

Investigating the effectiveness of clothes recovery programs in promoting a circular economy: a review

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Abstract. Textile plays a crucial role in a circular economy and its traditional use needs to be replaced with sustainable ways. A circular economy gives repurpose and value to a resource in a continuous loop to be useful to its maximum extent at the end of stage life. Also, with the increase in population, consumption of resources, inflation, and environmental impacts are aggravated. Therefore, a literature review in this scenario which represents the solutions and the scope to incorporate circular economy with the clothes recovery is useful. The highlight of the review includes external hindrances such as consumer preferences, garment styles, and the need to involve indigenous productions in the regulations of the circular economy. In Swiss fashion firms, it's harder to set circular economy principles as compared to Italy. Further, rich fashion brands do not generally favour the idea of a circular economy. However, a few young businesses, despite the complexities of each stage, are inclined more towards a circular economy. The overview of the current review gives various ideas, limitations, and the future perspective for the application of circular economy integrated with textile. Also, it gives an opportunity to assess and compare the circular economy hindrances and scope among different countries.

1 Introduction

The circular economy related to reusing and recycling depicts the utilization of resources to prepare, use and discard with a purpose. The aim of circular economy is to minimize waste generation and utilization of the resources to its maximum potential [1-7]. The principals of circular economy focus to mitigate the negative impact of an activity at all stages along with enhanced use of materials and products by rejuvenating the ecological system [8-12].

Circular economy plays a pivotal role to achieve United Nation sustainable development goals (SDG) comprising 17 goals, especially the SDG 12 which emphasis on minimum use and proper utilization of materials and natural resources to promote sustainable patterns of consumption and production [13-16]. Thus, SDG 12 mainly focuses on the circular economy implementations [17,18]. The circular economy of clothes is relevant to the textile industries. Thus, it is one of the significant industries with increasing trend of population and textile production [19-21].

In the year 2017 based on the estimation of United States Environmental Protection (US EPA) the production by textile industries was 16.9 million tons and the recycled product rate was 15.2% with correspondence to 2.6 million tons [22]. The fashion business plays a crucial role in a circular economy; therefore, it may be termed circular fashion. It is one of the major industries with environmental and social impacts with intensive consumption of nonrenewable resources on a massive scale, resulting in depletion of natural resources with noticeable ecological footprint by disturbing nature. Its production and consumption stages generate tremendous amount of pollution; thus, making the future generations vulnerable to the availability of resources [23].

To overcome this issue, research is conducted in the area towards the reuse or recycle of textile waste world-wide to promote recycling and repurposing of textile waste [24-29]. Reuse or recycling of waste is extremely important due to the following advantages:

- The waste is potentially reusable and valuable
- It takes less raw materials, energy, and water to produce new clothes
- Carbon footprint and greenhouse gases in production of new garments is minimized
- Waste in landfills is reduced
- Pushes people to focus environment impacted by their actions
- Promotes livelihood and economic stability since recycling centers require intensive labor.

Despite the advantages there are certain challenges to recover and recycle textile waste such as high cost related to the process, finances, technology, policy and academic limitations [30-31].

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Although there are several countries which practice clothes recovery including Denmark, Norway among the Nordic nations, Sweden and China, yet there is need to understand more about the clothes recovery program as the practical implications among different countries [32-34]. Therefore, the aim of this paper is to explore case studies of successful clothes recovery initiatives and compare their strategies, outcomes, and limitations. For an easier reading, in the present paper the commercial abbreviations have been omitted.

2 Comparison of clothes recovery program

2.1 Case study of successful recovery programs in the context of Italy

In [17] the authors investigated the implementation and challenges in Italian fashion industry. The investigation was made on the four companies namely Candiani Denim, WRAD, Dress you Can and Gucci. Candiani Denim, is one of the oldest, large scale and sustainable denim mill company. It was situated near Milan, founded in 1938. Due to its sustainable efforts, it is renowned to be "the green textile mill". The focus of the company is on reliable quality products, innovation in products and consideration of environment concerning resources.

WRAD is a small-scale important design company. It was established in 2015 to spread awareness about the environmental and social impacts related to the fashion business. The company claimed its position stronger in 2017 by developing recycled products manufactured using recycled graphite powder from industrial waste by Tecno EDM, a company in Turin, that produces electrodes to make Graphi-tee t-shirts. WRAD is a promising company in Italian fashion business and won several awards.

