand, that seem to get success and have a positive impact on the way to

sustainability of the fashion industry as they provide the three main characteristics already discussed of this new fashion approach.

Table 7. The "born sustainable" companies in the fashion resale segment

Vinted	**Second-hand clothing resale online platform**	Vinted can be considered the most successful start-ups in the Baltic countries, since the HQ is Vilnius (Lithuania). The company starts to sell pre-loved clothing through a mobile social app since 2008 but reaching the peak of success last year when customers outside Germany (the biggest Vinted market) consider this marketplace as a way to rid of their unwanted fashion products such as clothes, footwear and other accessories. ***Type of business:*** C2C (Customer to Customer) ***Targeted segment:*** Millennials, with low availability to spend but at the same time purchase in a sustainable way. In this online platform, the most common items come from fast-fashion brands (Zara, H&M, Primark) ***Price strategy:*** Selling is free, the final price is usually reached after a match between seller offers and buyers' willingness to pay.

		Additionally, buyers pay a special protection fee of 5% on item's cost, plus a 70$ fixed fee and cover the freight costs. Sellers can pay for boosts in order to make their items more visible to possible purchasers. ***Market presence:*** On-line platform and smartphone app
vinokilo	**Vintage clothes pop up**	Vinokilo's story backs to 2015 when the founder Robin Balser, a German guy, decided to organise the first event (pop-up store because there is not a physical shop, but it is organised through events all around Europe), during which vintage clothes were sold. They select clothes from the 60s to 90s from containers of clothing-waste, giving them a new opportunity to be worn after being curated, cleaned and repaired. ***Type of business:*** B2C (Business to Customer) ***Targeted segment:*** People aged between 23-27. They want to be inclusive, so not expensive items but at the same time not affordable to most people. They want to give the

		opportunity to purchase second-hand clothes (most of them vintage items) to people of all income levels. In Vinokilo, it is possible to find items from premium brands as well as from the fast-fashion segment. ***Price strategy:*** The price of the clothes purchased is based on the kilos and usually it is between 35 and 45 € for a complete outfit. ***Market presence:*** Pop-up events and marginal online shops to differentiate the sales and get the opportunity to reach a wide range of customers
depop	**Peer-to-peer marketplace**	Since the launch in 2011, Depop has increase the number of users that interact to buy, sell and discover unique fashion items. In 2020, the Revenue was estimated to be around $ 70 million thanks to the presence of more than 30 million active users. ***Type of business:*** C2C (Customer to Customer) ***Targeted segment:*** Millennials and Gen Z (90% of the users are under the age of 25). The most popular categories are Vintage, Y2k (items that remembers Early 2000's style),

		Streetwear and one-of-a-kind 8rare, deadstock or limited editions) especially from the fast-fashion brands as Nike, PrettyLittleThing, Boohoo and Missguided. ***Price strategy:*** Consumers simply freely list their clothes or accessories on their accounts earning money from the sell and at the same time Depop retains 10% commissions on sales (computed as the of item or items plus the shipping costs). ***Market presence:*** Online marketplace
	**Contemporary designer resale**	BIVIO has been founded in 2013 by Hilary Walker and it is a Milan based company in which "pre-owned" clothes are bought and resold reducing in this way having the possibility to "re-distribute" those garments people never put on and giving back to them cash or a voucher to purchase in all the BIVIO's shops. ***Type of business:*** B2C (Business to Customer) ***Targeted segment:*** Vintage clothes' lovers ***Price strategy:*** The garments brought into the shop are selected by the

		buyers. If they are interested in keeping, they will establish the price at which the clothes will be sold in the stores, excluding the flat-rate VAT applied by law in Italy to second-hand goods. Of the total amount obtained from the evaluation of the products, the buyers can choose to receive 33% in Cash or 50% in a Purchase Voucher valid for one year in all BIVIO Milano Stores. If BIVIO's buyers discard some items and the customer does not want to take them home, are given to charity directly by BIVIO. BIVIO's business model does not add additional production or transport costs to an already saturated market. ***Market presence:*** Two boutiques based in Milan (Italy)
Stuffstr	**Re-commerce**	Stuffstr is an English company based in London born in 2014. It establishes partnerships with retailers to buy back used clothes and give them another life with the purpose to make them out of the landfill and get value. ***Type of business:*** B2C + B2B (Business to Customer + Business to Business)

		Targeted segment: Gen Z that base it purchases decisions based on lifestyle choices instead of loyalty to popular brands ***Price strategy:*** Stuffstr collaborates with clothing brands to gather data about all their products in their inventory dated at maximum of five years to fill the platform. When customer decides to sell an item, it has to be matched with the right retailers account, in this way seeing immediately the right price. If customer decide that it is the right price, he/she can gather his/her unwanted garments and using the app, a courier comes to pick up those clothes for free that will be resold. The customers get back a gift card that can use to purchase new items. Stuffstr mainly make the revenues from the brands partners with which operates (the most important partnership is with Adidas) ***Market presence:*** Online app
	**Third-party marketplace**	Launched in 2009 and based in Paris, Vestiaire Collective is the global leader resale marketplace for premium and luxury pre-owned fashion. Here, customers can choose between more than 600 thousand fashion items,

joining the world of circularity and sustainability in the fashion industry.

Type of business: C2C (Customer to Customer)

Targeted segment: Gen Z and Millennials that want to have access to fashion they want in a more sustainable way as possible and at the same time been connected to a big community, which drives increasingly the demand for responsible items. Vestiaire Collective is specialised in the luxury products, this the reason of its wide popularity.

Price strategy: If a person wants to sell an item with simple five steps it can upload on the cloud. The Vestiaire Collective team will make a check of the post and if it's all in order, will publish on the site. When the item is sold, it has to be sent to Vestiaire at the address provided by the team, and they will then send it to the buyer after checking its quality and authenticity. Once the transaction is complete, the seller receives the payment. On the amount paid by the buyers, Vestiaire Collective retains a commission that varies according to the volume of sale, that floats between 25% and 17%.

		Market presence: Online presence
  	**Brands with resale program**	Included in the resale business model in the fashion industry, it is possible to identify some brands that have decided to re-commerce their own items and this is the case of Patagonia, Eileen Fisher and Levi's. Customers can trade their items bot online or in stores, where they receive a reward (like a credit to spend on future purchases). There reasons under this commitment towards the resale of pre-loved garments are different of course to be sustainable but also to attract more customers (especially ones belonging to the Gen Z) and to stay relevant. ***Type of business:*** B2C (Business to Customers) ***Targeted segment:*** Gen Z ***Price strategy:*** • According to Levi's Second-Hand policies, the price strategy wants to reward everyone that decide to engage in sustainability and in the possibility to extend the life of a pair of jeans. For these reasons, if a pair of Levi's jeans can be

		resold, they offer between $15 and $25 and in a case of a vintage pair they give about $30-$35 to spend on store. Levi's will put them on the online marketplace for roughly $30 to $100. Almost the same occurs for Patagonia and Eileen Fisher. ***Market presence:*** Online e-commerce, resale online by partners and physical stores.

Worldwide many consumers are trying to sell their used clothes; the total sellers in 2020 have been 53.6 million, thanks to easier possibility they have to put fashion items in the market but also due the pandemic. In fact, it is possible to identify the main drivers of the post-pandemic consumers to purchase second-hand clothes, especially characterizing the Gen Z (the segment that use the most resale platforms):

1. *Sustainability is at the centre of purchase choices:* 1 in 3 consumers want to wear sustainable clothes;

2. *Saving money is one of the most important priorities:* 60% of consumers wants to save more money instead buying unnecessary clothes;

3. *Resealable garments are preferred that the disposable ones:* 43% of shoppers ask for higher quality fashion items;

4. *Reduce fashion waste has become important:* 51% of users are willing to reduce eco waste.

Of course, there are some limits to the spread the success of the resale business model. Taking as example the Vinted case, every item must be sorted, priced, photographed and described. People do not always have time or wants to do that, ending deciding to trash many good clothes that could be resold. Moreover, the companies that embrace this BM end up gaining little fraction of revenues, as the case of Vinted that get its earnings only from visibility boosts (an add that consumers can use if they want to increase the view of the possible purchasable items), advertisements and buyer protection (Peterson, 2020). Moreover, some other problems that companies in the rental business model usually face are linked to the availability of used inventory and the engagement of customers to purchase second-hand garments.

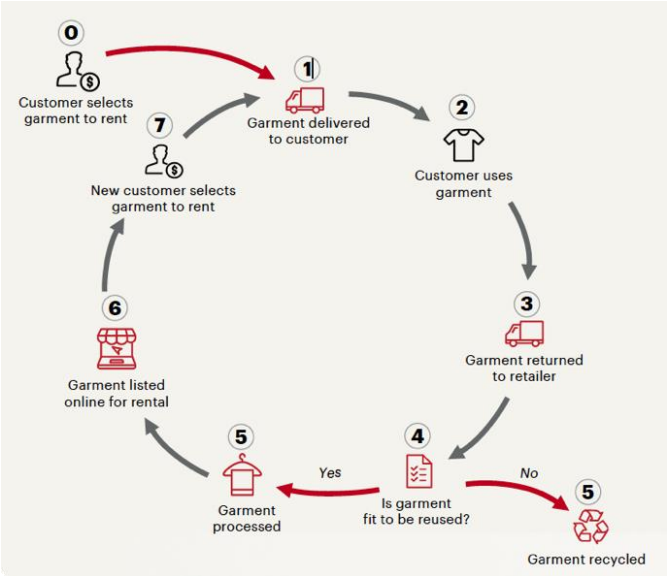
There are other limits related to one of the possibilities mentioned between the resale business model in the fashion industry, third-party marketplace. As seen with Vestiaire Collective, customers can find different fashion items of premium brands and the luxury segment this is since those brands are not willing to resale by their own the pre-loved garments because they think it is much easier to do through a proven resale platform primary because they are not able to effectively manage resale logistics (Ruben, 2021). However, it is possible that the long-terms goals of brands and third-party marketplaces are not aligned and for this reason, brands can lose the control of their heritage and equity that as more likely to be maintained in the way Patagonia, Eileen Fisher and Levi's operated in terms of resale of pre-loved items.

Governments should intervene to enable resale to achieve the potential positive environmental impact through the removal of tax and providing tax credit on second-hand shopping or the establishment of tax deduction for brands that decide to pursue certified resale programs, as the companies seen before (ThredUp, 2020).

2.3. The Rental business model: Ending the fully ownerships of fashion products

The Rental business model can take three different shapes, that all works in similar ways (as shown in *Figure 7*): rentals by private owner, subscription-rental or direct-to-consumer rental services.

Figure 7. The flow of the Rental model in the fashion world



Source: Accenture Strategy & Fashion for Good. (2019). *The future of circular fashion. Assessing the variability of circular business models; p.16.*

Since customers are continuously asking for newness, variety and affordability, this economic approach have lots of potentials to provide them the best service to satisfy their needs but at the same time have a sustainable approach on how those fashion products are used. In fact. the key success factors of the rental business models can be summarized in three points:

- *Customer-centric service*, as they can choose between an endless wardrobe, have an all-inclusive rental service (from shipment to cleaning after use) and in many cases a customized subscription membership;

- *Accessible solutions*, the resale platforms allowed to rent clothes or accessories from expensive brands at lower prices and at the same time have the possibility to return them once worn for the special occasion saving in this way money and space but also at the same time the products can be used again decreasing the waste and providing a sustainable solution;

- *Extension of the inventory investments,* since the production of new items required the use of virgin materials and one of the main aims of the sustainable development is the utilization of recycled materials, rental business model allows brands to expand their inventory and attract at the same time more customers.

Connected to all the three factors, there is the willingness to shift the fashion industry to a more sustainable path and for this reason, it has been estimated the most positive environmental impacts noticed from this innovative business model can have across the global value chain phases are:

1. *Reduction of virgin material demand*, through incentives for the production standards and the extension of garments' life;

2. *Overall fall in CO2 emissions* by 40% compared to the linear model of the fashion industry;

3. *Decrease of water and waste footprint by 20-30%* (Ellen Macarthur Foundation, 2021).

2.3.1. Opportunities to sustainable extent the wardrobe

Some of the most known and effective start-ups that have spent their efforts to develop their business toward the fashion rental economic approach are enclosed in *Table 8.*

Table 8. Prestigious examples toward the sustainable extension of fashion wardrobes

	**Shared designer closet**	Rent the Runway is considered the pioneer of woman's rental market in the fashion industry. Since 2009 (the year of foundation), it has gone through ups and downs to establish as leader in the apparel rental segment, but today the net worth of the company is about $1 billion thanks to its popularity between more than 9 million of active users of the platform. Rent the Runway offers fashion freedom (since different styles are proposed), total flexibility (because the closet can be changed over time), sustainable footprint and also inclusivity.
	**Fashion Renting (online and store)**	DressYouCan is defined as the Airbnb of the wardrobe, as customers can rent clothes and accessories when they want and need to have an exclusive look every time. This star-up dated in 2015 and based in Milan is accessible by customers in two ways: through the website or booking an appointment in store. The value proposition that DressYouCan is very high, people that enjoy the world of sharing economy in this case as an all-inclusive service from the rent to the post use phase. Not only, customers can have access to

		luxury brand as well as garment from emerging designers.
DREXCODE DRESS YOUR CODE	**In the cloud fashion wardrobe**	DrexCode has been launched in 2015 by Valeria Cambrea and Federica Storace and the HQ is based in Milan. The Co-founders have decided to create a community using the social medias in which people can rent clothes and accessories. Following this path, nowadays DrexCode counts about 250 thousand users, that are willing to share the wardrobe not only to have access to more looks but also to reduce waste. Drexcode also provides resale and revive service. In fact, customers can buy preloved clothes or accessories between the ones in the cloud fashion wardrobe, extending the life of the garments. The revive service is an upcoming news for DrexCode, which means that clothes that have ended their life are used to give birth to something new giving an endless life.
	**Fashion rental platform and mobile app**	By Rotation's story backs to 2019, when the founder Eshita Kabra-Davies was shocked by the effects of textile disposal in India during her honeymoon and she decided to do something to decrease this huge impact. By Rotation counts a huge users base, estimated to be over 150 thousand in 2019, and it is still

		continuing to attract new customers since the special feature of this very innovative UK-based start-up is that the app has different communities of users which give them the sense of inclusivity (also due to the subscription fees absence) and have access to more different wardrobes. By Rotation's main aim, following its motto "reduce, reuse, recycle, rotate", is to make people think to renting instead buying new clothe every time they need or want.
REVEST	**Renting – haute couture**	Founded by Costanza Beretta, REVEST is a renting fashion company that allows to change luxury-branded clothes or accessories for every special occasion without buying anything new. REVEST could be defined one -off peer-to-peer rental by private owners since people that commit their clothes to this company, they remain effectively the legitim owners and obtaining a margin for the renting offered. Potential customers have the possibility to exploit the REVEST's service online or in Milan-based showroom.
BANANA REPUBLIC STYLE PASSPORT ANN TAYLOR LOFT	**Direct-to-consumer rentals**	Many brands are now developing projects toward the rental path, offering a direct-to-consumer renting service. Banana Republic Style Passport, Ann Taylor Infinity Loft and

VINCE. unfold *Endless layers to discover.*		Vince Unfold are based on the subscription of customers for the service paying a monthly fee that goes from $75 to $160, giving access to endless looks. These companies are some examples of how famous fashion brands can move in the near future to become increasingly sustainable and extend the life of a product.

There are also some limits connected to the rental business model that are worth to be explained in order to have a better overview of the future possibilities of improvement.

