Towards a Circular Supply Chain for Textiles: an overview of cases

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Abstract: The fashion industry is currently the second most polluting one in the world, after the oil and gas sector. Moving to a Circular Economy for textiles is thus a topic of great concern and relevance. However, and even though Circular Economy is now on the rise in the policy agenda, this model is still not applied on a large scale. Providing success cases of companies operating in the fashion industry who succeeded in implementing Circular Economy is of paramount importance for the widespread of this paradigm. Thus, this paper carries out a multiple case study of companies that, by operating in the wool supply chain, has successfully started to provide a Circular Economy solution. Put together, these cases become an excellent example of a Circular Supply Chain for textiles based on recycled wool, since they reduce the environmental impact and contribute in closing the loop. The cross-case analysis led to the identification of a set of key elements that are needed for introducing Circular Economy in the textile industry. As a result, legislation, product design, certification labels, traceability and competences emerged as focal points on which to invest in order to successfully set up a Circular Supply Chain for textiles. Although preliminary, this exploratory research lays the foundation for a stronger and more systemic understanding of the role of the ecosystem in a Circular Supply Chain architecture, at least for textiles.

Keywords: Circular Economy; Fashion industry; Sustainability; Textile; Circular Supply Chain

1. Introduction

The transition towards a Circular Economy for the textile and clothing industry is a topic of major concern, since the fashion industry is the second most polluting industry in the world (after oil and gas): each year it consumes 98 million tons of non-renewable resources, over 93 billion m^3 of water and emits about 1.2 billion tons of CO_2 (Ellen MacArthur Foundation, 2017). Nowadays, the 63% of the global fibres production are derived from petrochemicals as polyester, while the 22% is derived from cotton (Fischer and Pascucci, 2017; Sandin and Peters, 2018). In the last 15 years, with the spread of fast fashion, clothing production has doubled. While on one hand the production has increased, on the other hand the life of a garment has been drastically reduced: overall, the number of times a garment is worn before it ceases to be used has decreased by 36% in the last 15 years (Ellen MacArthur Foundation, 2017).

Overall, Circular Economy is gaining great attention as a means to reach sustainability by decoupling economic growth from resource extraction and environmental losses, in a way to substitute end of life with restoration and closed-loop cycles (Tunn et al., 2019). In a Circular Economy, energy and material efficiency is pursued, while waste is turned into raw materials in a restorative and regenerative way (Bressanelli et al., 2019a; Morseletto, 2020). Consequently, energy and material consumption are reduced, products are reused, components are remanufactured, and materials are recycled. To that end, a systemic change in the design of products, business models, supply chains and consumers' awareness should be pursued by companies (Bressanelli et al., 2019b). Products should be redesigned in a way to extend their lifespan and improve their recyclability (Bovea and Pérez-Belis, 2018); business models should be moved towards the offering of the service instead of products, as in the case of pay-per-use or sharing models (Tukker, 2015); supply chain should be closed by collecting products after use for creating value from them (Batista et al., 2018); consumers' acceptance and adoption rates of Circular Economy solutions should increase (Camacho-Otero et al., 2019).

Although Circular Economy is now on the rise in policy agendas, this model is still underdeveloped in practice (Vehmas et al., 2018), and especially in the fashion industry. The Green New Deal of the European Commission (2020) recognizes the textiles as one of the key products value chains where to apply new eco-design measures, product-as-a-service business models and advanced collection, sorting, reuse and recycling activities. Accordingly, textile recycling is a way to implement Circular Economy. However, little is known about how recycling is put in practice, and only 20% of all textiles are recycled – meaning that the 80% is still landfilled and incinerated (Koszewska, 2018; Sandvik and Stubbs, 2019). Moreover, in most cases recycling means downcycling (e.g. using textiles for making cleaning towels), thus very far from what Circular Economy should be in practice (Fischer and Pascucci, 2017).