Dress you Can is the one of who initiated the "rental dress" in Italian fashion industry situated in Milan in 2014. The aim of the company was to fulfil the needs of women with online and offline service providence in terms of clothes, shoes, accessories particularly on occasions to promote reuse and recycling. It provides the customer with the relaxation to have variety of clothes on low costs thereby promoting circular economy. It promotes the sharing of each other's wardrobe and making designer clothes available for customers at low prices. In Italy renting clothes is still uncommon therefore Dress you Can put efforts to create awareness, communication, transparency, and outlet store with rent cloths availability.

Gucci is renowned fashion luxury brand which is strong influencer at large scale with the launch of clothing and many products such as bags, accessories etc. It was established in 1921 in Florence. Gucci developed "culture of purpose" comprising 10 years of sustainability plan focused on positive environmental and social impact on planet through Gucci Equilibrium platform.

3 Strategies adopted

The following sustainable strategies were adopted by companies based on four fundamentals reuse, recycle, product-life extension and resource preservation. It must be pointed out that the Italian Government recently set textile recycling as one of the priorities in the sector of waste management and ecological transition in agreement with the EU vision [35].

3.1 Product-life extension

Different companies have incorporated product life extension in various ways. For instance: WRAD and Candiani Denim focus on design, production, and resources whereas Gucci and Dress you can, focus consumer-based side where the companies inclined the consumer to retain the products for long time. Candiani Denim emphasizes product life extension from a design point of view. For instance: generating premium denim which is made to be reliable and recyclable thereby reducing the fast consumption and waste. It promotes a gradual fashions trend for example: a pair of jeans can be worn till its torn apart.

WRAD uses reusable and recyclable fibre to make the products lifelong. From the design point of view the reuse and recycle of packaging is promoted. While Dress you Can discourage the discard of products and encourages the extension of products' life. It makes consumers the clients and suppliers as it promotes the sharing of clothes that are second hand or not used among consumers. On the contrary, at Gucci, personalization on the consumers' side regarding product life extension is retrained. For example, in a well-established fashion brand one cannot do things freely as they desire.

3.2 Reuse

The following firms actively follow the reuse practices in all stages: materials utilized, production and end of life. Candiani denim production stages involve: water recovery for cleaning purpose, utilizing CO2 emission for pretreatment of water used in production also to promote recycling and recovery of 100% cotton waste and minimize the acids used in production process. Whereas, in 2019 RAD started a reusable collection of garments made by reused fabrics and recycled organic cotton. The company strongly encourages and promotes "Fashion Revolution" movement focused on the conservation and restoration of environment.

Dress you Can focuses on the reuse of final products in fashion business. It helps customers to have more variety to wear any dress on the occasions among large extent of shared wardrobes with the support of application to share economic logic with fashion world. Whereas Gucci highly supports reuse practices as in 2018 with the help of non-governmental organizations 11 tons of leather scraps were reused. It also supports the group of marginalized people to involve them in recycling activities. Besides, the example is “Re-verso” project which shows the efficient use of scraps of fine wool to prevent the use of cashmere to protect the Cashmere goats in Mongolia. Another project called “I was a Sari” initiated in 2013 by Stefano Funari in Mumbai, India, where he used discarded sari, a traditional garment as a cheap raw material to manufacture new accessories. He hired local women from Mumbai to promote their craft. These women were given training upcycling of saris. In 2017, Funari collaborated with Gucci to promote the garments on a flourished fashion platform with the application of Gucci’s meticulous embroidery techniques.

3.3 Recycle

Candiani Denim promotes recycling since 1976 when the company promoted continuous regeneration with the installation of closed loop system and recycled cotton waste as part of its own production. WRAD supports recycling of resources such as in its signature T shirts Graphi-Tee is manufactured by 100% organic cotton with application of upcycled graphite. This helped to manage tons of graphite powder, which was supposed to be disposed of on landfill, later then used in proper recycled applications. Although, at Gucci recycling for differently designed garments doesn’t take place as they are disposed of. But Gucci is involved in producing recyclable plant based synthetic fiber to be used as raw material in production phases. Similarly, it initiated the use of new life polyester manufactured from post-consumer bottles, also the ECONYL regenerated nylon. Also, Gucci prohibits the use of PVS in its products and uses recyclable plastic.

3.4 Recycling in End of life

At Candiani Denim, the separation of production waste takes place and handed over to certified waste managers, thereby reducing burden on landfills. External companies recycle the waste from jute bags and fibers. WRAD promotes take back programs to return the used products and recycle the fibres to form new clothes. Dress you can plans to recycle old clothes to form packaging.