The rental business models seem to fit better for clothing for special occasions and for the luxury segment, however it is been found that customers are willing to pay for an occasional rental up to a threshold that goes around $225, for this reasons companies have to be aware of the price they set for an item since they could decrease the profits also due to the fact, as already mentioned, that in the most cases the retailers offer an all-inclusive service (including packaging, laundry and transport) and this could be a source of loss. There is the need to balance the renting price between supply and demand to remain on market without losing market share (Accenture Strategy & Fashion for Good, 2019).

As already mentioned, the rental business model includes the possibility that private owners rent their fashion items, however there are very limited cases because people prefer to trust actual company, as Rent the Runway, DressYouCan or Revest, rather than a private peer. The main motives are because the well-known rental start-ups have disclosed hygiene standards or warranties that private owners are not able to offer.

There are other concerns about environmental sustainability. Even if the fall in CO2 emissions related to the fashion rental business model is about 40%, it is necessary to take some actions from the retailers in terms of the investments in renewable energy for

warehouses, reduce packaging waste (as done by Rent the Runway shipping the items on reusable garments bags and hangers) and switch to wet cleaning (Cline, 2019).

It is possible to say that the resale business model for the fashion industry is not the best solution for a more sustainable path, however there are few evidence that the companies that are working on this economic approach can have great potentials to develop a complete sustainable business model for the future.

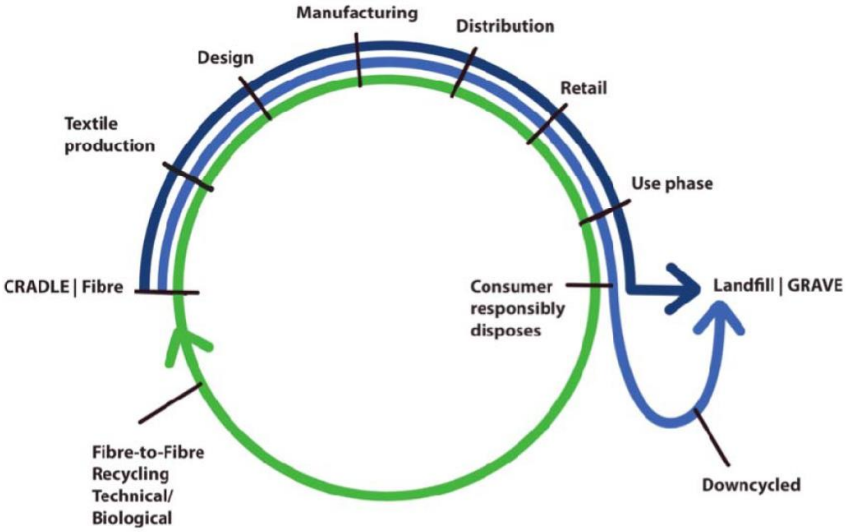
2.4. Optimizing existing resources: The recycling business model

To tackle the limits of the fashion resale and rental business models and to increasingly follow a path towards the sustainability of fashion industry, innovative companies are trying to emerge and establish in the market, providing new solutions. The recycling business model and the co-creation business model seem to be the most impacting ones as positive effects for the future of the sustainability, not only in environmental but also in social terms, of the global apparel industry.

The recycling business model in fashion industry in general refers to donation, the creation of a product from already existing products or components such as recycled textiles or natural sources and reuse; however, it is important to not make confusion between “real recycling” (intended as the breaking down of materials or transform natural scraps into something new), downcycling (turn old clothes into law-quality items) and upcycling.

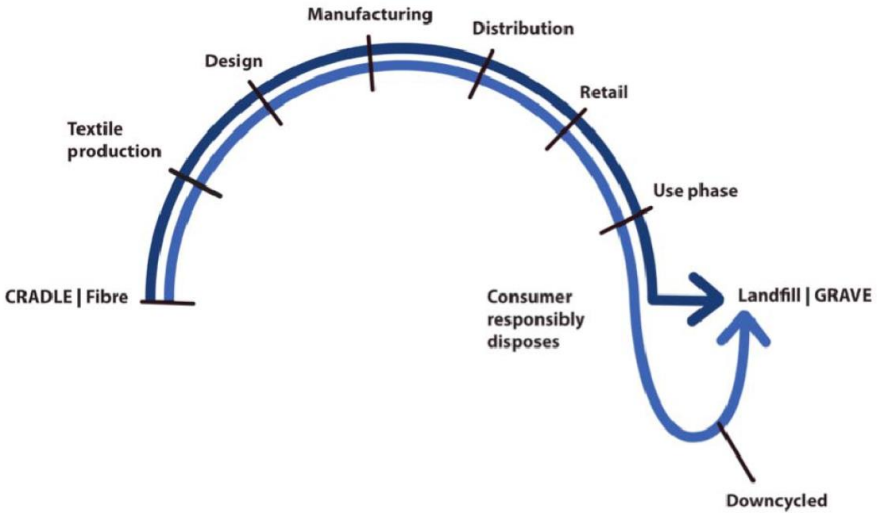
This section will be focused to analyse the first two cases that can go under the umbrella of the recycling business model, that their operations can be visually idealized with the following *Figures*.

Figure 8. The Closed-loop Recycling business model in the fashion industry



Source: Clemente Tartaglione, S.C. (2013). *Il "fine vita" deo prodotti nel sistema moda.* Roma.

Figure 9. The path to create low-quality items from fashion industry's waste



Source: Clemente Tartaglione, S.C. (2013). *Il "fine vita" deo prodotti nel sistema moda.* Roma.

As seen in *Chapter 1*, in the fashion industry the yarn and textiles production are the most impacting phases in term of GHG emissions. Moreover, less than 1% of those materials produced for the fashion industry are recycled for the realization of new clothes and this

is reflected into an annually estimated loss of textiles' worth for more than $100 billion and as a direct consequence the accumulation of those materials in landfills and incinerators (we will go further to this topic in the next Chapter). For example, in 2020, it has been estimated that the recycled fibres in comparison to the yarn and textiles production was only about 8% and between 7-7.5% was represented by polyester recycled from plastic bottles instead of recycling textiles (Global Fashion Agenda (GFA) & McKinsey&Company, 2021).

However, even if this trend is only at the beginning it is important also to underline that Italy trying to do well in the fashion recycling segment. Interviewing Anna Fiscale (CEO of Progetto Quid), what comes out as positive factor for the success of her company is the availability in Italy to lot of different textiles' leftovers especially coming from the industrial cluster of Prato, specialised in the textile production.

Talking about data and considering this reflection during the interview, it almost seems obvious why Italy is considered to be world's capital of recycled textile materials. In 2021, Italy has collected 15% of its textile waste for reuse purposes and at the same time it has imported large amounts of textile waste. The Prato cluster plays a fundamental role, in fact many companies in that area traditionally convert old rugs of used clothes into fabrics for new clothes. It has also been estimated that Prato's textile industry has transform 142 million kg of old materials into fibres used by global fashions chains as Armani, Banana Republic and many other brands (CBI - Ministry of Foreign Affairs, 2021).

2.4.2. From clothes scraps to value products

After the previous considerations, there is the need to move forward from this unsustainable loop and embracing the recycling business model addressing mainly four areas of actions:

1. Rethink the way fashion products are designed and manufactured (for example extending the life of a garment to fall the demand of virgin materials);

2. Progress new technologies (invest in R&D efforts to find better solution to improve recycling in the fashion industry): the major textile recycling technologies that are already commercially ready or pilot are mechanical fibre-to-fibre, regenerative cellulosic, regenerative synthetic, thermo mechanical synthetic and regenerative blended recycling;

3. Creation of new star-ups that are able to capture new value from pre-used materials (not only from yarn or textiles as well as other natural components as discussed in *Table 9*);

4. Implementation of clothing collection, increase the collection service where exists and create it in places where is not activated.

Since the purpose of *Chapter 2* is to explore new sustainable business model, in *Table 9* it is possible to appreciate some very impressive examples of star-ups, some of them Italy-based, that seem to have a good impact on the recycling movement in the fashion industry.

Table 9. The recycling start-ups of the fashion industry

ORANGE FIBER	**Recycled fabrics from citrus juice**	Italy is one of the top producers of citrus fruits between the Mediterranean countries (more than 700.000 tons every year), however the scrapping of these products can reflect into huge economic and environmental impact. In 2012, Orange Fiber, a Catania based start-up, has seen an opportunity to transform the disposal of citrus fruits into sustainable fabrics matching luxury and premium brands needs.
		Manteco is a Tuscany based company that has developed its business around

MANTECO® MANTELLASSI COMPAGNIA TESSILE	**High-end recycled textiles**	the so called closed-loop recycling BM (as seen in Figure 7). It is engaged in different environmentally sustainable projects, summed ups as follows: • *Project 43:* as they are manufacturer of fabrics, its main purpose is to optimise the existing materials and they develop this project to recover offcuts from the garments manufactured and regenerate the fabrics used into recycled luxury fabrics ; • *Project 53:* they recycle garment making offcuts and knits from other textiles suppliers. Manteco sorts and stores the offcuts/knits that would be recycled into new fibre. This fibre is then spined to create new yarns and after other mechanical steps the result is new recycled fabric; • *Zero Waste:* Manteco has a dedicated department that is in charge of dealing with the gathering of scraps mand leftovers along the fabrics production chain, thus not wasting those materials and having the opportunity to have an endless and green

		production cycle. Thanks to this project, they have been able to save 301.013 kg of textile waste from their production; • Sustainable Design: as said by the definition, Manteco has developed a project that wants to focus the attention on how the fabrics are designed. They study to find the perfect mixed between performance, durability and sustainability in order to create recyclable fabrics.
VEGEA	**Biomaterials for fashion production**	VEGEA has been founded in 2016 and it is established in Milan. The main purpose of this very innovative company is the creation of new eco-sustainable products (such as raw materials using vegetables, recycled materials or bio-based polymers) through the collaboration between chemistry and agriculture. As seen with Orange-Fiber, VEGEA is developing products using wine waste, reducing in this way the disposal of natural materials.
ECOALF	**Recycling brand**	ECOALF's foundation backs to 2012, when the founders Alfredo and Alvaro wants to create a sustainable fashion brand in the recycling fashion segment as they truly believe there is no plan B

		for our planet and the fashion items should be more durable and responsible. The recycled materials that ECOALF is engaged of are polyester, nylon, cotton and wool. In addition, they have launched a project "SCafé" that through the combination of coffee grounds and fabrics, it is possible to obtain yarn for fashion uses.
	Recycling and reuse service (downcycling)	The work of FABSCRAP (founded in 2016 and actively present in New York and Philadelphia) can be summarized using a very intuitive circular scheme, following three defined steps which are all connected to each other: 1. *Recycle:* companies can ask for pick-up or join to the regularly scheduled pickup dates by which FABSCRAP collects bags of textiles that, after been checked and tracked, can be recycled or in the worst-case scenario have to be disposed; 2. *Volunteer:* during this phase, people on a volunteer based, join the warehouse where the textiles are sorted between textiles that will be recycled, downcycled or go on landfill; 3. *Shop:* in FABSCRAP's shops, fashion companies can

		purchase recycled textiles that can be used to create new collections and in case of excess fabrics, they will end to recollected by FABSCRAP pickup service, closing the circle of recycling.
		FABSCRAP is also engaged in a downcycling project; in particular the textiles that cannot be recycled end up in the shedder where the product resulted from the process is fluffy fibre (called shoddy) used in different applications: insulation, carped padding, mattress stuffing and many more. Even if this company main business concerns the recycling, this complementary operation helps to extend the life of fibres.

Orange Fiber, Progetto Quid, VEGEA, ECOALF and FABSCRAP are some of the most virtuous examples of the "born-sustainable" star-ups that operate toward the sustainability, however recycling is complicated for the ways in which the products are designed and manufactured and lacks some infrastructures and technologies innovations that could hinder these companies to boom. The downcycling business model also is not a complete circular business model as even if the materials are used to give new life to law-quality items, these have a higher percentage to rebecome waste in few months.
However, if the fashion industry moves increasingly into the direction of the recycling path (intended as the way Orange Fiber creates sustainable fabrics), many benefits in terms of environmental sustainability can be appreciated. In particular:

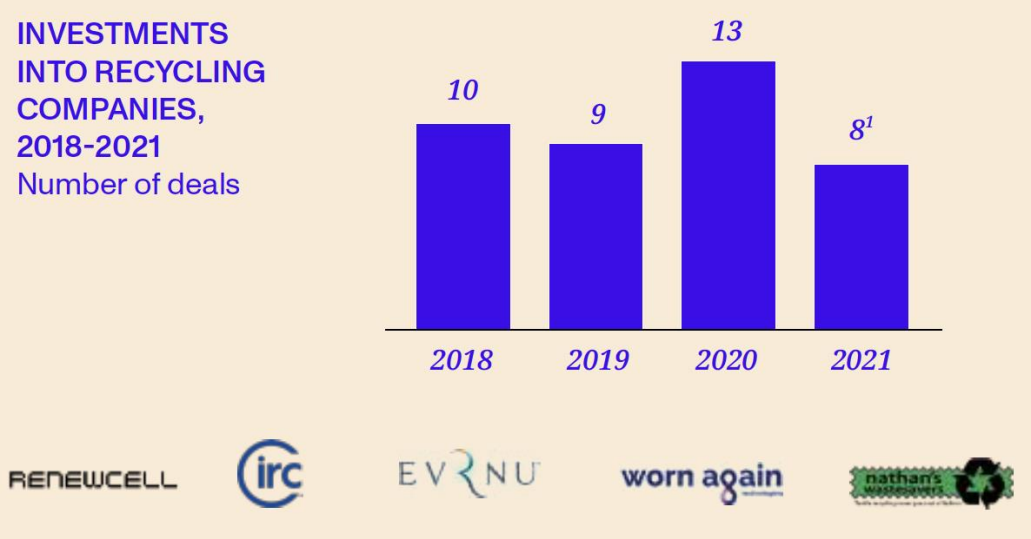
- *Reduction of GHG emissions*;

- *Water depletion and use fall*;

- *Land use decreases as well as the use of fertilizers and pesticides,* that in most cases have a high impact on biodiversity and soil quality.

Summing up, there is the continuous need of investments to improve recycling technologies and make them more agile for the next few years. Positively, from 2018, it has been registered an increasing trend in terms of those investments as in the technologies indicated under *Graph 5*.

Graph 5. Positive trend in the recycling technologies' investments[2]



Source: Global Fashion Agenda (GFA) & McKinsey&Company. (2021). S*caling Circularity: Lessons learned from the Circular Fashion Partnership for building pre-competitive collaborations to scale upstream circular fashion systems; p.39.*

[2] In Graph 5, in 2021 the number of deals regarding the investments into recycling companies comprehends the ones closed until September 2021.

2.5. Co-creation business model: From customers' ideas to network-shared creations

Co-creation business model in the fashion industry has become an increasing trend since the COVID-19 pandemic, since customers have started asking more for high quality and non-massive products. However, there seems to be a mismatch between the supply and demand of fashion products even if the production volumes in the last few years have increased and for this main reasons people are perceiving the needs to differentiate themselves from the others. Co-creation business model could be the way to tackle this need but also try to have really good social and environmental impacts.
Co-creation can be defined in different ways, but there are some points in common to all the definitions:

- *Creating value and products,* customers and the firm can create together values and product co-join their primary ideas or solutions. With the co-creation approach, the products are not only developed by users' ideas but also valued by them, giving the possibility to companies to have direct feedback from their clients and in this way developing a strong brand awareness;

- *Increase consumer engagement,* customers can do a personalized experience in the creation of the final products with the interactions to other users and though the use of new advanced technologies

- *Pursue the zero-waste aim,* with the co-creation business model it is possible to minimize the consumption of materials thanks to the adoption of innovative and more efficient production process, such as additive manufacturing or the introduction of Industry 4.0 like the first two star-ups discussed in *Table 10*.

