



Procedia Environmental Science, Engineering and Management **9** (2022) (4) 953-959

25th International Trade Fair of Material & Energy Recovery and Sustainable Development,
ECOMONDO, 8th-11th November, 2022 Rimini, Italy

INDUSTRIAL SYMBIOSIS - FASHION SECTOR: CHIENGORA STARTUP – TECHNOLOGICAL INNOVATION*

Federico Motta¹, Federico Mertoli^{1}, Antonio Zerbo¹, Raffaele Puleo¹,
Samuele Russo²**

¹*Department of Economics and Business, University of Catania, Corso Italia 55, 95129, Catania, Italy*

²*Department of Economics and Business, Luiss University Guido Carli, Viale Romania 32, 00197,
Roma, Italy*

Abstract

The project is related to “the industrial symbiosis for the National circular economy strategy” and comes from the increasingly current need to bring the textile market closer to sustainability. The idea is based on the use of canine undercoat also called "Chiengora" to create wovens. This type of waste is generated naturally with the dogs brushing and allows the creation of knitwear and clothing fabrics. Obtaining the raw material is the project keypoint, to be able to create a network of highly relevant and branched agreements to better optimize the collection of Chiengora waste through pet shops, breeders and dog owners. The goal is to create an app that can interface with suppliers that can report the achievement of a certain quantity, and customers who can easily purchase the items and products available. The project starts from the transformation process, from the raw material to the final product, with the possibility of being able to create different finenesses, up to the 24 thousand count, obtaining different fabrics and knits.

Keywords: Chiengora, fashion sector, industrial symbiosis, start up, technological innovation

1. Introduction

The traditional production model is the one related to the so-called linear economy based on the pattern of "extract, produce, use and throw away". This model turns out to be

*Selection and peer-review under responsibility of the ECOMONDO

** Corresponding author: e-mail: federicomertoli@hotmail.it

highly detrimental to the planet. Industrial symbiosis encourages the transformation of linear supply chains into interconnected systems, where waste from one industry becomes a valuable input for another. This concept promotes the circular economy principles of reducing waste, recycling materials, and extending the lifespan of resources. By implementing industrial symbiosis, industries can minimize their environmental impact, conserve natural resources, and foster sustainable economic growth (Astarita, 2017; Brunori et al., 2016; Cutaia et al., 2015). By transforming linear supply chains into interconnected systems, industrial symbiosis allows for the circulation of materials and resources within a network of industries, mimicking the nutrient cycles in natural ecosystems. Instead of considering waste as a liability, industrial symbiosis views it as a potential resource that can be utilized by other industries, thereby reducing the need for new raw materials and minimizing environmental impacts.

In fact, the traditional economic system is being increasingly replaced every day by that of the Circular Economy. The intent of this model is to reduce the waste of natural resources belonging to all kinds of sectors by being more efficient. It revalues the quality and quantity of goods by reusing, repairing, reconditioning and recycling materials and products in the market (Mancuso and Fantin, 2017). The circular economy principles mentioned align with the goals of industrial ecology. By reducing waste, recycling materials, and extending the lifespan of resources, industrial ecology aims to create closed-loop systems where resources are continuously cycled and reused. This approach helps to minimize the extraction of new resources, decrease pollution, and improve overall environmental sustainability (Ehrenfeld, 2004).

As soon as the asset's state of dormancy is reached, such a system allows the creation of a link between different types of assets, so as to reintroduce the materials of which it is composed into the same, or different, production cycle and allow some waste to become resources in other production cycles (Scilletta et al., 2020). Doing so, the effect is to extend the products life cycle. It is important to take measurability into account, to achieve positive economic, social and environmental feedbacks.

With various tools and indicators both economic and capable of measuring the physical part, like material and energy flows, it is possible to assess the degree of circularity of any resource. Thus, the European Commission has developed, through a working group, a set of indicators to measure the circularity performance of the 27 European countries. (Villari et al., 2020). Within the territory of the European Union, in June 2018, the "Circular Economy Package," an action plan aimed at promulgating the transition to the circular economy, has been institutionalized (Razzante, 2018).

The aim was to realize the fundamental goals for the environment and economy: an average annual reduction in emissions of about 617 million tons of CO₂ and, according to European Parliament estimates, up to 7 percent more GDP growth by 2035. The paper purpose is to propose and analyze a start-up idea from the perspective of circular economy in the textile-fashion sector. The business idea named "Pom Era" intends to reduce the waste generated by pet stores, breeders, kennels and individual owners. The main goal is to be able to collect Chiengora's waste and then to create a network with suppliers to use the waste for the purpose of making textiles and garments and thus transform a waste and reinsert it within a production cycle through transformation processes that can be either artisanal or industrial.