Unlike polyester, wool fibres has long been compatible with recycling processes, thus reducing environmental impact and contributing in closing the loop (Ravasio and Rodewald, 2018). Wool garments and clothes are produced by complex, global supply chains (Wiedemann

et al., 2020). According to Russell et al. (2016), wool recycling is an important and cost-effective alternative to using virgin fibre. More specifically, previous research shown that wool garments have the potential for two or more usage cycles, for a total active life of 20-30 years. Globally, most of the fibres are polyester-based synthetic fibres or cotton fibres; wool-based fibres are a small niche products – around 5% in volumes (Koszewska, 2018). The district of Prato (Italy) successfully established a woollen industry based on recycling since centuries, where yarns are produced from scraps and fibres obtained from pre- and post- consumer textiles (Borsacchi et al., 2018; Leal Filho et al., 2019). Each year about 22,000 tons of rags are recycled, leading to savings of about 60 million kWh of energy, 500,000 m^3 of water, 650 tons of chemical auxiliaries and 300 tons of dye and about 18,000 tons of CO_2 (Camera di Commercio di Prato, 2019).

Thus, the purpose of this paper is to identify a set of elements that are needed for introducing a Circular Economy in the textile industry, by providing success cases of companies operating in the Prato district that, put together, provide an excellent example of a Circular Supply Chain for textiles based on recycled wool. The rest of the paper is organized as follows. Section 2 presents the methodology. In Section 3, the Prato regenerated wool supply chain is introduced. Section 4 presents the case studies. Lastly, Section 5 discusses the results, highlighting the elements needed to introduce a circular supply chain for textiles, while Section 6 concludes the work.

2. Methodology

To explore the elements needed for implementing Circular Economy in the textile industry, the Prato textile district is investigated. First, secondary sources are analysed to understand and depict the wool regeneration process in a Circular Economy context (Section 3). The supply chain representation is complemented by direct company and plant visits. Then, a multiple-case study methodology is chosen (Yin, 2009). To enhance the validity and the reliability of the study, a research protocol is developed, encompassing four stages: sample selection, data collection, data analysis and results formalization. According to the research protocol, a judgmental sampling technique is used to select cases: companies should: (i.) belong to the Prato textile district, (ii.) being involved in Circular Economy and (iii.) cover different supply chain activities. Four companies have been selected (Table 1): Alpha, Beta, Gamma and Delta meet the criteria and agreed to participate in the study. Their identity is concealed to ensure confidentiality.

Following the research protocol, semi-structured interviews are carried out, and different company roles are consulted. The focus of the interviews is put on the drivers, challenges and enabling factors needed to introduce a Circular Economy in the textile industry. All interviews last between 1-2 hours and are complemented through company visits. All transcripts are coded and validated with the respondents. Secondary sources are used for triangulation. The data analysis and coding is carried out within cases, to search for cross-patterns (Yin, 2009). Data are used to identify key, recurrent elements that are needed for introducing a Circular Economy in the textile industry.

Table 1: Four companies investigated

Company	Supply Chain Role	Turnover	Employee
Alpha	Woollen Milling	10 million €	35
Beta	Carded Spinning	6 million €	10
Gamma	Dyeing	18 million €	160
Delta	Tailoring	0.5 million €	5

3. The regenerated wool supply chain

Prato is one of the most important textile production centres in the world (Borsacchi et al., 2018). According to Borsacchi et al., (2018), the Prato textile district counts about 7,200 companies and 35,000 direct employees, and covers the 17% of Italian textile exports. In the Prato textile district, the regenerated wool production process is not usually fulfilled by a single company performing all the phases (carding, spinning, weaving, dyeing, finishing, to mention a few). Instead, many companies, each one highly specialized in one or more phases, are coordinated by focal firms (yarn or fabric producers). In the following, the overall Prato regenerated wool supply chain is described, focusing on the production processes needed to recycle used clothes (Camera di Commercio di Prato, 2019; Ravasio and Rodewald, 2018). The aim of this process is to recycle clothes and scraps into new fibres, to be used for realizing wovens, knits and new garments. Although the generalization is low, the wool regeneration process can be split into three main steps.