Table 10. Sustainable choices: towards innovative co-creation start-ups

LANIERI ITALIA	**Co-creation e-commerce**	Lanieri's scope is the reduction as minimum as possible of waste, for this reason, starting from 2013, they produce menswear only on request giving also the best customized product to the final consumer. Through a digital platform, data (fabric, size and customization) about the customer are collected and then the fashion item is produced following those data. The e-commerce exploits an algorism that is able to check all the information given in order to reduce any possibilities of mistake and of course the creation of waste.
ELSE Corp™ A Virtual Retail Company	**Virtual Retail and Cloud Manufacturing**	ELSE Corps was born in 2014 in Milan and it is a B2B start-up that provides the fashion companies with which collaborates different services as smart mirror and dressing room technology, Virtual Couture Fashion and Product Customization & Personalization, with the aims of reorganize the fashion value chain through new technologies (as 3D Virtual Retail or augmented reality, what it is possible to call Industry 4.0) and the minimization of store inventory.

AWAYTOMARS	**Co-creation from creative minds all over the world**	Awaytomars (founded in 2015) is a very innovative platform where creative ideas of people can be produced. Through this start-up, the users can create a 100% product from their ideas following a well-defined process: 1. On the co-creation forum of Awaytomars, any users can upload their ideas, that can be commented by other users to promote some improvements of the initial sketch; 2. For each idea, the user has to individually crowdfund and at the same time a team of expert has the functions to choose the materials and all the design of the cloth; 3. Once done the previous steps, Awaytomars create the prototype that will be produced by European-based factories; 4. The pieces are then sold through the online platform of in the pop-up store. The total profits from the sale of the pieces are shared between the designer (20%), Awaytomars (20%), European manufacturers (50%) and finally between the Awaytomars'

	community that has developed the creative sketch (10%).

As the co-creation business model is something new applied to the fashion industry, it is not easy to estimate the positive impacts as well as the critical issues that the operators in this segment have to face. However ELSE Corp, one of the examples shown in *Table 10*, has provided a very simple scheme that summarise the impacts of the Virtual Retail product lifecycle that can be extended also to the other fashion co-creation platforms.

Figure 10. From customers' ideas to co-creation: the future of the fashion industry

Source: https://www.else-corp.com/virtual-retail

2.6. Focusing on the end of the pipe: How to renew and extend the life of the garments

There are two last sustainable business models that are establishing in the fashion industry scenario, not only because they can have a really impressive impact in terms of reduction of the CO2 emissions or waste, beneficial effect on the society but also because they seem the best approach to combine business modelling with innovative technologies and the so-called Industry 4.0.

The upcycling and renewal business models seem to be the answer to the lacks that presents the other business models that operates in the fashion industry and become the most scalable economic approach at international level. Before going through the detailed analysis of the upcycling and renewal world in the fashion industry and take a look on the start-ups and companies that stand out to operate in this direction, there is the necessity to set the grounds identifying what are the elements that can boost the increase investment in these types of businesses.

For this reason, in the last paragraph of *Chapter 2* will be touched some main concept to have a better overview of the maturity of the fashion and renewal segment through the various steps from the complexity of the international systems to gather used clothes to the extension of garments' lives. Second, there will be a detailed study of some very interesting and successful real case studies that operate worldwide. This section has the aims to define which are the strengths, weakness and most important the opportunities to expand these sustainable business models in a more international context.

2.6.1. Tidying up: What really occurs to our unwanted clothes

When we decide to get rid of our clothes, we don't know exactly where they will end up. Most of them even if are gather by associations or inside the dedicated baskets, it has been estimated that 85% of disposed fashion items end their lives being exported to other countries, mostly to East Asian and African countries and landfilled or incinerated. At the same time, 95% of those 85% could be recycled and renewed but data shows that only 1% becomes new clothes and 13% are transform into minor value products such as rags and padding, in this way about $100 billion value is lost every year in terms of resources and textiles usable for new items (Ellen MacArthur Foundation, 2017). It has also been estimated that the loss of value has been worsening during the Covid-19 as a direct consequence of between €140/160 billions of fashion items unsold worldwide (with a -51% global fashion purchases in 2020) and the waste of those pieces. The main causes related to Covid-19 shock on the fashion value chain and the consequential increase of textile waste production are:

- Disruptions in manufacturing process due to the social distance required;

- Slowdown of raw material arrival in the production facilities and a direct rise of prices;

- Delays of payments and as a result cancellation of orders (Fashion Revolution, 2020).

Despite the different initiatives of used clothes collections, that are going to be explained in the next sections, beyond the loss of value, those unwanted garments become trash for other people and a problem for the environment, even if not so high in comparison to the manufacturing stages. However, as seen in *Chapter 1*, most of our clothes are made by organic (cotton) and synthetic fibres (polyester); those organic fibres when finish in the landfill can produce methane gas, that represents a major factor of greenhouse gas emission causing climate change and at the same time the synthetic fibres (made of fossil fuels) emit pollutants toxic to health, that includes particulate matter, dioxins, lead and mercury.

By a literature review and some interviews made with sector professionals, it has come out how the recycling and the renewal business models have the main purpose to reduce fashion waste focusing on the end of pipe, which means that they have the central of attention to intervene and change what has been called in *Chapter 1*, the "End-of-life" phase.

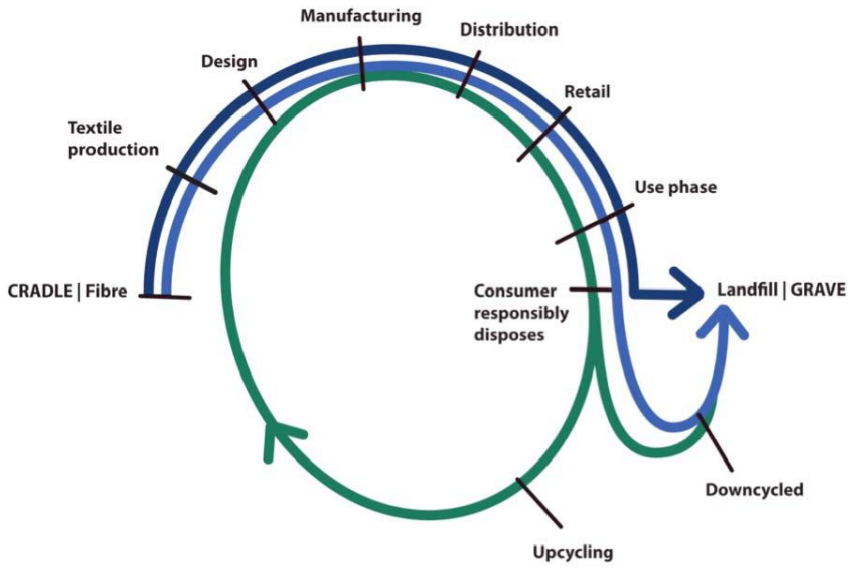
2.6.2. The upcycling business model: a new way to rethink waste

It is possible to talk about upcycling in the fashion industry when a product is transformed into another product of same or higher quality and value in comparison to the initial item. In the sector analysed during this research, the garments can be disassembled and converted in new products, giving birth to a new life cycle, and increasing in this way the entire wheel of life.

The term upcycling was coined for the first time in 1994 from journalist Reiner Pilz: "Recycling," he said, "I call it downward, smash bricks, ruin everything. What we need is upcycling, where old products are given more value, not less". It was then officially taken in use through the publishment of the homonym book of Gunter Pauli in 1997, where he detected the ways to achieve a zero emissions production by using already existing materials.

The definition that can most correctly be used to describe this economic model is "creative reuse" emphasising the creative and reworked part that is fundamental.

Figure 11. The pathway to the upcycling of clothes: where old products are given more value



Source: Clemente Tartaglione, S.C. (2013). *Il "fine vita" dei prodotti nel sistema moda.* Roma.

Following the establishment of the concept, thanks also to the two pioneers in industrial upcycling in particular McDonough and Braungart, the popularity of the practical implementation of upcycling has grown and especially is continuing growing in the fashion industry, pushed by the fact that there is the need to reduce the environmental impact of the second worldwide most polluting industry.

To better understand how it works and the possible applications of innovative technologies and industry 4.0 (explained in next *Chapter*), it is important to identify which steps are involved in the upcycling process, in details:

1. Used clothes and textile leftovers collection;

2. Sorting and processing;

3. Sustainable repurposing;

4. Marketing, sales and distribution.

The upcycling applied to the fashion industry allows not only to pursue positive environmental goals, but also covers other important aspect as summarised in the following points:

1. *Sustainability:* the circular economy model makes possible to have different clothes but without creating new ones and polluting in the process.

2. *Uniqueness:* it allows you to have singular, even extravagant and unique garments, exactly the opposite concept to mass production, no one will have a jacket or a bag that looks like no one will have a jacket or bag that is the same as someone else's.

3. *Savings:* the economic factor is certainly a fundamental aspect; the starting product already exists or in any case you have to assembled with fabrics that cost much less than standard.

2.6.3. Collecting real case studies working in the fashion upcycling

Referring to the steps previously seen, it is possible to state that the companies and start-ups working in the fashion upcycling do not perform all the functions from collection to distribution, but it is more likely to observe a sort of specialisation in one of the phases.

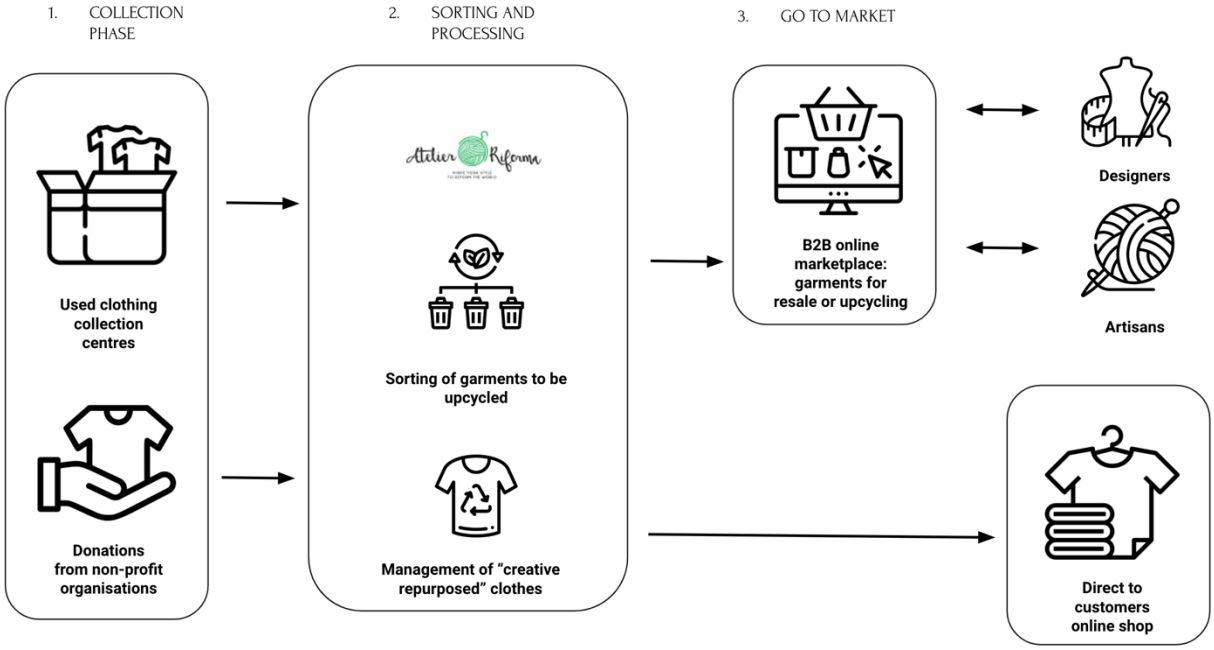
The result of this conclusion is a more efficient management and pursue of sustainable purposes and a wider involvement of actors in making the life of garments longer. For this reason, it will be presented three case studies, Atelier Riforma, Progetto Quid and Must Had, which are focused primarily on of the phases previously explained.

Sorting and processing

Atelier Riforma is an innovative start-up based in Torino whose activity is primarily focused on the sorting phase. In details, after collecting used garments, textile leftover or deadstock from different sources as donations by no profit organizations or bulk purchases, they are sorted and catalogued based on different parameters and then distributed to a network of actors which are in charge of the upcycling activity based on their creativity and sartorial knowledge.

If before 2020, Atelier Riforma worked only on a B2B base, starting from 2021 it works on a B2B2C path thanks also to the introduction of the online platform where customers can purchase directly the upcycled items.
Figure shows in detail the various steps involved in the supply chain which characterises the start-up founded by Elena Ferrero and Sara Secondo.

Figure 12. Every waste is an opportunity: the supply chain of Atelier Riforma



Source: Personal elaboration from (Ferrero, Atelier Riforma, 2022)

The supply chain which is proper to Atelier Riforma allows to reach noteworthy results in terms of sustainability:

- *Between May 2020 and April 2021, they have collected 8.000 used clothes from privates and non-profit associations, with a decrease of about 800 kg of C02 emissions;*

- *With the collection of those garments, it has been possible to produce 400 upcycled fashion items;*

- *In only five months by the launch, through the B2C e-commerce it has been sold 55 renewed garments;*

- *Social inclusion and enhancement of sartorial craftsmanship*

- *Increase of traceability since all the information regarding a garment are gathered from the collection phase to the sale.*

The business model proposed by Atelier Riforma could be scalable and further implemented with the technology innovation, since the sorting process in which this start-up is focused need to be redesigned and make more agile to find the best possible sustainable solution to repurposed used clothes, textile leftovers and deadstock. This business model offers the possibility to make the difference in terms of a swift to a sustainable fashion supply chain and as it will be discussed in the next *Chapter*, Atelier Riforma is working to provide a service at worldwide level that match the positive environmental path to the use of the Artificial Intelligence.

Sustainable repurposing

Progetto Quid is a fashion brand that combine the world of sustainability with the ethic one, since the collections are made with the use of fabrics' surplus from luxury brands and the textile sectors (as Marzotto Fabrics, Tessuti d'Autore Golden Group, Olmetex, Tessitura Taborelli) and at the same time women with a difficult past are involved in the creation of the unique items. This Verona-based company, since 2013, has restore about 1.200 km of fabrics in this way pursuing two of the objectives of sustainable development: responsible consumption and production and climate action.

Starting from an innovative idea at the end of University studies, they have been able to overcome some difficulties as start-up such lack of entrepreneurial experience, trust and credibility as well as other obstacles problems related to the market conditions at that time (economic and financial crisis, labour costs, offshoring of production and emergent brands vs established brands) and difficulties to find the right spots to sell our collections, and becoming nowadays an establish companies that counts 150 employees and with quite high success.