2. Materials and methods

Italy is the third-largest textile-clothing exporting country in the world, the trend of revenue growth remains stable and the Italian Fashion brands like Luxottica, Ferragamo, Moncler and Prada have marked a relevant performance in 2016. In fact, it is quite evident how Made in Italy is attractive to the eyes of the rest of the world in the textile sector. The

changes that will be a consequence of new consumer trends will bring new supply choices from manufacturers and end sellers toward the circular economy. By the end of 2021, a record 80 billion in turnover has been reached, with an increasing importance of Italian GDP, which will exceed 1.2 percent (Benini, 2016). Textile products must comply with the provisions of general EU consumer goods legislation, such as: the General Product Safety Directive (EC Directive, 2001), which establishes general safety requirements for all products placed on the market for consumers; the REACH regulation (EC Regulation, 2006); the Biocides Regulation (EU Regulation No. 528/2012 concerning the making available on the market and use of biocidal products); and EU Regulation No. 850/2004 on persistent organic pollutants. New provisions on the use of the terms "leather" and "fur" and those derived from them or their synonyms and the related sanctioning discipline (Law 68, 2020), the provision imposes the obligation to label the composition of products that invoke the terms "leather," "skin," and "furs," sanctioning operators who fail to provide the information to consumers. This is a measure that updates the rule dating back to the 1960s with reference to new materials on the market and is a tool to counter unfair competition and counterfeiting, widespread in the leather and fur industry.

Globally, the textile industry is worth about \$1.3 billion involving about 300 million people in the entire supply chain, the production of clothes has doubled, driven by a growth in purchasing by the middle class of the world's population; therefore, there has been a noticeable increase in collections from year to year and this phenomenon has been called "fast fashion" (<https://ellenmacarthurfoundation.org/a-new-textiles-economy>).

At the G7 in Biarritz in 2019, the 32 most important brands signed the "Fashion Pact" a document that aims to align the fashion industry with the UN Sustainable Development Goals (SDGs), the 17 goals set by the United Nations Organization focused on three major themes "climate," "biodiversity," and "oceans". This document was also created thanks to the goals previously drafted by the Science-Based Targets (SBT) Initiative (Rinaldi, 2019). This organization wants to stimulate businesses by providing useful information and tools in each work sector to improve environmental performance. All the questionnaires and surveys conducted around the world contain important information that makes it clear how consumers are slowly changing their purchasing choices and how demand is therefore changing, businesses that won't adapt to this change will see their turnovers drop by heading for bankruptcy in the long run (<https://www.euromonitor.com/podcast/fashion-friday-sustainability-in-beauty-and-fashion>).

The Global Organic Textile standard certification is among the most important in the textile industry with regard to sustainability, it is recognized and promoted by the leading organizations in organic agriculture, to try to ensure responsible development in the perspective of Circular economy. It is an international recognition that allows the company that are able to obtain it a competitive advantage to target environmentally conscious customers throughout the global market (Segre Reinach, 2015).

GOTS involves the issuance of a third-party verified environmental declaration that attests to: the organic natural fiber content of both intermediate and finished products; the maintenance of traceability throughout the entire production process; restrictions in the use of chemicals; and compliance with environmental and social criteria at all stages of the production chain, from field harvesting of natural fibers to the subsequent manufacturing stages, and the labeling of the finished product. Textiles, manufacturing operations and textile chemicals can be certified under GOTS.

The Global Organic Textile Standard guarantees: Products containing at least 70 percent natural fibers from organic agriculture, such as (but not limited to): fibers, yarns, fabrics, clothing, textile accessories, textile toys, household linens, mattresses and bedding, and personal care products. Manufacturing activities, such as dyeing or printing, carried out on behalf of third parties, which are provided by operators who have themselves adopted

management models and procedures that comply with the required requirements; Chemical products used in the processing of the textile industry that comply with the required requirements, through appropriate assessment, based mainly on the verification of toxicological characteristics. Fast fashion has a sharp increase in the amount of garments produced, used and then discarded. In February 2021, the European Parliament voted for the new Circular Economy Action Plan, calling for additional measures to achieve a zero-carbon, toxic-free and fully circular economy by 2050. Also included are tougher recycling standards and binding 2030 targets on material use and carbon footprint. Among the proposals, MEPs also called for new measures against the release of microfibers into the environment and stricter standards for water consumption. According to the European Environment Agency, textile purchases in the EU in 2017 generated about 654 kg of CO₂ emissions per person. The way people dispose of clothing they no longer want to keep at home has also changed: many garments are thrown away rather than donated. Since 1996, the amount of clothing purchased in the EU per person has increased by 40 percent as a result of a sudden drop in prices. This has led to a reduction in the life cycle of textile products: Europeans consume nearly 26 kg of textiles each year and they dispose about 11 kg of it. Used clothing may be exported outside the EU, but mostly it is incinerated or taken to landfill (87%). Globally, less than 1 percent of clothing is recycled as clothing, partly due to inadequate technologies. (European Environment Agency, 2020). According to the waste directive approved by the European Parliament in 2018, EU countries will be obliged to provide separate collection of textiles by 2025. The new strategy also includes measures to support circular materials and production processes, to counter the presence of hazardous chemicals, and help consumers choose sustainable textile products.