First, materials are taken from both pre-consumer (such as textile production scraps, weaving trims or leftover yarns) and post-consumer (i.e. wool clothing and garments) textiles. In the case of post-consumers, materials generally come from post-consumer traders of garments from all over the world and are received in pre-picked bales. Such materials differ by colour, composition and quality. Then, a manual sorting procedure is carried out. This activity is still done manually, relying on competences of technical personnel (in Italian these workers are called "cenciaioli") who sort materials by colour, material and quality. This sorting activity requires specialized personnel: years of experience are needed to be able, only through the touch, to understand the fibre composition of rags. In this step, all foreign materials (e.g. buttons, zippers or labels) are cut out.

Second, sorted materials undergo a tearing and fraying process. Since wool coming from rugs always contains impurities and foreign fibres, before being recycled it undergoes a *carbonization* process. In this process, sulfuric acid in the form of vapor solution is used for destroying these particles. This step can also be used to remove cotton or other cellulosic material from the wool garments, since the cotton is chemically degraded during this process, thus leaving the wool behind. This phase does not affect the colour and the composition of the material to be regenerated. Before moving on to the next

phase, a worker manually checks the carbonized garments. Then, a *tearing and fraying* phase is carried out through a special "tear and scrub" machine (in Italian called "Lavastraccia") that simultaneously carries out the washing and the fraying phases. Thanks to a set of blades and teeth, the "tear and scrub" machine tears the rags reducing them into threads and shreds. Usually, this is a wet process: the use of water facilitates the sliding of the fibres and allows to obtain longer lengths of regenerated materials compared to those that would be obtained with a dry process. The material is reworked several times to obtain the desired quality, ensuring that the entire rag is converted back into fibres. Lastly, a spin dryer phase dries the materials. In this way, it is possible to obtain the so-called regenerated wool (also called mechanical wool), which is the starting point to obtain the desired regenerated carded yarn. Before that, the colour composition of the final yarn is determined in laboratory. In this step, fibres of different colours are blended to obtain the desired colour. The purpose is to obtain the desired colour outcome (as required by the customer) avoiding the dyeing phase of the fibres. The ability to blend the fibre batches is thus critical and requires personnel with specific skills and competences (in Italian, they are called "feltrinisti"). In the laboratory, the fibre blending is usually done using a lab-scale carding machine, which produce a carded web (containing fibres of different colours) to simulate the outcome of the overall process. This lab-scale carding is done several times until reaching a homogeneous mix, which allows checking the colour according to the customers' needs. It is nevertheless important to consider that it may be difficult to achieve specific colours based on 100% recycled wool. Thus, most yarns and fabrics will contain some small percentage of virgin wool or other virgin fibres (such as cotton, nylon or polyester). At the end of this step, the fibre mix is ready for carding.

Third, and last, the full-scale bulk blending process is carried out through the traditional carding, spinning, weaving (or knitting), finishing and garment-making processes. These steps are the same as those performed for virgin fibres. First, blended fibres are transformed into a carded web through *carding*. Carding is a mixing and disentangling process where fibres are passed through a series of rotating toothed rollers in order to form a rope-like structure. This structure is then turned at approximately 90° to start a second carding cycle, and so on until achieving the final carded web. The carded web is then packaged and sent to the next phases, which consist of spinning, winding on bobbins and delivery for weaving/knitting. The *spinning* phase transforms the carded web into a yarn, thanks to the combined action of stretching and twisting. This phase gives to the yarn the characteristics of resistance, elasticity and strength. Torsion is achieved by rotating a bundle of parallel fibres around its own axis (helical arrangement). Then the *winding* transfers the yarn to bobbins, which are stored and ready to be sent to the next phase of knitting or weaving. *Weaving* is the process that transforms the yarn into a fabric. It is carried out by a loom able to weave weft and warp. Lastly, the garment making phase (finishing) is carried out, which consists of laying and cutting the fabric, assembly, ironing, pressing and vaporization, final control and packaging.