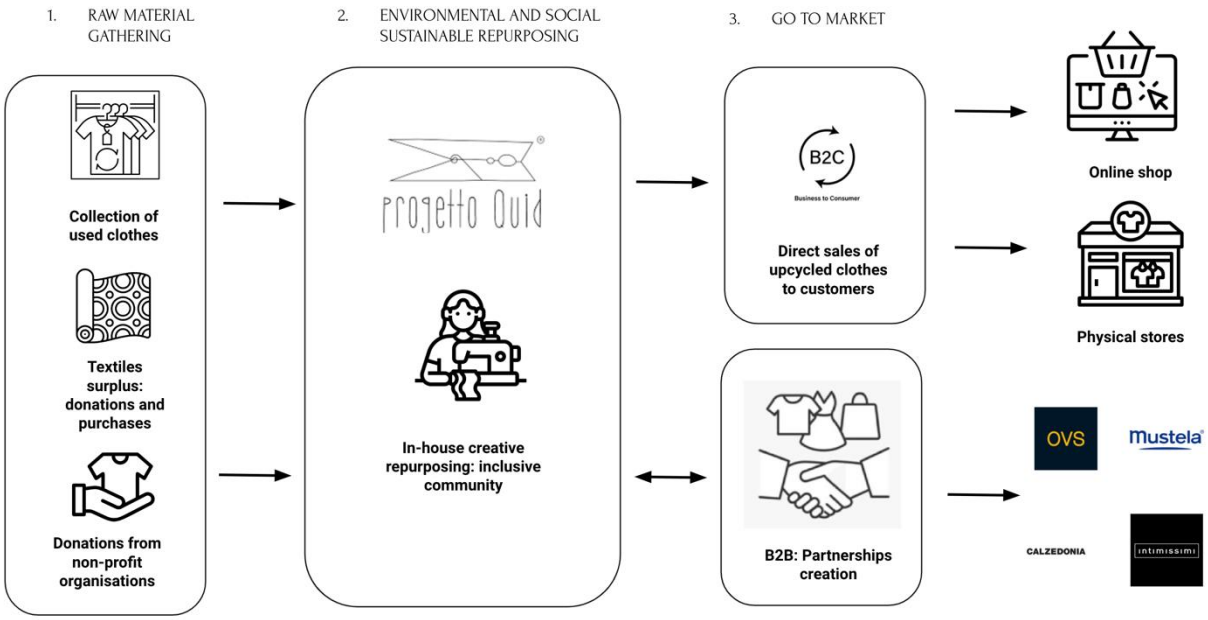
Progetto Quid is focused on the repurposing phase, its creations are made by almost exclusively from textile leftover or surpluses, often too small for large production for large-scale production or discarded due to trends or fabric characteristics. With a network of 52 fabric suppliers Progetto Quid is able to extend the life cycle of fabrics and

shorten the carbon footprint of tens of thousands of metres of fabric each year, with a total 1.200 km of recycled fabric (2013-2020).
With its in-house factory, the collected textile leftover and the used clothes are reused to create new items, that meet the tastes of the moment but at the same time are accessible since for the CEO Anna Fiscale the ethical fashion should be democratic and not only for a niche.

Progetto Quid is also a Certified B-corporation since 84% are women and the majority are people with a history of fragility, a term that includes invalids, ex-convicts or ex-drug addicts, but also women over 50, young NEETs, women victims of trafficking and asylum seekers. Quid also has two workshops in the Montorio prison near Verona, in the women's and men's sections, where about 10 inmates are employed. In the following graph is possible to observe the increase of women employed by Progetto Quid since its foundation to the most recent data collected.

Figure shows how Progetto Quid operates and which are the steps involved in its upcycling business.

Figure 13. Creating inclusivity by the upcycling process



Source: Personal elaboration from (Fiscale, Progetto Quid: towards an environmental and socially responsible company, 2022)

The particular business model through which Progetto Quid is having success could be replicated at international level, the only consideration to make is the need that the country in which the companies operate have a strong textile tradition (as Italy has) and as a direct connection where it is easy to have access to textiles. In fact, since the repurposing phase is done internally is necessary to have availability of material (textile scraps or used clothes) to perform the productive and creative process.

Marketing, sales and distribution

Must Had is an innovative benefit start-up founded in Turin in 2021, through a digital platform it has the purpose to create a community for the artisans, designers and small brands that recovers and reuse fashion items to give them new lives.

Must Had's business is to provide a service to all the professionals to make their businesses grow in terms of visibility and a greater access of customers' base. The start-up focused on the marketing, sales and distribution phase has a complete offer in terms of digitalisation, marketing, logistics and complementary services (e.g. recycled packaging).

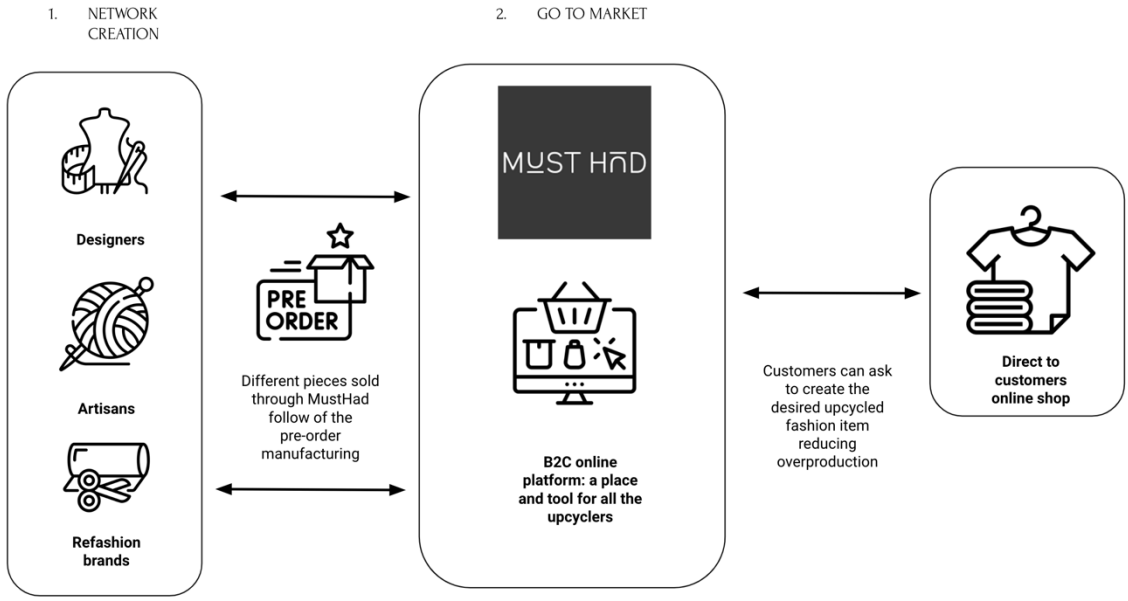
Must Had has the main purpose to become a reference point for small brands and artisans who want to follow a path focused on circularity, providing different parallel opportunities such as:

- *Continuous creation of trust and loyalty between upcyclers and customers:* Must Had shares photos and information regarding the repurposing process, making it transparent;

- *They allow to create collaboration between different partners involved in the community:* especially promoting the pre-order project, where the collection using

leftover or pre-own clothes are done when an order is placed, avoiding in this way the problem of overproduction.

Figure 14. Increasing traceability to a network creation: Must Had the "Refashion" community



Source: Personal elaboration from (Torino social impact, 2022)

The importance to have a well-developed online marketplace will be underlined in the next *Chapter*, but introducing the topic, one of the difficulties that many artisans, designers and all the actors that do upcycling is to find the best way to connect with customers. Sometimes they do not have the availability of a proper sales channels, people are reluctant to buy repurposed clothes and in some cases the prices are not accessible to the medium class. An online marketplace who manages the upcyclers can be the best solution to develop further this movement in the fashion industry (Ferrero, Atelier Riforma, 2022).

2.6.4. The renewal business model

The renewal business model is having success thanks to different brands that are engaging in environmentally sustainable projects. In particular, the companies working

in this segment as the Renewal Workshop, generally establish partnerships with fashion brands and perform activities to recover value from their unsellable returns and excess inventory, giving a new opportunity to those items. And the end of the renewal process, these renewed clothes are sold directly by the partner brands or by the online platforms owned directly by the renewal companies.

It has been seen that this business model can improve the way in which fashion brands have to create new collection and produce them, since usually the companies whose main business is to renew collect data about the products they received.

The Renewal Workshop

To fill the gap many fashion brands face every day, the lack of proper systems to recover value from unsellable inventory or deadstock, the Renewal Workshop proposes itself to be the bridge between the different opportunities to the commitment to sustainable process (shifting to circular manufacturing process) and the different actors involved on the fashion supply chain.

Due to higher expectations from customers that are continuously asking for more sustainable products to the different norms introduced to reduce the environmental footprint, brand working in the fashion industry needs the right technology and infrastructures to recover value from waste. For these main reasons, though the settle of different partnerships, the Renewal Workshop is able to take back discarded apparel and textiles and perform the processes of products renewal, material upcycling and feedstock recycling. The American-based start-up is not only this, because through the use of the technology it creates a dataset which helps fashion brands to make improvements in terms of production and items management. This model can lead to a zero-waste system where for every piece the value is fully recovered.

It has been proved that through the activity performed by the Renewal Workshop the processed garments have by 18% recycled, by 36% repaired (thanks to a substantial

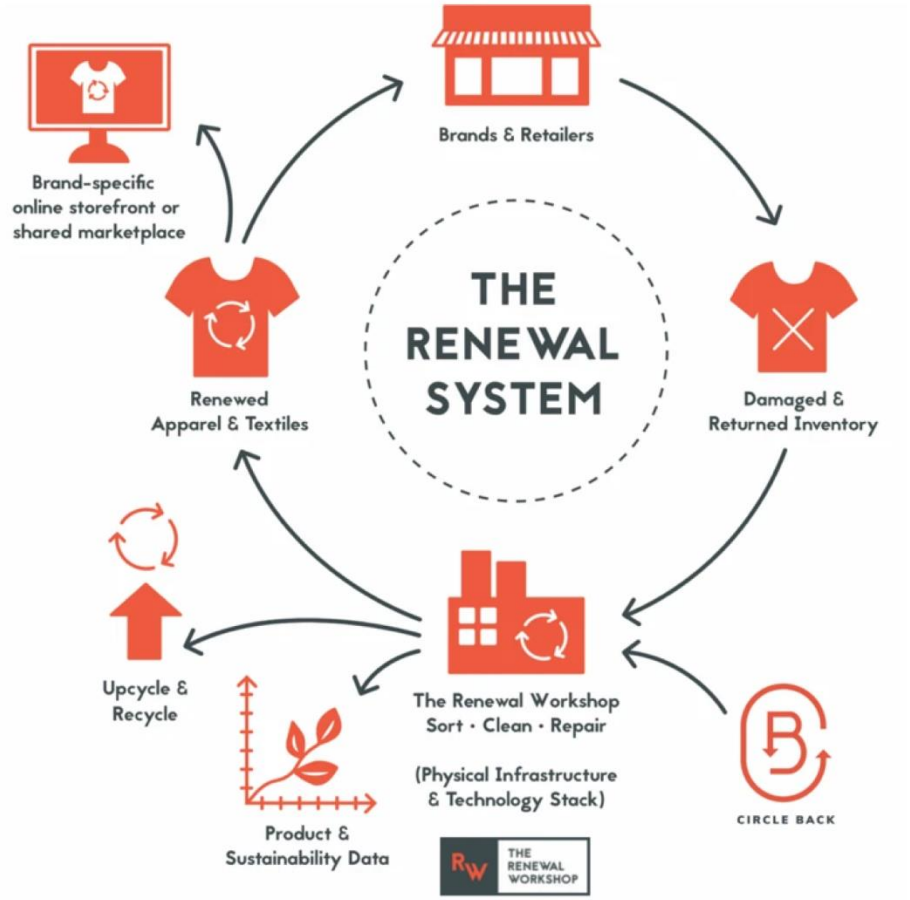
noticeable repairing activity) and by 46% restored which means they need only a light or minor repairs (The Renewal Workshop, 2020). The renewed products are then sold in two options:

1. The shared marketplace directly managed by the Renewal Workshop;

2. Brand's sales channels that most of the time is on the dedicated online platforms.

The flow of activities performed by this innovative and sustainable business model are simply summarised in the following *Figure*, which allows to understand how it is circularly organised and developed.

Figure 15. Circular flow of the renewal performance



Source: Retrieved from (The Renewal Workshop, 2020), *pg. 2.*

To the different successful partnerships that have been established since the foundation in 2016, the Renewal Workshop counts projects with famous fashion brands as The North Face, Champions, Carhartt and Toad&Co. The renewal process allows to get very positive environmental impacts, in particular:

- *Reduction of GHG emissions equals about to 284 Kg/CO2;*
- *Save of water of 347 L/Kg;*
- *Decrease of the volume of waste from landfill by 130.000 Kg*

3. Technology and innovation in business modelling: What next for the future

Since the thesis is based mainly in finding real and concrete solutions for a shift from the "take-make-dispose" model to the "make-use-return" model, many literatures show the importance of digital technologies and the application of the so-called Industry 4.0 as enablers of reaching the sustainability (environmental, social, and economic) of the textile and apparel industry.

The upcycling and renewal business models seem to be the perfect way to mix the circular modelling with the innovative technologies, however, to make this combination successful there is the need to an adaptation in both ways: digital technologies are designed or adapted to the circular business models but at the same time there is the necessity to an upgrade of those sustainable economic approaches. This is the reason why it is believed that digital technologies can be both critical enablers and tiggers for circular business models.

Technology innovation drives the possibility to have processes, way of working, communication, sale and distribution channels as well as could enables better use of resources and economic growth.

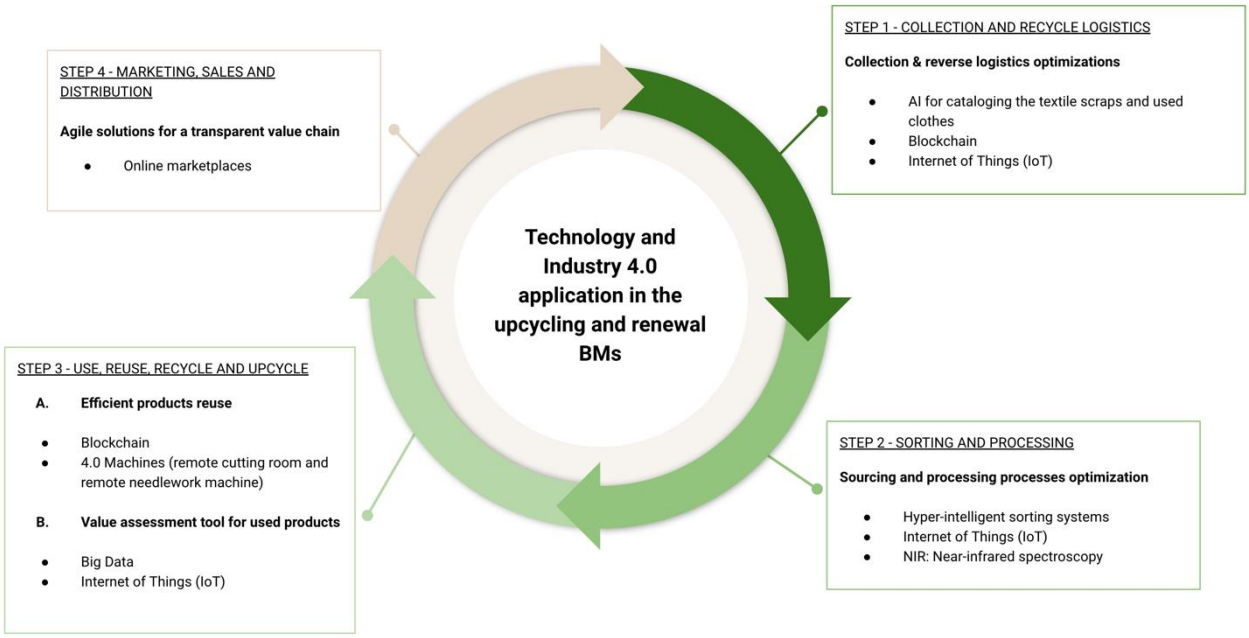
Many studies and research underline that the application of digital technologies and the Industry 4.0 to sustainable business modelling is still on a pilot phase and only in the last few years it is possible to observe real case of development of the topic. Despite this premises, there is the willingness continuing to invest in money and in time to the progress of sustainable business modelling in the fashion industry and conjunct it to the progress of technology and industrial revolution, thanks also to high interest of companies, governments and international institutions to pursue the Sustainable Development Goals by 2030 and in particular Goals 9, 10,12 that are proved to be the most reachable and positively impacted by the circular fashion (lablaco, 2020):

This *Chapter* has the aim to identify those enabling technologies that can be applied by the companies and star-ups seen previously in *Chapter 2* and define an action plan to make those realities agile and replicable in an international context.