The Italian Ministry of Economic Development's plan "Impresa 4.0" sets policy and strategic goals to achieve the "Fourth Industrial Revolution" by which digitization and important technologies enable to change the way products, services and processes are made and implemented. The policies were based on four pillars: The support of digital investment; improvement of workers' skills; digital infrastructure, including 5G; and digital services through mechanisms of competence centers and digital hubs. In 2019, the Minister of Economic Development opened the door to funding for specific new technologies such as artificial intelligence (AI) and blockchain to have a more economically efficient fashion industry by minimizing human errors in the production process.

3. Case study

Currently, thousands of kilograms of Chiengora waste from all over the world are thrown away never to be reused again and ending up a very large part in landfills.

"Pom Era," wants to create an efficient and effective supply chain so that much of the waste can be sourced and turned into fabric, effectively achieving waste reduction and plastic free production. The startup plans to obtain funding through Invitalia, Private Equity, Crowdfunding, business angels, in order to gradually integrate the machinery of the production process and analyze and patent the best ways to obtain less impacting clothes. The very first action necessary to be carried out in order to eliminate any allergic substances, odors and clean the raw material is definitely the washing phase, the material has to be washed, in a manual way. Nowadays many machineries are able to wash also the Chiengora such as the Tumbler which is used to eliminate all the contaminations from the fibers and can be used both before. After this phase, a second washing is carried out through a machinery called Wash System where the fiber can be selected through 8 different types of washing including a soap with 3 different categories according to the degree of purity of the material.

Through another machinery called Pucker the fibers are placed and rotated inside after compacting the fibers an oil is introduced which serves to eliminate static electricity

and keeps the fiber elastic during the processes. The fiber separator is designed to selectively remove coarse guard hairs and other forms of contamination. The finer fibers are placed in the belt mold, in a collection box for further processing.

The next step involves the Carder which processes the material to stretch it and make it homogeneous, from this it can be made felt, knitted or woven because here the fibers are separated and aligned longitudinally and homogeneously. The Rug Yarn Maker creates a wound yarn core in combination with the carder, this is a great way to use coarser fibers. It can be crocheted or felted into a variety of products. The Spinder Spinner is a machine that is able to vary the thickness of the yarn to the manufacturer's liking based on the need and the requested quality. The Cone Winder is a winder that is used to prepare the yarn for artisans, skilled in crochet work but also for industries with textile machinery, it is therefore used to prepare the yarn for the realization of the final product in relation to the Cone Winder the Steamer should also be applied in order to be able to dry and ensure greater quality to the material.

The Dye Vat is a machine that washes the processed product to clean it permanently, then it must be dried to be ready for garment making. The word Chiengora comes from two separate words "chien" which means dog in French and "angora" which is known for angora wool. This is a waste in all parts of the world and is generated in the shedding period of dogs, when they are washed in pet stores or privately and finally when they are brushed to keep their coats healthy. Chiengora after several analyses has found comparable characteristics to cashmere, in addition to this it is possible to obtain both knitwear at the moment produced by different artisans around the world.

4. Results and discussion

The main innovation of the start-up is the procurement mode, i.e., the supply chain system rooted in the territory, first regional and then national in order to optimize Chiengora waste collection from pet stores, breeders, kennels and individual owners. It will require a mobile app and website that interfaces with the supplier and the customer. The supplier will be able to report the quantity collected in kilograms that can be shipped with in return an economic incentive that "Pom Era" will guarantee, while the customer will be able to purchase the garment directly if they are an end customer or fabric if they are a brand. In addition, an explanation will be provided on how to facilitate the collection phase to suppliers through the most suitable practice in hair brushing. In the production process, finishing and machine loom are useful that will allow to obtain a fabric with 100% Chiengora, also Chiengora can be mixed with other natural fibers such as for example Broom, Bamboo, Hemp, Eucalyptus, Cyprus and Viscose allowing to vary the type of fabric with more elastic and lighter characteristics. Through the use of the latest frontiers of digital technology (virtual reality), it will be possible to build customer loyalty by showing them sensory experiences related to the company's history. In addition, blockchain and Iot sensors allow Pom Era to be able to be higher performing in the production process and more efficient regarding transparency. IoT sensors make it possible to digitally connect all the physical devices therefore also the machinery, once the connection is done, it will be possible to measure speed, errors and other important production factors that allow working on errors to improve production performance.