4. Case Studies

In the following, the four case studies that builds a Circular Supply Chain for Textiles are introduced.

4.1 Alpha

Alpha is a family-run company (today it has reached the third generation) in the textile district of Prato. The company was founded in 1951, with initial activities in the marketing and processing of textile raw materials that has been extended, over the years, until turning Alpha in a real woollen mill. To date Alpha offers a wide range of carded yarns and fabrics, together with the marketing of textile raw materials. The company has 35 employees and a turnover of about € 10 million. Revenues are equally split into regenerated wool (33%, sold as raw material), carded yarns (34%, sold to finishing companies) and fabrics (33%, sold to garments making companies). Customers are based all over the world, but especially Italy and Sweden.

Recycling is at the basis of Alpha way of doing business: its objective is to regenerate both pre- and post-consumer textiles, transforming them into top-level regenerated material to be used in the production of carded yarns and fabrics. Every year, the company transforms with its own production plant about 5 million kg of textile waste, mainly coming from post-consumer use and otherwise sent to landfill. As mentioned above, Alpha carries out three main activities: the resale of regenerated wool, spinning (to sell regenerated yarns) and weaving (to sell regenerated fabrics). Thus, the first phase of its production process is the buying of bales of post-consumer garments waste. Sorting and cleaning phases are entrusted to external companies: suppliers carry out selection, dividing clothes into garments sent to reuse for second-hand markets (60%); textiles sent to recycling (38%); textiles sent to landfill or incineration (2%). All within the Prato textile district there are about 100 companies offering this kind of sorting services. Then Alpha carries out all the activities needed to recycle wool fibres, as described in Section 3 (carbonization, tearing and fraying), internally: the company owns a carbonization and a water-shredding plant. A first concern regarding the materials to be recycled arises in this step: if the garment has not been designed with recycling in mind, the entire cloth cannot be further processed. An example is given by woollen garments with gaskets in polyester: since the recycling process is not designed to eliminate polyester (the chemical process is not able to erase plastics), the entire garment is sent to landfill. Since Alpha is a member of a consortium that offers a refining system for the recovery and reuse of wastewater, the water used during the tearing process is treated and subsequently reused for industrial and civil purposes. After the carbonization and raying process, the rags become fibres ready to be processed as regenerated wool. Alpha owns a laboratory where fibres are blended, and colours are tested. The ability of the "feltrinisti" in this stage vital: if they work

well, the dyeing phase can be avoided, saving the related costs and avoiding the connected environmental impact (in terms of chemicals, energy and water consumption as well as CO_2 emissions). Spinning and weaving are all outsourced activities: Alpha collaborates with around 10-12 spinning mills and 3-4 weaving mills. Alpha is certified GRS (Global Recycling Standard), i.e. a certification owned by Textile Exchange (non-profit organization) for the promotion and development of sustainability to increase the use of recycled materials in the final products and reduce and eliminate the damage caused by the production of textile products. According to the GRS, each stage of the production must be certified, and all phases of the supply chain must be managed to ensure the correct identification of the recycled materials, thus ensuring the traceability of the origins, flows and recipients. According to Alpha evidence, the Italian legislation about the End of Waste Directive seems to complicate rather than facilitate the wool recycling process. More specifically, it is not clear which products should be considered waste and which by-products. The company is thus committed in the current working table organized by the Italian Ministry of Environment, in order to make known what is done in the Prato district.