3.1. Introducing enabling technologies and Industry 4.0 application for circular fashion transition

With the premises that the Industry 4.0 and technology can be considered as an acceleration element for the transition to the sustainability in the fashion supply chain, *Figure 16* shows the steps involved in the upcycling and renewal processes and the applicable technologies, that will be explained further in the following paragraph.

Figure 16. Technology and Industry 4.0 application in the fashion upcycling and renewal BMs



Source: Elaboration from (Huynh, Enabling circular business models in the fashion industry: the role of digital innovation, 2022) and (Ferrero, La tecnologia per creare una filiera circolare, 2022).

To better match the proper technology to the right application, in *Figure 16* it has been divided the main steps that characterize the value chain of companies working in the fashion upcycling and renewal segment. According to the literature, the four steps identified are:

1. *Collection and recycle logistics:* the first step that companies have to perform is the collection of textile scraps, leftover and used items. It is necessary to make a differentiation between the way in which enterprises get the "raw material" to conduct their processes.

   In case we refer to the upcycling, the most important input source are donations from charitable organisations or companies working on the fashion industry (inbound and outbound), from private owners and purchase to textile suppliers.
   On the other hand, as seen in previous *Chapter*, the companies working on fashion renewal projects, usually operates as partners of apparel brands ton recover value from their unsellable returns and excess inventory, so simply it is possible to state that the main source of raw materials comes from those brands.

2. *Sorting and processing:* as many of the companies and start-ups analysed on the previous Chapter relies extensively on human capital, the sorting and processing phase is based mainly on separate textiles and fashion items based on parameters that the employees can notice by sight and touch as colour, fabric, quality, style, brand, complex textile and occasion.

3. *Reuse, recycle and upcycle*: after the collection of all information regarding the clothes intended to have knew life and performed the sorting and processing step, they are directed to reuse, recycle (in the case for example the items are damaged) and in the most likely situation they are upcycled.

4. *Marketing, sales and distributions*: after the performance of previous stages, the items have to be put again on market, first they have to be promoted, sold and then distributed.

To make the companies more and more agile, able to become fully sustainable and also increase the presence on the worldwide market, it seems there is the necessity to combine the simple modelling process to digital technologies and Industry 4.0. Before going into details and see how the application of the technological innovations can have a significant impact, in the following *Table* they will be generally summarised and explained.

Table 11. The types applied digital technologies and Industry 4.0 through upcycling and renewal business model

Artificial Intelligence (AI)	Artificial Intelligence simulates the human intelligence in machines (as pattern-recognition, perception and learning). The upgrade from human capabilities is the ability to handle big data and boost companies' decision making.
Blockchain	It is defined to be an innovative technology that allow the continuous tracking of data about products and processes through the supply chain. Blockchain is the solution to more transparency along it.
4.0 Machines	The digital application of textile machines can make the industry more agile, reduce the material waste and make possible of different combinations of textiles and products. The make possible the connection between information gather by other applied technologies and the real production phase.
NIR: Near-infrared spectroscopy	NIR technology can recover value form used clothes and textile wastes sorting by an automated system and diving the items based on the materials composition. Applied with AI technology can be the

	perfect solution to have high percentage of right destination of used and second-hand clothes. The spectrometry is one of the choice techniques that can be used in the sorting process.
Big Data	It helps to increase the capacity of storage, management and analysis of enormous amount of variety, volume and velocity of data. Bug Data helps to implement the human capital ability to make available of information regarding fashion items.
IoT	In the case of the fashion industry, clothes and accessories can be connected to electronic devices, smartphones and radio-frequency identification (RFID). In particular, referring to the industry in question, RFID is the most possible applicable technologies thought to be a "wireless USB memory stick" that allows to collect data and remotely been read.
Digital platforms and mobile applications	Through an interface or digital service, they allow interactions between different users, that could be consumers or firms, thanks to the Internet.

Source: Elaboration from (Huynh, Enabling circular business models in the fashion industry: the role of digital innovation, 2022) and

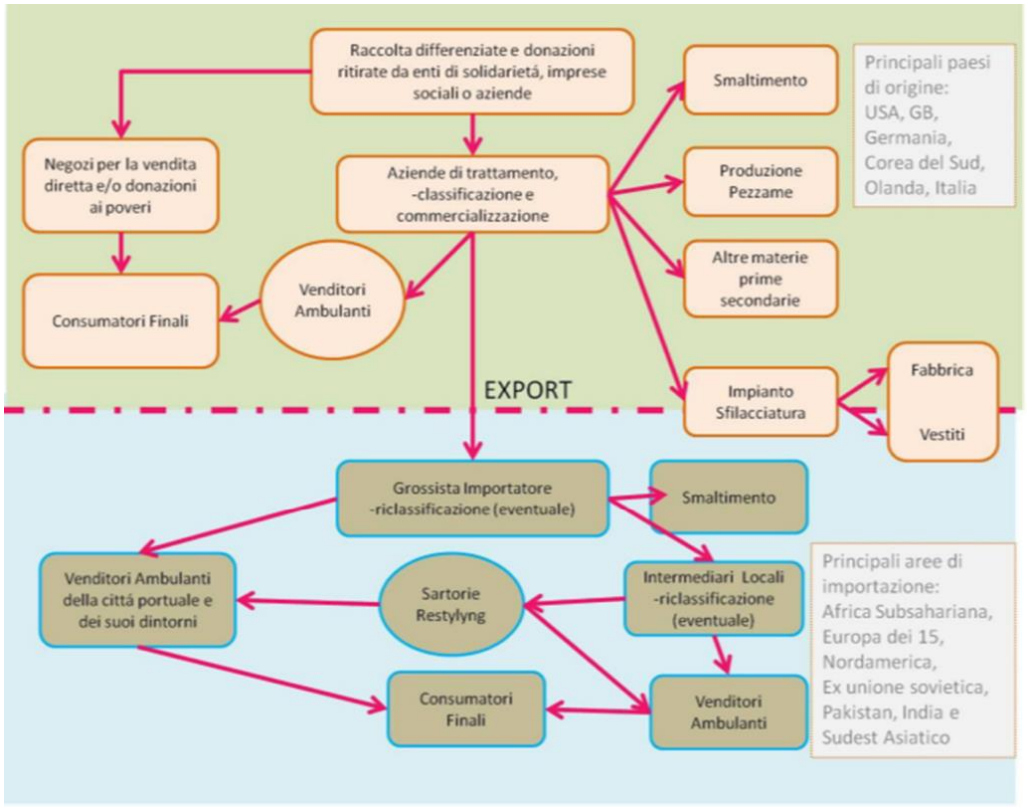
3.2. Applying the digital technologies and Industry 4.0 to the sustainable business modelling

After seeing the different steps involved in upcycling and renewal business models in the fashion industry and the possible applicable solutions, it is important to find the right matches between these two sides. Following a linking process, in this section it will be proposed an insight on which digital technologies can be implemented for each of the previous seen stages, underlying how they can be applied and what are the improvements and benefits that those technologies can bring.

Stage 1 - Collection and recycle logistics

The collection of used clothes, even if it is done by the municipal organisation, by charity associations or by specialised shops, is not so easy as it appears in some cases difficult also due to some limits that people have in donating or recycling garments. Generally, the supply chain of used clothing gathering can be thought to be developed in several stages (or "rings") before reaching the final user of the used clothing or the recycling and recovery industry. In fact, it is correct to imagine the chain not as a linear chain, but as if it were a tree, with many roots and many branches, and in which each branch has a different weight, as it is possible to appreciate in the following Figure.

Figure 17. The international chain of used clothes



Source: UTILITALIA, (2020). *Linee guida per l'affidamento del servizio di raccolta e avvio a recupero degli indumenti usati (Cod. EER. 20.01.10 – 20.01.11).*

According to different studies, people are reluctant to take part on these initiatives and respect the regulations regarding the recycling of used clothes for three main reasons:

1. They do not think they could adhere because their clothes were worn out or dirty;

2. They do not have time to go to the places where recycling takes place or they are bothered to sort the garments based on the different components they are made;

3. They are not aware that clothes can be recycled (Smithers, 2017).

Despite those limits, the collection initiatives are one of the enabling elements for the success and further extension of the fashion upcycling and renewal movements. Taking as example the European Regulation for the differentiated textile collection emanated by and European Parliament Directive (851/2018) which implementation will be obligatory

by all the European countries by 2025, there is the need to improve the collection process thank also the implementation of tech innovations.

Different studies have pointed out that the digital technologies that can be applied for the collection and recycle logistics are mainly four:

1. *Artificial intelligence (AI):* as the transition to a sustainable fashion industry, there is the possibility to introduce the collection stations with equipment for products identifications and product assessment. The AI could be the right technology applied with the blockchain that could make easier the collection of used clothes. The possible advantages from the application of this technology can be summarised as follows:

    - Enhance the decision making in terms on how the collected garments can be reused and making the sorting phase even more lean;

    - Better waste management;

    - Improvement of logistics, inventory management and the planning of collection actions.

2. *Blockchain:* even if there are different charities and companies whose main business is focused on the collection, it has been found that most of the collected second-hand or used clothes end up being exported to developing countries instead of distributing those garments to other companies that can give them a new life and losing in this way the opportunity to create value from already existing materials.

    The blockchain technology should be introduced to the upstream business model with the aim of mitigating the barriers of the lack of collecting, sorting and recycling and improve the traceability and tracing of the value chain. Through the combination with the Internet of Things, the blockchain collects verifiable and

immutable information flow about every single item and make possible to have a portfolio which contains all the details and the IoT connects all the objects to increase sorting automation and reuse, recycling and renew efficiency (Huynh, Enabling circular busines models in the fashion industry: the role of digital innovation, 2021). The application of those technological innovations makes available sustainability metrics to customers as garment components, CO2 saved and all the steps involved in the new life of the cloth. The most relevant opportunities that blockchain technology can provide are:

- Improvement of efficiency in second-hand or used clothes collection planning;
- Continuous possibility to monitor energy consumption and material flows;
- Increase efficiency in reuse, recycling and repairing activities;
- More credible and transparent information (e.g. material sources, production) that incentive consumers to buy sustainable items.

3. *Internet of Things (IoT):* the use of RFID systems in the collection of preloved clothes is becoming a reality also in correlation to the regulatory frameworks regarding the sustainable solutions of gathering of apparel items. The benefits are similar to the Artificial Intelligence as:

    - Improved logistics, inventory management and collection planning;
    - Improvements regarding the use of energy since the collection become faster;
    - RFID tech allows to collect information and transit to the concept of e-waste aiming the sustainability of the fashion industry.

Stage 2 – Sorting and processing

The sorting phase seems to represent a big opportunity for companies and start-ups working in the upcycling and renewal segment since to find the best field to apply new technologies. This favourable match is also push further due to new legislation supporting the circular transition in the fashion industry. Just only looking at the European scenario, by 2025 in all the EU it would be mandatory to collect separately textiles and by the next few years all clothing brands will be obliged to contribute financially to the sustainable management of the discarded products (ERP – Extended Producer Responsibility). Following these premises and underlying that currently the sorting process is manly manually done (loosing essential information needed to recover garments), there is the strong need to introduce new technologies, which could be:

1. *Near-infrared spectroscopy (NIR):* the spectroscopy is nowadays used in different sectors as in PET recycling, it can be applied alto to the fashion industry in particular during the sorting phase. In fact, the collected clothing is for the most part sorted manually, losing different possibilities of proper classification. Using the NIR technology, the used clothes or textile scraps are selected based on the type of fibre and colour and this allows an efficient and profitable sorting to match clothes collection and an adequate used of those materials. The NIR technology has to be used in association with a database since the spectrometry operates on molecular identifications measured in the near infrared part of spectrum, that after other processes end up with a characteristic spectrum of the different fibres or a combination of them of the garment of textiles analysed. At the same time the resulted spectrum needs to be compared with different information collected in a database and then it is possible to identify the exact material (Tossavainen, 2019). In this field, Fibersort and Phycbet are launching some projects based on the NIR spectroscopy.

   The environmental impact could be huge if applied: it has been estimated that using the recycled fibres from a pair of jeans can save 53% of energy in comparison with the use of virgin materials and 99% of water savings (Leblanc, 2020).

2. *Hyper intelligent sorting systems based on Artificial Intelligence (AI):* before clothes are repurposed in a circular way, the collected items have to be classified and divided. As in the case of Atelier Riforma that outsource the reuse, recycle and upcycle step as well as the case of the Renewal Workshop which done it internally, the AI can make their activities easier and innovative. The Artificial Intelligence provides the possibility to create an in-cloud copy of the garment thanks for example taking a photo and collecting all the information contained in the labels and have the access to all the necessary information of each garment managed. For Atelier Riforma purposes this means give the right garments to the right upcyclers and for the Renewal Workshop have a better management of the inventory and all the clothes given by the partners in order to give new life to them.
   The main positive achievable impacts in terms of sustainability can be:

   - Reduction of the quantity of used clothes that end their life in landfills or being incinerated;

   - Availability of a wider range of information to the final customers since it is possible to create a digital copy of the all the process from collection to the repurposing activities and have a transparent value chain;

   - Efficiency improvements since the AI applied to the sorting allow the possibility to match the right repurposing between reuse, recycling and upcycling;

   - Better and more efficient inventory management.

3. *Internet of Things (IoT):* with application of the Internet of Things to the fashion industry there could be the possibility of connection of clothes and accessories to electronic devices, smartphones and radio-frequency identification (RFID). In this case, RFID seem to be the best technology as it is thought to be a “wireless USB memory stick” that allows to collect data and remotely been read. An RFID based system can be adapted and allow to sort garments based on specific parameters.

In fact, it could be set the types of information that the tag has to collect for example an undesired presence of chemicals or simple parameters as colours or sizes. Moreover, compared to the NIR spectrometry, the application of an RFID system has wider functionalities and allow to have access much more detailed information further than the fibre components identified by the NIR tech.
This technology is said to be proper for the traceability along the value chain of a garment and RFID could perform many benefits if applied correctly, in particular:

- Instant tracking of material resources;
- More efficient recycling, returning used materials into the cycle as a resource and reduce at minimum the waste;
- Better monitor on how energy but also raw materials are used;
- Wider information available for businesses and final consumers.

Stage 3 - Reuse, recycle and upcycle

In this case, there is the need to make a distinction between two purposes of the application of innovative technologies: efficient products reuse and value assessment tool for used products.
Companies and start-ups working in the upcycling and renewal business should apply:

1. *Blockchain:* as seen in Stage 1, blockchain technology helps to collection information from the very beginning of the upcycling process. The products passports are useful in this phase because with a simple look of the data companies can distribute garments to the right destinations between reuse, upcycle and renew. After the efficient processing, the customers have availability to all the value chain of each single fashion item, having the possibility to purchase sustainable products since they have all the data available also in terms of positive footprints.

2. *4.0 Machines:* in order to reduce the waste of materials and makes the production phase more agile, some companies are developing highly technological machines as the remote cutting room developed by Morgan Tecnica and the needlework machine by Il Punto s.r.l. To the different advantages connected to the industry 4.0 it is possible to find:

- Decrease in costs and time of production;
- Optimisation of energy and materials consumption;
- Improvement on the reduction of scraps.