The blockchain which is a set of technologies, where the ledger is structured as a blockchain containing transactions and the consensus is distributed across all nodes in the network. All nodes can participate in the process of validating transactions to be included in the ledger. This system will provide transparency in the complete supply chain that can clarify the path taken to produce finished product so that environmental impact can be measured. From this comes sustainable utility from both environmental and economic

perspectives.

5. Conclusions

The future Start-up Pom Era offers relevant environmental benefits regarding the material used for the creation of the fabric, because it is a waste that is generated globally in industrial quantities, only in Sicily regarding pet stores it is estimated that the potential amount is 500 kg, between Chiengora and sheared fur useful for the realization of the felt, then at the national level the amount can reach even 5000 kg, without considering the individual owners and breeders whose potential monthly amount can exceed 10000 kg, a considerable amount given that currently all these kilos are thrown in the undifferentiated waste.

Thus, it is clear that the environmental benefit manifests itself on two levels: on the reduction of waste from future suppliers and the use of plastic free raw material with the possibility of mixing Chiengora fibers with other natural fibers while keeping the product sustainable. Technological and digital strategies will help the start-up to improve indirect pollution from the production stage and transportation. The economic benefits are clear deriving from a clear profit margin. B2B is the most immediate strategy by Pom Era, because it will take care of producing the fabric by bearing the costs of sourcing and production and selling the fabric to high-fashion Brands guaranteeing a high profit margin such as the signatories of the Fashion Pact and the Life Program. B2C represents the second stage of the business that is definitely more profitable as Pom Era will be able to create its own collection of clothes and sell them directly to customers via the mobile app or site by also creating an avatar with the customer's measurements in order to try on the clothes with the measurements matching the real ones directly from their smartphone or pc. A lot of brand creation and communication will be made in order to expand the customer base and loyalty.

References

- Astarita S., (2017), Green Economy and industrial symbiosis: Italian and European perspectives, (in Italian), *ISAG*, **6**, On line at: https://isagitalia.org/advice-attended-the-2nd-asian-marine-casualty-forum-2-9/wp_8846263/
- Benini R., (2016), The Italian fashion system in the evolution of skills and world trends, (in Italian), *Rivista trimestrale di scienza dell'amministrazione*, **4**, 7
- Brunori C., Mancuso E., Luciano A., Sbaffoni S., Barberio G., La Monica M., Scagliarino C., Cutaia L., (2016), The circular economy for the containment of greenhouse gas emissions (in Italian), *Energia, ambiente e innovazione*, **1**, 46-49.
- Cutaia L., Luciano A., Barberio G., Sbaffoni S., Mancuso E., Scagliarino C., La Monica M., (2015), The experience of the first industrial symbiosis platform in Italy, *Environmental Engineering and Management Journal*, **7**, 1521-1533.
- EC Directive, (2001), Directive 2001/95/EC of the European Parliament and of the Council of 3 December 2001 on general product safety, On line at: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32001L0095&from=EN>
- EC Regulation, (2006), Regulation No. 1907/2006 on the registration, evaluation, authorisation and restriction of chemical (REACH), On line at: <https://osha.europa.eu/en/legislation/directives/regulation-ec-no-1907-2006-of-the-european-parliament-and-of-the-council>
- Ehrenfeld J., (2004), Industrial ecology: a new field or only a metaphor?, *Journal of Cleaner Production*, **12**, 825-831.
- Law 68, Legislative Decree No. 68 of 09 June 2020, On line at: <https://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto.legislativo:2020-06-09;68>
- Mancuso E., Fantin V., (2017), *Methods and Tools for the Implementation of Industrial Symbiosis - Best Practices and Business Cases in Italy*, Proc. of the 1st SUN Conference, ENEA, 25th October, Roma, Italy.

- Razzante R., (2018), The 'circular' economy: critical issues and prospects (in Italian), *Gnosis*, **4**, 234-247.
- Rinaldi F.R., (2019), *Fashion Industry 2030*, Egea (Eds.), Bocconi University Press, Roma, Italy.
- Scilletta S., Russo S.I., Puleo R., Matarazzo A., Vescera F., (2020), Technological innovation in biological wheat chain productions for the revaluation of Sicilian minor islands, *Procedia Environmental Science, Engineering and Management*, **7**, 261-269.
- Segre Reinach S.M., (2015), *The Identity of Italian Fashion, The Evolution of a Cultural Industry*, In: *The New Vocabulary of Italian Fashion* (in Italian), UNIBO, Roma, Italy.
- Villari E., Mertoli F., Tripi G., Matarazzo A., Albertini E., (2020), Innovative tools of smart agriculture to protect the supply chain of Sicilian blood orange PGI, *Procedia Environmental Science, Engineering and Management*, **7**, 175-184.