4.2 Beta

Beta is a family-run company founded in 1984. Beta employs about 10 employees and sells regenerated carded yarns to wool mills, for an annual turnover of around € 6 million. The main market is based on Italy (85%), even though the company is also expanding to foreign countries such as Spain, Portugal and Japan. The company has always specialized in regenerating wool, integrating perfectly within the Prato textile tradition: 80% of the volumes are made up of regenerated fibres obtained coming from both pre- and post-consumption processes. Consequently, the strategic goal of Beta is to increase customer awareness from an environmental point of view: carded yarns in regenerated wool have the same characteristics as virgin wool yarns but they lead to environmental advantages as the reduction of water consumption (500 litres less per kg of yarn), lower CO_2 emissions (36.3 kg of CO_2 less per kg of yarn) and the recovery of material that would otherwise go to landfill. As far as customers are concerned, the main difficulty is to make them understand the importance of regenerated carded yarns and their conditions. For instance, very often customers (especially those who are not familiar with the recycling process) ask for particular colours (impossible to be obtained without dyeing) or for materials 100% free of certain chemical substances (impossible to achieve in the case of regenerated wool). In fact, depending on the colour requested by the customer, it is not always possible to offer a regenerated yarn without carrying out the dyeing phase.

The main activity of the company is warehouse management: Beta offers stock-service for their customers, in order to reduce delivery times. Furthermore, marketing, logistics and R&D (the company has a small laboratory to perform chemical tests on materials to be regenerated) are also carried out internally. On the other hand, all the production processes are outsourced, since the company manufactures internally only yarn samples. As in the case of Alpha, also Beta relies on an external spinning mill, while sourcing the regenerated fibres from the so-called "cenciaioli". Since the most important partners are the spinning mills, Beta has established a strong collaboration with one of them. This fact shed light on a limit in the current Italian End of Waste legislation: a large amount of material deriving from pre-consumption is conceived, by the current Italian regulation, as waste and therefore is no longer reusable within the processing cycle. However, it does not even differ from the final product and thus should be considered as by-product. An example is provided by the winding phase in which there is about a 2% of scraps. These scraps would already be good yarns, since they have the same product characteristics but, due to the structure of the current legislation, they should be treated as waste (thus needing special authorizations to be further processed).

As Alpha, also Beta has the GRS certification, since it believes that traceability should be guaranteed. The company is also committed to avoid as much as possible the dyeing phase, since is one of the most polluting, trying to obtain the desired colour by mixing and blending the fabrics to be recycled. However, it is obvious that this is always not possible: as mentioned above, customers' awareness in the choice of colours is vital.

4.3 Gamma

Gamma is a leader in the textile dyeing sector, both in staples and tops. Recently they have also successfully started dyeing textiles directly in the bobbins. The company was founded in 1952 and today is organized in three divisions. Overall, it employs 160 about employees and has a turnover of about € 18 million.

The dyeing of the staples is mainly applied to natural fibres of vegetal origin (e.g. cotton), natural fibres of animal origin (e.g. wool, cashmere, etc.) and synthetic fibres (e.g. nylon, polyester, etc.). Staple-dyed fibres are used in many processes of the textile chain, in particular in carded spinning. These fibres can come either from virgin or from regenerated materials. In fact, depending on the colour requested by the customer, it is not always possible to offer a regenerated yarn without carrying out the dyeing phase. The dyeing of the tops is another type of dye that can be applied to the same fibres of the staples dyeing, but the main difference is that the fibres are worked in the form of combed ribbons. In addition to the dyeing phases, Company C carries out other treatments as flame retardant, antibacterial and water repellent treatments.

Gamma relies on a laboratory able to combine colours on all types of fibres. Studies start from the early stages of colour design and then follows the reproduction in the laboratory, the production and the final quality control. The laboratory also offers services such as the creation of customized colours or the reproduction of colours on samples starting from digital samples.

Sustainability has become a main value of the company, since it pursues responsible consumption and the elimination of chemical and toxic substances from

production processes in the long run. Moreover, Gamma is in fact a plastic-free company. Responsible consumption is promoted through renewable energy (the company has one hydroelectric plant, four photovoltaic plants and a wind turbine). The company also held various certifications, such as GRS and EMAS just to cite few ones. According to Gamma, the current Italian legislative framework regarding End of Waste is becoming less clear, often imposing difficult obligations to pursue. For instance, sorting work in Italy is decreasing because difficulties are increasing due to legislation constraints. The fact that with the current legislation the cost of a regenerated garment is almost as much as the cost of virgin material shows how many problems are still to be faced.