3. *Big Data:* as it is defined as the combination of structured, semi structured and unstructured data, Big Data could be the right match between the Artificial Intelligence, the RFID tags and the NIR spectrometry. This toll can allow upcylcers, customers and resellers to read the condition of a garment, certify its value after the productive process and have available an assessment of the most appropriate after-use pathway increasing the trust and the efficiency in the second-hand market (Ari Happonen, 2020).

Stage 4 - Marketing, sales and distributions

Online marketplaces: since the concept of upcycling and renewal in the fashion industry is a new concept, some start-ups are developing online marketplaces where the upcyclers can meet the demand and find the better place where sell their remake pieces. The development of technological platform is also driven by the technological revolution and the need to reach a wider customers based. The online marketplaces can take to different shapes: B2B, where used clothes or textiles leftover are sold to economic operators for their upcycling or renewal purposes or B2B2C, where final customers can purchase regenerated fashion items. Some of the most impressive examples are the B2B online marketplace developed by Atelier Riforma and the B2B2C platform by Must Had.

As it will be explained in the next paragraph, in the online marketplace by Atelier Riforma the buyers are all actors that operates in a circular way in the fashion industry which have the necessity of the availability regarding the material compositions of the garments or brands that to the tailoring upcycling, that need to see the pictures of the different items to make their collections in terms of creativity. In this case only clothes collectors and circular fashion business can interact.

In the other hand, as the in the case of Must Had, refashion brands, artisans or designers can therefore take advantage of the direct-to-consumer digital sales window to reach conscious consumers who share the same philosophy and want to buy unique or limited-edition garments.
The advantages connected to the online platform, B2B or B2B2C, are:

- Cutting the supply chain, having less intermediaries involved;

- Particularly referring to the B2B2C platforms, shopping experiences go beyond the product and allow the customer to discover what went on behind the remanufacturing of the garment.

3.2.1. Re4Circular: How AI-based technology can be strength pulse of sustainable start-ups

The combination between technologies, Industry 4.0 and sustainable business models is a new field that lacks papers and insights and since all the structure of this research is to provide real impacting case studies. This paragraph has the aim to demonstrate that the technology can be the strength of the start-ups working in the fashion upcycling because by the application of tech innovation and the development of services based on it could be the key to make scalable at international level this business model. In particular, it will be shown a real case study in which the Artificial Intelligence is applied in the sorting phase and also the strengths connected to the availability of an online marketplace. The sorting process is one of the crucial steps performed in the upcycling and renewal business models, in fact if it is not done properly could results into loss of opportunities

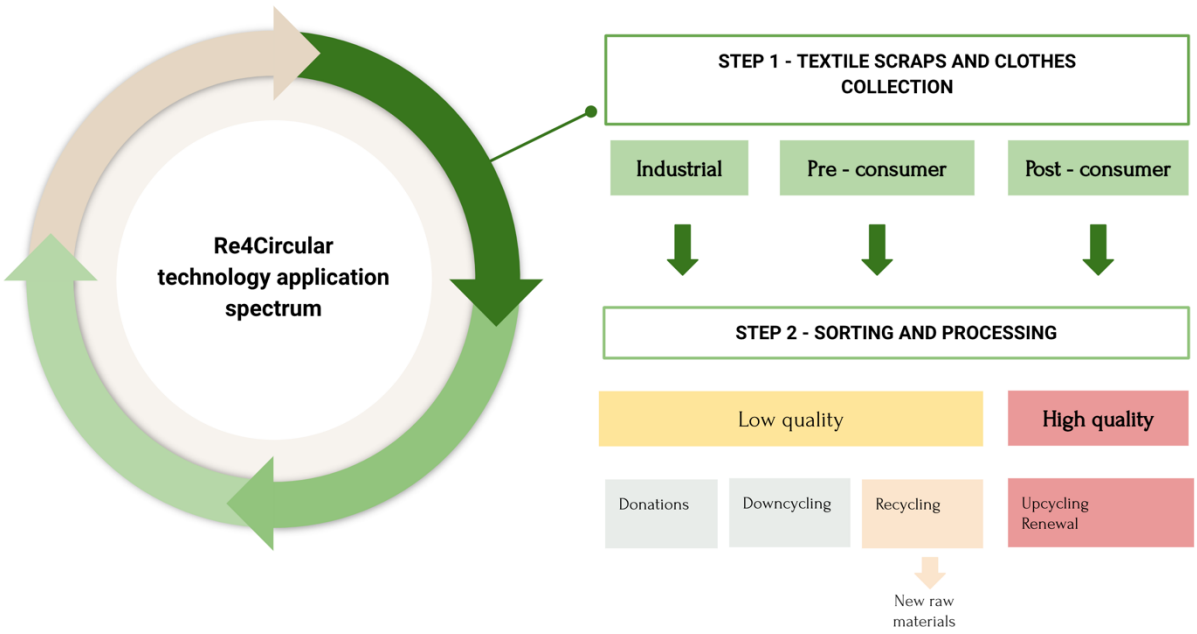
in terms of creative repurposes of used garments and in this way not pursuing the closing loop model. The practical example takes in consideration the project “Re4Circular” which is developing by the innovative Torino-based start-up Atelier Riforma and it will supported by insights got by the CEO and Founder Elena Ferrero.

Insights from the future international scalable service: applying the AI in the sorting phase

Since currently the sorting phase is done manually and primary carried out by collector or sorter companies, it has been observed that many essential information for the recovery of the garment is lost through the process. And this is also one of the main causes of the low percentage of recycled material into new clothing.

The sorting process is said to be complex and time-consuming, for this reason Atelier Riforma is working to introduce a new AI technology called “Re4Circular” for cataloguing and sorting of textiles waste and meanwhile recording their image and all the necessary features to result into a “digital copy” of them. Re4Circular can be considered a connection platform between to realities which have difficulties in matching the world of used clothes collection and the world of circular fashion. The AI technology developed by Atelier Riforma aims to direct as many used garments as possible towards sustainable uses, such as reuse, recycling and upcycling and prevent them from ending up in landfill; in details *Figure 18* shows the application spectrum along the upcycling business model value chain and what it is possible to appreciate is that the two first steps are the ones interest by the innovative tech.

Figure 18. Re4Circular technology application spectrum



Source: Elaboration from (pwc, 2021) and (Atelier Riforma, 2022)

Moreover, the AI tech is connected to a digital platform that helps to combine the sustainable management of dismissed clothes and the economic actors that can use them through their circular activities. This B2B online platform allows to match the supply and demand for dismissed clothing and from them is important to underline that Atelier Riforma is able to get profits thanks to the use of the service provided. Since the online marketplace is directed to businesses, it is important to make a distinction between what are the actors and how the match works.

The supply side is represented by two targeted customers collectors and sorters of used clothes. They collect used clothes but at the same time are overwhelmed by them, and they end up to not find the right placement, with a high percentage to become waste and at the end landfilled. Thanks to AI technology developed by Atelier Riforma, the part of garments that does not suit with the people that ask for these used garments could be resold by the digital platform and invest those money in their projects. On the other hand, in the demand side falls second-hand shops, recycling companies and upcycling professionals that are looking for the most suitable clothes for their activity.

Re4Circular is the means between the supply and demand: the suppliers paying a subscription for the use of the technology are able to catalogue their clothes and sell them

through the online marketplace and at the same time the buyers can buy the clothes they need online (Re4Circular receives a fee on each transaction).
This new technology will enable to apply the upcycling business model not only by the new-born start-ups or companies but also from many fashion brands with big realities all around the World (Ferrero, Atelier Riforma, 2022). In fact, Re4Circular is a scalable technology since it is under the patenting process, it will become a service which can be purchased by everyone working on the fashion industry and want a smart tool to manage the sorting and cataloguing the used clothes or textile scraps to foster the sustainability in this industry.

This technology, even if it is at the stage of prototyping seems to have already gathered success by many fashion realities, as came out during the interview with Elena Ferrero, CEO & Funder of Atelier Riforma. This general consensus is given by the positive effects in terms of sustainability, transparency and efficiency that Re4Circular provides, in particular thinking that when a second life to a garment is given, the environmental impact is reduced by 79%. Since 100 billion of garments are produced every year, emitting 1.7 billion ton of CO2 and at the same time 80% off those clothes end up in landfills. Embracing this innovative sorting technology, fashion brands, upcyclers and all the actor involved can make a huge difference decreasing the percentage of items that are disposed and using existing materials. Moreover, it has been summarized four main points in which this tech provides innovation:

1. *Every garment has a chance:* through the processes of tech sorting, it is possible to attribute the right destination to each garment, valorising in this way its characteristics;

2. *Digitization and online B2B marketplace:* thanks to the collaboration between the AI technology and an online marketplace, the garments are digitalized and put directly into a circular market designed for companies that are engaged or willing to take sustainable measures;

3. *Shorter supply chain:* since the fashion value chain, as it is still organized nowadays, is very long Re4Circular can have an impact on the decrease of waste export and retain most of the value in the country where the technology is applied;

4. *Boost for circular fashion:* thank to the previous points, Re4Circular allow easier procurement of second raw materials that most fits with the needs of each player in circular fashion.

The application of technologies in the pathway towards sustainability in the fashion industry is still at the beginning of the development process and has also come out by the interview with the CEO of Atelier Riforma, the creation of a tech facilities is not easy, and it need lots of enabling factors such as funds, practical competencies and time of fashion actors' engagement. For these reasons, for the development of the AI tech of Re4Circular, between 2020-2022 it has previously raised funds for an amount of € 43 million and moreover Atelier Riforma is supported by an expert team. The Torino-based start-up will continue to gather funds in order to boost the technology but at the same time, as previously mentioned, it will get money from the purchase of the technological services (AI tech + the B2B marketplace).

3.3. New challenges for a technological transition

Despite the possibility to introduce new technologies and the industry 4.0 along the phases of the upcycling and renewal BMs' value chain, there are some difficulties and challenges that companies and start-ups may have to face for the technological transition. The most likely challenges can be summed up in eight points, which can vary according to the different type of enabling technology:

Challenge 1. Costs and complexity

The innovative technologies seen previously and the industry 4.0 features complexity and high costs when speaking of implementation, maintenance and updating. Even if established companies with high revenues decide to implement those technologies it

would affect the final cost of the fashion article. Thinking about those start-ups that many have little accessibility to funds, it is hard to think they get the right opportunities to make possible the introduction or development of high innovative technologies. As underlined by Elena Ferrero, to develop Re4Circular they started raise funds from 2020 and continue to collect them to improve and make more scalable the AI technology.

Challenge 2. Requirements of use of energy

This challenge particularly refers to what have been called 4.0 machines. Of course, the remote cutting room can reduce the waste of materials and make the "reproduction" phase more agile in terms of use of materials and time of processes, this does not reduce at zero the consumption of energy.

This is also a downside connected to the implementation of the blockchain in the transition to the circular economy. In fact, to power the blockchain there is the need of a quite significant amount of energy since as it is constructed is computational-intensive (Abderahman Rejeb, 2022).

Challenge 3. Privacy and security risks

The third challenge is particularly addressed to AI, Blockchain, Big Data and consequentially to the online platforms.

Regarding the privacy issue, these technologies are used to collect information primarily needed to catalogue and sorting used clothes and textiles in order to identify the best match with sustainable purposes. Taking as example Re4Circular, with this service Atelier Riforma makes available a wide database to all the companies that decide to use it as a decentralised platform. Since the Founders of the str-up want to make the model scalable in an international level, they have registered the patent.

With this premise, the privacy challenge is mainly connected to the uncertainty of legal implications and issues as AI use can pose legal questions in the realm of intellectual property rights and ownership. Without the registration to the competent authorities, AI

technologies (as an explanatory example) can be easily replicated suffering about privacy legitimacy (Natter, 2020).Other problem related to privacy is the possibility to suffer hacker attacks since those technologies work mutually with the Internet.

There are some doubts about the security of the blockchain since many business data are collected and stored. Particularly referring to the application to those sustainable business models in the fashion industry, false information can still be held into a blockchain, hindering in this way the truthfulness of data. This could be a general problem related also to the other technologies mentioned (SDA Bocconi - School of Management, 2021).

Challenge 4. Difficulties of integration with existing systems

The tech innovations and the application of industry 4.0 in the fashion industry is still quite on the process step. For this reason, the likelihood to invest in something unexpected reduces the willingness to implement new technologies in the desired sustainable activities and to embrace the technological transition to make the fashion industry even more circular, companies should be open, willing to take risks and have a clear organizational reconstructing strategy.

Challenge 5. Data collection complexity

Data storage represents a scalability issue as it requires time and competencies. This challenges particularly refers to AI, Blockchain and Big Data in which the transaction needed to be handle are many. This could be resulted in the slowdown of the process of data collection, also mainly due to the immaturity of the technological innovation applied in the circular business model of the fashion industry.

Challenge 6. Need of new professional profiles and competencies

The implementation of new technologies has necessity of availability of well-skilled experts in order to have a proper adoption. In addition to knowledge domain and more generally all those competences related to the traditional fashion system, the “4.0

employee" must possess transversal knowledge of a social, managerial and problem-oriented orientation.
In practice, the job enrichment process involves not only the need of training the staff in the use of new enabling technologies, but from a profound rethink of the very role of work, which itself, will no longer be of a merely executive nature, but also as regards the less qualified professions, will have strong areas of autonomous decision-making autonomy.

The challenges will be address to each of the previous technologies in *Table 12*, the presence of a thick underlines the fact that there is interlocking between the technology and the difficulty identified.

Table 12. Collecting tech innovation applied in the fashion industry and challenges to foster application

TECNOLOGIES/ CHALLENGES	**AI**	**Blockchain**	**4.0 Machines**	**NIR**	**Big Data**	**IoT**	**Digital platforms and mobile applications**
Costs and complexity		✓	✓	✓	✓	✓	
Requirements of use of energy		✓	✓				
Privacy and security risks	✓	✓			✓		✓
Difficulties of integration with existing systems		✓	✓	✓			

Data collection complexity	✓	✓			✓		✓
Need of new professional profiles and competencies		✓	✓				

Source: Elaboration from (SDA Bocconi - School of Management, 2021) and (Ari Happonen, 2020).

Conclusions

Citing Bedàt: "The global fashion industry and the global economy are not a force of nature unable to be tamed. They were designed and can be redesigned just like our jeans. The choice is ours".

Taking this quotation, from the research it has been pointed out how it is possible to reshape the linear model upon which the fashion industry is based. There is no more time left for unsustainable choices and all the actors involved in the fashion supply chain need to take real and impacting actions. As pointed out by the analysis conducted in *Chapter 1*, the enormous magnitude of the industry (with an estimated worth value of $ 2.5 trillion in 2020) causes many problems as GHG emissions, water overconsumption, emission of toxic substances and a huge amount of waste, that no longer can be hidden and ignored.

The shift to a circular model represents a big challenge in terms of needs of new investments, infrastructure, companies' reorganisation and technological innovations, but at the same time it can lead to the pursue of the Sustainable Development Goals. For these many reasons, the study has been done with a positive point of view, identifying previously what are the main hotspots along the value chain but then trying to provide real solutions on how the circular shift is possible.

Sustainable business modelling and then the application of innovative technologies have been the centre of analysis, where the result shows how the upcycling and renewal economic approaches seems to match perfectly with the technological tools since they can be implemented in the different stages involved in the recreative processes.

In details, *Chapter 2* has focused the attention on some revolutions in terms of business modelling in the fashion industry. From the resale to rental, from the recycling to the co-creation and finally through the upcycling and renewal, this part attempted to shed light on how sustainability can be integrated into the classic business model of fashion industry, how those practices can foster the decrease of raw material usage and waste, transparency and traceability, what are the main forces influencing the actions taken and what the next steps to develop further these approaches.

For each business models, different companies and start-ups have been categorised to show the best practices trying to provide a sort of open recommendations to economic actors of the sector.

Through the research and analysis presented in this thesis in conjunction with interviews' insights, data and information gathered through webinars and online conferences, it has been set some priorities that need to create a path in the restructuring of the business model towards the fashion industry is based upon, in details: importance to recreate the concept of purchase choices, extension of products' life, need of transparency and traceability thanks also the use of new technologies.

As consumers, we should be aware of our purchase choices and we should adopt a conscious and healthy relationship to buying. Sustainability is taking more awareness between consumers, especially for the youngest generations as Gen Z. Consumers have the power to speak through their buying habits. If simply we are starting slow down the purchase of fashion items process, we can begin having positive gains on this off the rails industry. It is fundamental to change the mentality and consequently the way if acting, buying used or pre-loved clothes, rent fashion items and co-create collections are some of the sustainable possibilities available. The benefits towards these new purchase habits are many as the fall of CO2 emissions, reduction of virgin materials use, decrease in water consumption and pollution. On the other hand, consumers can exploit the possibility to more accessible wardrobe, unique pieces and a wardrobe that is never old.

Previously it has been cited as *Chapter 2* has been focused on the analysis of innovative business models and what it is possible to appreciate is that between the main purposes of each of them is to extend the life of every single item. The approach is different based on the different process performed but the concept remains the same: every garment needs a second opportunity.

As final key point, the study reveals that new technologies such as Artificial Intelligence, Blockchain, Internet of Things and online platforms can play a critical role in the circular economy realisation. The possibilities of the technologies in terms of more agile supply chain, increase of transparency and extension of product lifecycle are attracting start-ups,

companies and organisations to stive in the investments, construction and implementation of tech CE practices. As seen with the case study of Re4Circular, used clothes, textiles leftovers and deadstock can be rightly directed to a creative repurposing, reuse or recycle in this way increasing the life of every single item and reducing the revealed 80% of clothe ending up in landfills after only few uses. The transition to a match between sustainable business modelling (in particular referring to the upcycling and renewal ones) and the technology is not simple, it asks continuous improvements, investments by companies, governments and institutions and the development of new professional skills.

For fashion sector, sustainability and innovation in business modelling is the chance to transform the huge unsustainable industry into a more regenerative model where the environmental and social challenges that exist in its global value chain can be addressed. The transition required is not easy and is significant, but with all the stakeholders aligned and use of new technologies, the fashion industry has a real opportunity to drive sustainable transition and establish a world leading circular ecosystem where creativity, uniqueness and beauty is retained, but at the same time the natural resources overexploitation as well as unproper labour conditions are banned.

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References

Abderahman Rejeb, K. R. (2022). Barriers to Blockchain Adoption in the Circular Economy: A Fuzzy Delphi and Best-Worst Approach. *Sustainability* , 1-23.

Accenture. (2020). *Threads That Bind. Transforming the fashion supply chain through transparency and traceability.*

Accenture Strategy & Fashion for Good. (2019). *The future of circular fashion. Assenssing the variability of circular business models.*

Adriana Bujor, L. A. (2017, December). Co-creation in fashion industry: The case of Awaytomars. pp. 22-25.

Ari Happonen, M. G. (2020). *Exploring Industry 4.0 Technologies to Enhance Circularity in Textile Industry: Role of Internet of Things.*

Atelier Riforma. (2022). *Re4Circular - Tech for circular fashion.*

Bédat, M. (2021). *Unraveled. The life and death of a garment.* New York: Portfolio / Penguin.

Casadei, M. (2019, July 2). Moda a noleggio: il business conquista le donne italiane. *ilsole24ore*.

CBI - Ministry of Foreign Affairs. (2021, August 30). *The European market potential for recycled fashion.* Retrieved from CBI - Ministry of Foreign Affairs: https://www.cbi.eu/market-information/apparel/recycled-fashion/market-potential

Clemente Tartaglione, S. C. (2013). *Il "fine vita" dei prodotti nel sistema moda.* Roma.

Cline, E. (2019). How Sustainable Is Renting Your Clothes, Really? *ELLE*.

DessYouCan. (n.d.). Retrieved from https://www.dressyoucan.com/come-funziona

DrexCode. (2021). *About us*. Retrieved from DrexCode: https://drexcode.com/it/chi-siamo/

ECOALF. (2021). *History*. Retrieved from ECOALF: https://ecoalf.com/en/p/history-99

ECOALF. (2021). *Materials*. Retrieved from ECOALF: https://ecoalf.com/en/p/materials-80

Ellen Macarthur Foundation. (2017). *A new textile economy: Redesigning fashion's future.*

Ellen MacArthur Foundation. (2017). *A New Textile Economy: Redesigning Fshion's Future, Circular Fibres Initiative.*

Ellen Macarthur Foundation. (2021). *Circular business models: redefining growth for a thriving fashion industry.*

Ellen MacArthur Foundation. (2021, November 23). *The social fashion rental app: By Rotation.* Retrieved from Ellen MacArthur Foundation: https://ellenmacarthurfoundation.org/circular-examples/by-rotation

European Environment Agency. (2014). *Environmental indicator report 2014. Environmental impacts of production-consumption systems in Europe.* Luxembourg: Bart Ullstein, Peter Saunders, Helen de Mattos (Banson/World Spotlight). Retrieved from https://www.eea.europa.eu/publications/environmental-indicator-report-2014

European Environment Agency. (2021). *Resource efficiency. Plastic in textiles: towards a circular economy for synthetic textiles in Europe.*

FABSCRAP. (2021). *FABSCRAP endeavors to end commercial textile "waste" and maximize the value of unused fabric*. Retrieved from FABSCRAP: https://fabscrap.org/

FABSCRAP. (2021). *FABSCRAP provides convenient pickup and recycling of textiles for businesses in New York City and Philadelphia*. Retrieved from FABSCRAP: https://fabscrap.org/recycle

Fashion Revolution. (2019). Retrieved from What's in our clothes and how does it affect the oceans?: https://www.fashionrevolution.org/whats-in-our-clothes-and-how-does-it-affect-the-oceans/

Fashion Revolution. (2020). *The impact of Covid-19 on the people who make our clothes.*

Ferrero, E. (2022, April 8). Atelier Riforma. (T. Zamengo, Interviewer)

Ferrero, E. (2022, February 17). La tecnologia per creare una filiera circolare. (F. Pistoletto, Interviewer)

Fiscale, A. (2021, March 11). La moda sostenibile di Progetto Quid. (E. Moscaritolo, Interviewer)

Fiscale, A. (2022, February 11). Progetto Quid: towards an environmental and socially responsible company. (T. Zamengo, Interviewer)

Gervasi Emma, M. s. (2021). *La transizione del settore della moda: criticità e soluzioni.*

Global Fashion Agenda (GFA) & McKinsey&Company. (2021). *Scaling Circularity: Lessons learned from the Circular Fashion Partnership for building pre-competitive collaborations to scale upstream circular fashion systems.*

Global Fashion Agenda (GFA) & The Boston Consulting Group (BCG). (2017). *Pulse of the Fashion Industry.*

Hill, T. (2020, October 26). The Renewal Workshop. (T. Zamengo, Interviewer)

Huynh, P. H. (2021). Enabling circular busines models in the fashion industry: the role of digital innovation. *International Journal of Productivity and Performance Management*, 870-895.

Huynh, P. H. (2022). Enabling circular business models in the fashion industry: the role of digital innovation. In *International Journal of Productivity and Perfromance Management* (pp. 870-895). Emerald Publishing Limited.

ILO. (2013). *Marking progress against child labour. Global estimates and trends 2000-2012.*

Institute of positive fashion. (2021). *The circular fashion ecosystem. A blueprint for the future.*

lablaco. (2020). *Year Zaero. Circular Fashion report 2020.*

Leblanc, R. (2020, January 29). *Automated Textile Sorting for Recycling.* Retrieved from the balancesmall business: https://www.thebalancesmb.com/automated-sorting-for-textiles-recycling-2878011

Maddalena, R. (2020, November 16). *Il gruppo Reda si compra Lanieri, l'e-commerce italiano che vuole digitalizzare la sartoria*. Retrieved from Forbes: https://forbes.it/2020/11/16/lanieri-l-e-commerce-di-sartoria-passa-nelle-mani-di-reda/

Manzi, C. (2020, February 11). *Le strade di Milano*. Retrieved from REVEST Milano | Renting the haute couture: https://le-strade.com/revest-milano-renting-the-haute-couture/

McKinsey & Company and Global Fashion Agenda. (2020). *Fashion on climate. How the Fashion industry can urgently act to reduce its greenhouse gas emissions.*

Moulds, J. (2015, January 19). Child labour in the fashion supply chain. *theguardian*.

Natter, B. (2020, October 12). *Artificial Intelligence and Its Impact On The Fashion Industry: Contemporary Legal Considerations*. Retrieved from JDSUPRA: https://www.jdsupra.com/legalnews/artificial-intelligence-and-its-impact-85022/

Orange Fiber. (2020, May 2). *Circularity in Fashion – The Vision & Values Behind Our Brand*. Retrieved from Orange Fiber: https://orangefiber.it/brand-vision-and-values/

Peterson, M. G. (2020, November 13). *Second-hand platform "Vinted" is minting a new app— can it merge its nearly 9 million users?* Retrieved from OMR: https://omr.com/en/vinted-bold-move/

progetto Quid. (2020). *Passione per la Bellezza e per l'Innovazione Sociale*. Retrieved from progetto Quid: https://shop.progettoquid.com/chi-siamo-moda-etica-made-in-italy/

progetto Quid. (2020). *Scopri i nostri tessuti*. Retrieved from progetto Quid: https://shop.progettoquid.com/i-nostri-tessuti/

PwC. (2020). *Global Consumer Insight Survey Pulse.*

pwc. (2021). *Re-fiber: Il futuro delle fibre tessili è sostenibile .*

Quantis. (2018). *Measuring Fashion. Environmental Impact of the Global Apparel and Footwear Industries Study.*

Regan, H. (2020, September 29). Asian rivers are turning black. And colorfoul closets are to blame. *CNN*.

Ruben, A. (2021, December 10). *The Outside View: With Resale Growing Fast, Why Are So Many Brands Handing Their Customers to Third-Party Marketplaces?* Retrieved from WWD: https://wwd.com/business-news/business-features/outside-view-andy-ruben-e-commerce-resale-marketplace-1235007119/

SDA Bocconi - School of Management. (2021). *Monitor fo circular fashion - Report 2021.* Milano.

Sita Mishra, S. J. (2020). The anatomy of circular economy transition in the fashion industry. In *Social responsibility journal* (pp. 524-542). Emerald Publishing Limited.

Smithers, R. (2017, April 6). Britons expected to send 235m items of clothing to landfill this spring. *The Guardian*.

Stuffstr. (n.d.). Retrieved from https://www.stuffstr.com/

Sustain Your style. (2020). *Working conditions in the Fashion Industry*. Retrieved from Sustain Your style: https://www.sustainyourstyle.org/old-working-conditions

The Renewal Workshop. (2020). *Leading circular - Pathways for evolving apparel and Textile Businesses from Linear to Circular.*

ThredUp. (2020). *2021 Resale Report.*

Thumwood, A. (n.d.). *sumup. Business Guide*. Retrieved from sumup: https://sumup.co.uk/business-guide/vinokilo-vintage-clothes-modern-thinking/

Torino social impact. (2022). *Must Had Srl Società Benefit*. Retrieved from https://www.torinosocialimpact.it/ecosistema/must-had-srl-societa-benefit/

Tossavainen, M. (2019, May 9). *Efficient textile recycling with NIR Sprctroscopy.* Retrieved from Spectral engines: https://www.spectralengines.com/blog/efficient-textile-recycling-with-nir-spectroscopy#:~:text=NIR%20technology%20can%20be%20used,well%20as%20cotton%2Fpolyester%20blends.

UN Environment Programme . (2020). *Sustainability and Circulairy in the Textile Value Chain - Global Stocktaking.* Nairobi, Kenya.

Un environment programme. (2018, Novembre 12). *Putting the brakes on fast fashion*. Retrieved from unep.org: https://www.unep.org/news-and-stories/story/putting-brakes-fast-fashion

UNECE. (2018, July 10). *UN Partnership on sustainable fashion and the SDGs.* Retrieved from https://unece.org/DAM/timber/meetings/2018/20180716/UN_Partnership_on_Sustainable_Fashion_programme_as_of_6-7-2018.pdf

Uva, D. (2020, February 18). *DressYouCan, la startup italiana per cambiare look 365 giorni all'anno*. Retrieved from Forbes: https://forbes.it/2020/02/18/fashion-renting-dressyoucan-app-noleggio-abiti-firmati/#:~:text=Fra%20le%20pi%C3%B9%20diffuse%20c,fra%20amiche%20%E2%80%93%20racconta%20Maestro%20%2D.

VEGEA. (2021). *COMPANY: Biomaterials for fashion, furniture, packaging, automotive & transportation*. Retrieved from VEGEA company: https://www.vegeacompany.com/company/

VEGEA. (2021). *Sustainability*. Retrieved from VEGEA comaony: https://www.vegeacompany.com/sustainability/

Walker, H. (2020, February 27). Guest expert: The Queen of Milan Designer Resale. (Italist, Interviewer)

Wrap. (2017). *Valuing Our Clothes: the cost of UK fashion.*

Appendix: Interviews

THE RENEWAL WORKSHOP

Tuesday, 10/26/2021 8 am PST (5 pm CET)

Taylor Hill, Brand Partnership Manager at The Renewal Workshop

1. **The main purpose of the Renewal Workshop is to make clothes' life longer and to do so you make partnerships with different brands such as The North Face or Patagonia. Which are the main factors to take in consideration when deciding to set a partnership?**

   The most important factor that the Renewal Workshop takes in consideration when deciding to make a partnership with a brand is the willingness and interest in investing in circular economy. Starting with this deep interest in circularity, the Renewal Workshop is able to set partnerships with different kinds of brands such as fashion brands, outdoor brands and in this way, we can work with different types of products. I believe the commitment is the most important factor to set a partnership and join our project.

2. **What are the main challenges that fashion companies are facing during the last years in terms of sustainability? What are the most important impacts of your project on the textile and fashion industry?**

   There are a lot of things that are impacting brands in terms of sustainability, for example higher expectations because customers are really asking companies not only to be sustainable but also transparent, and their commitment to sustainability. I think brands are highly accountable for the first time. Companies have to manage products that are unsellable or from past seasons, ecommerce returns even if most of these garments are almost perfectly good but it is hard to find valuable channels for them and so I think the most positive solution is services like the one the Renewal Workshop provides. I also think these technologies of pre-cycling are a big challenge and it is the final frontier for this project.

3. **Connected to this last point, do you think there are enough technologies to enable this revolution in terms of fashion sustainability or is there a lack of them? Do you think Governments should invest more in these technologies also to keep up with environmental standards that they are setting up for the next few years?**

   In terms of recycling technologies, I think there is a huge gap. Most textiles can be recycled in their current form, especially any mixed materials so we see opportunity for mono materials like cotton and polyester. We are very optimistic that there will be more sophisticated technologies in the future available to recycle these products and for this reason we support R&D.

4. **As a result of your very innovative project and partnerships with well-known brands that are closely connected to a young customer base; which are the reasons that should increase the purchase choice towards products that can be considered circular?**

   There are a lot of benefits connected to that; we are doing something good for our planet, that is good for the economy, and it is investing in new business models and secondly these types of clothes are more affordable for people who like a brand but are not able to buy a piece when it is completely new. We should also keep in mind that to have a good resale program the quality has to remain high even if we manage second-hand clothes and this is connected to longevity, and this gives the opportunity to customers to have more confidence in the products they are purchasing and the availability of a premium experience because there almost no differences between completely new products from renewed products.