4.4 Delta

Delta is a start-up company founded in November 2017 with the aim of offering clothing and accessories that are locally produced (within the Prato district) and made using 100% recycled textile fibres.

In 2019 the company achieved a turnover of € 300,000 (in 2018 the turnover amounted to € 85,000), employing less than 5 employees. The company sells garments and fashion accessories that are made using 100% recycled fibres. According to the company, it was possible to undertake this kind of project only in Prato: the Prato district is able to cover all the recycling and production phases, starting from the sorting of post-consumption waste to the process of knitwear, thus providing unique skills and abilities in the world. The company exists not only because there are customers, but especially because in Prato there are suitable partners guaranteeing availability and flexibility. For Delta, the main source of competitive advantage is undoubtedly to be inside the Prato district, in order to both exploit the skills and to reduce management costs due to proximity with partners.

Delta sells shawls and shirts in regenerated cotton, sweaters in regenerated denim and sweaters, gloves and socks in regenerated wool. The sales market is 40% Italian and 60% European. The company internally carries out the design, R&D, marketing, communication and after-sale activities. Collection, sorting, manufacturing and transport activities are outsourced. It is thus clear that a strong cohesion and collaboration among the supply chain actors is fundamental. In this regard, Delta collaborates with about 10 companies. A peculiar feature of the process is the avoidance of the dyeing phase, which is very impactful from an environmental point of view.

Even though the collection and the sorting of post-consumer textile waste is outsourced, the company allows customers to book the pick-up of used clothes directly through the company website. However, all the sorting and selection work is done directly by "cenciaioli", who are one of the main partners. This task requires a high degree of experience as well as years of practicing. Moreover, customers can bring their used sweaters directly to the company store for repair or for fibres recycling and regeneration, to transform the old sweater into a new one with the same quality as the original. Even though repair has a lower environmental impact, to date regeneration is the main activity carried out by the company (about 99% of the total). It is important to stress out that, from a regulation point of view, in the case of regeneration the old sweater is initially considered as waste (not by-product). Even though offering regenerated products targeting high-segment customers, the company prices are competitive. This is achieved through three reasons: the adoption of a direct-to-consumer sale model (without the presence of intermediaries), a make-to-order production policy (which minimizes waste and the inventory costs) and the lower cost of regenerated yarn (for instance, in the case of cashmere, the regenerated yarn costs less than the virgin one).

Using recycled materials, Delta reduces energy consumption by the 77%, chemical pollution by the 90%, CO_2 emissions by the 95% and the use of dyes by the 90%. The company is certified GRS and, to accomplish social aims, the company also invests part of the revenues in social projects.

5. Discussion: towards a Circular Supply Chain for Textiles

Case studies about the Prato wool district presented key elements that are need to introduce a Circular Supply Chain for Textiles (Table 2). Put together, these cases become an excellent example of a Circular Supply Chain for textiles based on recycled wool (Figure 1), since they reduce the environmental impact and contribute in closing the loop. Legislation, product design, certification labels, traceability and competences emerged as focal points on which to invest in order to successfully set up a Circular Supply Chain for textiles.

Table 2: Key elements emerged from the case studies

Element	Alpha	Beta	Gamma	Delta
Legislation		X	X	X
Design	X			
Labels	X	X	X	
Traceability	X	X		
Competences	X			X

Legislation emerged from all the case companies investigated as a clear enabling factor of Circular Economy (Määttänen et al., 2019), but only if well designed. In Italy, both pre- and post- consumer textiles are considered as 'special waste' - instead of by-products or secondary raw materials. Thus, transportation and handling activities are limited, since they must comply with additional legislative framework. The Italian government is currently working on the transposition of the EU 'End of Waste' Directive but, until its conversion in national law, the entire wool recycling industry is constrained by additional efforts. Another very important element that emerged from the analysis of the case studies is linked to product design. Since most of the clothes are currently not designed with recycling in mind, a full exploitation of Circular Economy is prevented at this