5. **What next for the Renewal Workshop? Are you working on new projects?**

   As we are new as a company, we are now working on some new partnerships to include in our renewal project and we are very excited for the way we are working in terms of making garments' life longer and being engaged in the circularity of the fashion industry.

PROGETTO QUID

Friday, 02/11/2022 10 am CET

Anna Fiscale, CEO at Progetto Quid

1. **What was the first idea to launch Progetto Quid? What are the competencies that you put in action at the beginning of your business?**

   In 2012, with a group of friends from different backgrounds, I decided to launch a social, ethical and environmentally sustainable reality.
   Working in contact with the world of women, searching daily for new spaces for female empowerment during my experiences in India and Haiti but also as a direct link with a past possessive relationship, I realised that fragility can be overcome, just by looking at the world upside down. So, in 2013 Quid was founded in Verona, a social cooperative which, through its ethical fashion brand - Progetto Quid - offers opportunities for stable employment and job growth to those who find themselves in fragile working conditions, with particular attention to women.

2. **During my research, I found there are many difficulties that star-ups in the circularity fashion field have to face. What were the main difficulties that you have to overcome and how do you that?**

   When I decided to launch Progetto Quid, since I was at the of my studies and I was 25, I have not lot of entrepreneurial experience and for these reasons the interlocutors did not have so much trust and at the beginning I also lacked credibility. Other difficulties that we took in consideration when we launch our start-up can be summarised as follows:

   - the sustainability (environmental and social) concept in the fashion sector was not a recognized problem as it is now;
   - Problems related to the market conditions at that time: economic and financial crisis, labour costs, offshoring of production and emergent brands vs established brands;
   - Difficulties to find the right spots to sell our collections

As already mentioned, I involved in this project a group of friends with different competencies to realize the first business plan, having the big opportunity to show it to Dr Veronesi, the Founder and CEO of the Group Calzedonia, that have provided the textiles leftovers and €15 thousand from his founding. The fact that we found Dr Veronesi available to invest in our project and give trust has helped us to launch Progetto Quid.

3. **Why your company is different from the other circular business model in the fashion industry? Which was the process to have success?**

The ethical fashion is considered in general to be untrendy, but our purpose is to create collections that are sustainable but at the same time follow the trends. For us, the fact that we use leftovers does not represent a limit but a strength, because we are able to use high-quality fabrics also from luxury brands and provide fashion items at accessible prices (for example on average an our-production dress costs between 50-70€). Most of times, the limits of ethical fashion are on the one side to not be in line with the tastes of the moment or on the other side be out the range in comparison to the other ethical fashion brands.
We believe that the ethical fashion should be democratic and not only for a niche.

4. **How does Progetto Quid change over the years and how has the market evolved in comparison to the year of launch your social cooperative?**

Nowadays there are more demand for ethically and environmentally sustainable products and also consciousness and desire to purchase in different way as done before.
I believe that the Covid-19 pandemic has represented to rethink about what is really necessary also related to the fashion products; abandon the take-use-waste concept and try to buy with attention.

5. **In which ways companies decide to provide Progetto Quid the textiles leftovers?**

Progetto Quid makes its creations almost exclusively from textile leftover or surpluses, often too small for large production for large-scale production or discarded due to trends or fabric characteristics. Thanks to a network of 52 fabric suppliers (stockists and brands including Calzedonia and Burberry), Progetto Quid is able to extend the life cycle of fabrics and shorten the carbon footprint of tens of thousands of metres of fabric each year, with a total 1.200 km of recycled fabric (2013-2020). The 90% of the fabric we use for our collections comes from within a 250km radius of Italy (as it is possible to see in the below Figure) and 10% from Spain, England and Croatia.

Figure 1. The Italian textiles suppliers of Progetto Quid

Source: (Fiscale, La moda sostenibile di Progetto Quid, 2021)

Each year we produce 100 thousand clothing pieces and 700 thousand accessories, the 70% of these items are made using the recycled fabrics that we gather from donations and 30% from the leftovers we buy. Those collections are sold in our direct shops or by our partners such as Calzedonia, Zalando, NaturaSì and many more.

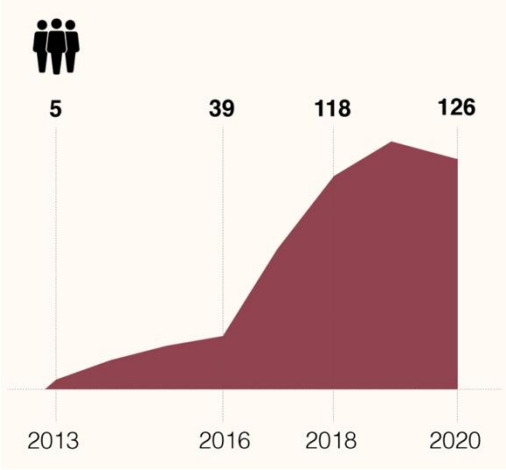
6. **I mean, your company is said to be sustainable, so do you choose textiles that are environmentally sustainable (I think about textiles made by the orange scraps)?**

   For our company is difficult to take in consideration those fabrics as they are often really expensive (on average 10/20 € for each meter) and it is not possible to make profits after the production.

7. **As the fashion industry is said to be unsustainable also on the social front, how do you choose the employees? What do you recommend to the fashion industry based on your experience?**

   Where the system sees only a problem in terms of social sustainability, Quid sees a fragility to be welcomed. For this reason, in 2020, of the 150 people hired by the cooperative, 84% are women and the majority are people with a history of fragility, a term that includes invalids, ex-convicts or ex-drug addicts, but also women over 50, young NEETs, women victims of trafficking and asylum seekers. Quid also has two workshops in the Montorio prison near Verona, in the women's and men's sections, where about 10 inmates are employed. In the following graph is possible to observe the increase of women employed by Progetto Quid since its foundation to the most recent data collected.

   Graph 1. Employment rates through years



   Source: (Fiscale, La moda sostenibile di Progetto Quid, 2021)

8. **How is divided your business? Is Progetto Quid only a direct to consumers or also a B2B project? How do you make your brand knowledgeable to the possible partners?**

   Progetto Quid does business in the B2C and B2B segments.

   The B2B has started with the support of Dr Veronesi and the founds he provided back in 2013. Nowadays, we collaborate with 25 brands, of which we are ethical suppliers, which include fashion but also lifestyle brands. Among the co-branding activities, Progetto Quid can boast a partnership with Calzedonia, as already mentioned, but also with NaturaSì, Vivienne Westwood and Zalando.
   To reply to the question in which ways we found our partners, in the past years we usually try to reach them through direct contact for example using LinkedIn or making visits to companies to show our work. As Progetto Quid is a more mature brands, in the last few years different companies directly contact us to establish a partnership.

   As an independent brand (B2B business), we have 10 stores and stores throughout Italy such as in Verona, Bassano del Grappa, Milan and in other locations.

9. **As your company is very successful, I think this business model can be replicated in an international context. Do you know any competitors and in which ways you are able to remain on top in the fashion upcycling sector?**

   I think the business model by which Progetto Quid operates is a very successful one and can be implemented in other countries. However, it is important to consider that in order to be able to expand the upcycling business model in the fashion industry, there is the need that the country in which the companies operate have a strong textile tradition (as Italy has) and as a direct connection where it is easy to have access to textiles. For example, we have the luck to have different industrial districts specialised in the textile sector.
   If we think to our direct international competitor “People Tree”, the pioneer of Fair trade the fashion industry, they outsourced the collection of textiles as well as

production to developing countries, so I think our strength is to have the chance to have donations from our country-based fashion districts but also the production.

10. What are the next projects for Progetto Quid?

Our next aim is to expand the partnerships with other companies because they commit to us continuative collections. The other goal is to consolidate our shops that in this moment are suffering a bit. The idea is to keep our two divisions B2B and B2C and develop both. We are working now very closely with IKEA, Zalando, Unilever. We want also to the make stronger our e-commerce.

ATELIER RIFORMA

Friday, 04/08/2022 3 pm CET

Elena Ferrero, CEO and Founder at Atelier Riforma

1. **Where the idea of developing an Artificial Intelligence based technology comes from? And why do you decided not to develop a technology based on the Internet of Things (in particular referring to the RFID) that seems to be useful and widely applicable in the sorting phase?**

   Normally, the confront is done between the spectrometry NIR technology and the Artificial Intelligence. Our idea of AI (computer vision and languages lecture) is born thanks to a meeting with another reality that is a sort of research Centre and is also a company that develops technologies based on the Artificial Intelligence. Talking with a friend of mine involved in that company, I explained the complexity of collecting and sorting used garments that are commonly shared by companies and start-ups working like us. In most of the cases, the sorting process is done manually, and it is a long step (ndr time consuming but information loss). One of the problems is when companies buy those materials, they do not collect data about the garments, but simply they are divided and that information are lost. Atelier Riforma is working on a technology that help to gather all the characteristics of the garments, directing them to the right direction (use, reuse, recycle, upcycle) and record all these data to transmit it to the company in charge of the recover that fashion item.

   Through our research, for us the AI has resulted to be the best solution. Re4Circular simply works through the photo of the garment and the label that allow the collection of information such as type, season, colour, material, size and these data are collected together with the photo and then the AI process them through an algorithm that created a digital copy in order not only to sort the item but also digitalizing it and put on sell. This operation helps to reduce time and give huge advantages in terms of sustainability. As you know the value chain is completely offline and very long with a low rate of transparency, in this way digitalizing the garment the value chain shortens.

The main limit connected to the AI technology is that not all the collected used clothes have no labels, or it is no longer readable and it represents a disadvantage since in there, you can find most of the information as the materials. For this reason, soon we are going to match the AI with the spectrometry NIR to identify the fashion item's material in case there is no label.

In this moment, the technology that is used in the cataloguing phase for used garments are mostly the spectrometry NIR, two realities are making the difference and they are Fibersort and Phycbet. This technology normally identifies the colours and the material and since we want to widen those range of information, we developed the AI technology that allow to have a larger data base. All the possible details that is possible to gather with Re4Circular are important for the recovery of the cloth, because the NIR technology is only used for a range of waste, the garments that could not be longer reused but intended to be recycled, that have a lower economic value in comparison to the other circular possibilities as reuse and upcycling.

2. **Can the RFID a technology that can be introduced in your circular business model? I mean, the RFID is an expensive technology and I assume that the start-ups like yours can face problems in terms of availability of fund to invest on those innovative technologies.**

   Indeed, we are going through the collection of funds in this moment. Re4Circular is now a prototype that it will be ready starting from the beginning of May 2022, without the AI. It is digital cataloguing platform that in order to make efficient all the process but has not the automation of AI yet. To integrate the AI, we are waiting to gather more funds.

3. **I see that the data for Re4Circular technology are collected manually from the photo of the cloth. Could you please explain further this process?**

   In the prototype it is done all manually, simply the operator will take the photo of the garment and will choose the other characteristics from a flag plate. With the AI

application, only with the photo of the cloth and the label will be possible to process all the information that in our prototype are done manually.

4. **Since your project seem to be applicable in different realities working in the fashion industry, do you have any companies that have expressed their interest in your technological platform? In case of positive answer, which type of brands are interest to join your digital shift?**

   Fortunately, we are seeing good chance to make Re4Circular available to different brands, but this is thanks to the fact that we have started to develop the sorting platform to respond to an increasing need. Our initial activity was to collect used clothes, sort and then distribute them to a sartorial network that upcycle clothes and after this process we sold those garments to the final customers through an e-commerce. We have developed a partnership with realities that already made the upcycling, especially with no-profits associations.

   These realities will be the first to apply our AI technology and for me it is important to think that they are different in terms of composition, from the classic LTD, social cooperation to no-profit associations. We can be useful to all those different facets of operator, imagine the case of no-profit. They collect used clothes but at the same time they are overwhelmed by them, and they end up to not find the right placement, with a high percentage to become waste and at the end landfilled. Thanks to our technology, the part of garments that does not suit with the people that ask for these used garments could be resold by our digital platform and invest those money in their projects.

5. **That's a good point. But since most of the problem of the unsustainability of the fashion industry comes from what we all know as fast fashion, could Re4Circular applied by the fashion brand that operates in this segment?**

   Of course, we are gathering consensus from some companies that creates garments for the fast fashion segment. There are many fashion brands that need to manage the deadstock, in the fashion industry this represents a big problem that

can no longer be solved as done in the past (landfilled it or incinerated). The brands that begin to use our technology have an opportunity to manage the deadstock in a circular way and this is the main reason why they are asking us when our model is ready to be introduced in their daily activities. They want to engage in our technology not only to manage the deadstock but also because many brands are activating take-back services. Those brands collect the used clothes but then they do not know how to manage them, because it results they do not have the capabilities and infrastructures to do the sorting and start the reuse, recycling or upcycling activities. For the fashion brands it is not an option to resell the used garments through for example their online platform because this would be "harmful" for their brand value.

There is a strong need from the fashion brands to use our technology also for transparency purposes and report of their activities to the clients, it is an instrument to testify there are doing sustainable processes in terms of recovery of used clothes.

6. **As you mentioned, the Artificial Intelligence technology developed by Atelier Riforma will be connected to an Online Marketplace. Are those fashion brands that wants to use the AI technology going to also use the Online Marketplace?**

Yes, our Online Marketplace is a B2B platform. The buyer of the Online marketplace are all operators that operates in a circular way in the fashion industry, in particular: used clothes shops, companies that perform textile recycling activities, that have the necessity of the availability regarding the material compositions of the garments or brands that to the tailoring upcycling, that need to see the pictures of the different items to make their collections in terms of creativity.

Nowadays the big problems of the mentioned realities are that most of the time they buy the garments for their purposes without seeing them before the tooth, they buy for example a box of 200 kg from the top category or second-hand but without choosing what is inside. This process makes waste time since they have to resort the items and find clothes that does not match with their business activities.

7. **Could the Online Marketplace be extended to the final customers, so becoming also a B2C platform? I mean, after for example the creative upcycling processes the customers can directly purchase the fashion items through the online platform.**

   This could be a future prospective but now we are focusing on doing one thing but in the best possible way, in our case the sorting process through an AI technology. At the beginning of our star-up we wanted to do all the activities but by the time we have seen that is not a scalable business model, it is better to focus on one phase of the circular upcycling process.

8. **In my last Chapter of my Master Degree's thesis I implement a business model based on the upcycling and renewal in the fashion industry where innovative technologies and the Industry 4.0 could be implemented in the different steps of the sustainable BM. Do you think that is possible to implement those innovations all at the same time by each company or is it better to create a sort of "companies and start-ups chain" in which each of them is specialised in something and this could improve the sustainability of the fashion industry?**

   In my opinion, the best solution is that each of the realities working on the fashion upcycling specialises in something. For example, MustHad functions only has sales platform and this clever. In this specific case, customers can purchase directly to the digital platform the upcycled clothes.

   Regarding the introduction of machines 4.0 as the remote cutting room could be implemented by a company that perform internally the upcycling process as the case of Progetto Quid.

9. **As final question and close the loop with a sustainable perspective. Could you give some numbers in terms of positive impact thanks to the development of Re4Circular?**

We based on a data that when a second life to a garment is given, the environmental impact is reduced by 79%. Since 100 billion of garments are produced every year, emitting 1.7 billion ton of CO2 and at the same time 80% off those clothes end up in landfills, we can make a huge difference decreasing the percentage of items that are disposed. The positive side of our technology is that it is a service, we do not use internally but we provide the AI technology to all the fashion realities in Italy but also in Europe. For this reason, we have registered our provisional prototype and this year our final prototype to make possible the spread of this instrument in an international level.