stage. This can be explained by the detachment between product development and supply chain processes that is characteristics of the fashion industry, given the fragmented, global supply chains. Recycling post-consumer textile waste is thus still currently a very challenging process. Cases also showed how certification labels such as GRS are important factors for dissemination and communicating the Circular Economy. In fact, all cases have at least one certification. Certifications are also the instrument that is used by companies to guarantee traceability and transparency of the products, especially in cases of low degree of vertical integration. It is important to stress out that, to that end, the Prato district has developed its own certification: the Prato's 'Cardato Recycled' (International Wool Textile Organization, 2019). This certification guarantees that all fabrics and yarns are produced in the Prato district, with at least the 65% of recycled materials. Traceability is at the foundation of such certification. Lastly, competences emerged as a clear enabling factor of Circular Economy too. All the wool recycling activities rely on the manual abilities of technical workers (as "cenciaioli" and "feltrinisti"), which are in danger of disappearing in the long run.

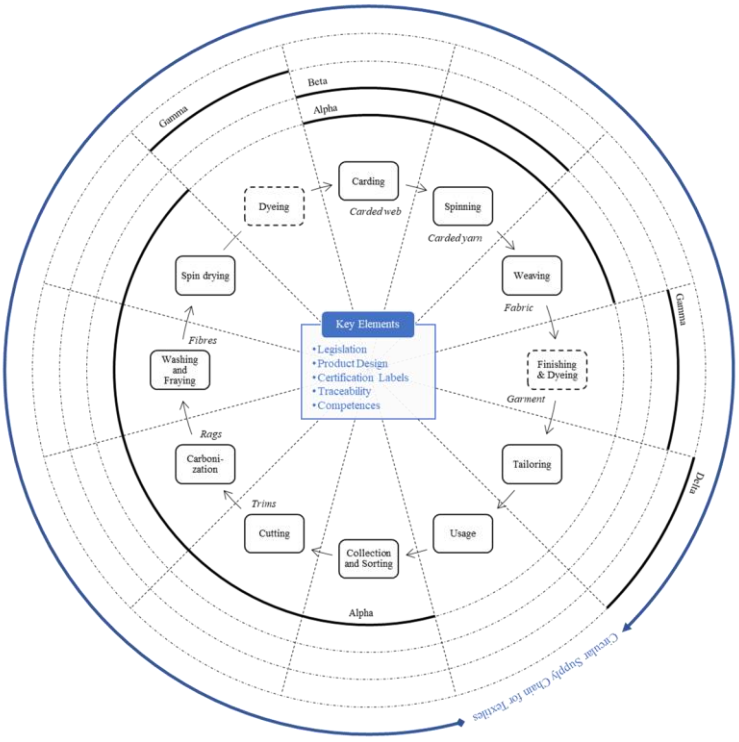

Figure 1 – The Circular Supply Chain for Textiles

6. Conclusion and limitations

Overall, this work explored the key elements for introducing Circular Economy in the textile industry, by investigating the Prato regenerated wool supply chain, providing an excellent example of a Circular Supply Chain for textiles based on recycled wool (Figure 1). Nevertheless, this work has limitations. Only one industry and four case companies have been investigated, thus limiting the generalization of the results. More companies need be investigated in the future. Moreover, many of the cycle processes are present only in one of the four companies investigated. Generalizing these elements to other industries besides the regenerated wool one provides a promising avenue for future research. Moreover, this research implicitly assumes the hypothesis that recycling wool is intrinsically positive for the environment. However, this assumption should be demonstrated through quantitative method and purposefully designed metrics (Corona et al., 2019; Kravchenko et al., 2019). Thus, another future research avenue is the quantitative assessment of the benefits generated by a full-scale application of the Circular Supply Chain structure to the fashion industry. Lastly, the establishment of a Circular Economy based on recycling and reuse of clothes not only depends on the supply chain, but especially on the consumer side. Thus, elements from the social sphere (marketing, social aspects, consumer behaviour, etc.) should be taken into account by future research on Circular Economy in the textile industry.

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