3.5 Resource preservation practice

In this phase, technology plays a crucial role in the production phase. in the case of Candiani, WRAD, and Gucci but also the introduction of a new paradigm in case of “Dress you can preserves” resources at best. In this aspect, Candiani Denim initiated using Kitotex, a sizing agent to weave the yarns to avoid breakage. Moreover, it’s made of Chitin, an ecofriendly composition than the traditional sizing agent made of plastic. The integration of indigo juice and Kitotex, minimizes water and chemical consumption by 75% and 65%. The company conducts weekly monitoring of hazardous waste generated. Moreover, in 2018 Candiani Denim initiated the “ReLast” program generating innovative ecofriendly fabrics made of certified recycled elastic fiber and Global Organic Textile Standard (GOTS) certified cotton. Also, environment friendly dyes and clean technologies and biodegradable fabrics cable to be absorbed by soil is under consideration. Whereas WRAD uses more resources less harmful for environment including organic cotton, beeswax and hemp. The water consumption to produce Graphi-Tee is 90% less and CO2 emission is reduced by 60% into the air as compared to the conventional T shirts. While Dress you Can promotes to preserve resource with extension of lifecycle of products with rental clothing. This helps to prevent exceeding production and consumption and provides monetary funds to customers via rent as they make money on their unused products. Similarly, Gucci initiated “Scrap less” project to minimize the use of leather [36]. It only takes the useful part of leather through tanning phase there by saving chemicals with enhanced quality. The Re-verso project has reduced 82% of minimizes energy consumption and 92% minimized water consumption and minimized CO2 production of 97%

4 Circular Economy implementation challenges

Despite the successful implementation of clothes recovery programs there are certain limitation which needs to be addressed. For instance: there is lack of post-consumer recycling technologies at Candiani Denim to achieve the best quality products. In case of WRAD, there is lack of communication with other business associates which makes the system complicated particularly based on the price of products as in Italy it’s difficult to use good quality material and makes its price cheaper for instance the price of Graphi-Tee is not less than €60. Besides, at Dress you Can the challenge is over consumption behavior of consumers and waste generation, Moreover, proper take back programs are needed to set up. Furthermore, at Gucci personalization and prototype garments are the major hindrances. In a luxury fashion brand personalization is restrained and prototype garments must be discarded.

In [37], a study was made of circular economic principles in the fashion industry system in 19 Swedish companies. The companies were small, medium and large sized which manufacturers’ products such as Children’s’ clothing, denim men and women, sustainable men’s wear, second hand, etc.

Similarly, [38] conducted circular economic business study in the context of sustainability, finances and consumer preferences for clothes in Finland and identified the similar hinderances mentioned in the above studies. The results suggested a reasonable extent of attentiveness towards the product service system. Surprisingly people in Finland were keen and adaptive towards the return backs, exchange, cloth rental and recycling practices especially the young customers and older ones accepted more the customer services such as reusing, mend, remake etc. Moreover, among all the aspects of circular economy environmental restoration was given the most preference. Second, was the sentimental aspect related to the customers' trust for increased product reliability. Only a few expressed negative perceptions related to mistrust of service or discomfort in terms of usage. In terms of sentimental values circular economy model was successful in Finland despite limited material used in dress making. The alternative of "adapt ton it yourself" gave a purpose to people to enjoy and adapt an innovative skill.

5 Strategies adopted

The following strategies reported in Table 1, were adopted by the companies: take, make, and waste.

Table 1. Font styles for a reference.

Element	Style
Take phase	Promotion: The focus is more towards the application of natural fibers instead of synthetic fibers.
	Quantification: The quantification of environmental impacts of production phases.
	Reduction: Limiting the environmental impacts from production phases for instance reduce the amount of dyes wastewater, and energy etc.
	Relocation: Employers to work on closely to the raw materials.
Make phase	Transitional flexibility: It takes into account from season to seasonless collection.
	Engagement: To be engaged in practices for the retention of values on secondhand products.
	Relationship building: To build relationships with manufacturers to incorporate environmentally sustainable methods during manufacturing.
	Partnership: To adopt intermediate coordination to support monitoring in the production facilities.
Waste phase	Development of clothes recovery programs: Clothes rental or the resale of clothes to increase the life of clothes is encouraged.
	Encouragement to use clothes responsibly: To encourage the consumers to take good care of clothes such as wash less or mend when possible.
	Promotion of take-back programs: To introduce more and more take back clothes programs
	Investment in Circular economy: To invest in recycling programs to reduce burden on landfills.

6 Challenges of Circular Economy

6.1 Take phase

In this phase, the extraction of raw materials is aimed to make new products [39]. This study revealed that out of 18 companies only 1 uses existing upcycled material in their design phase while all others use new raw materials. The challenge among larger brands is the measurement of carbon emissions upon each garment. Although efforts and resources are put to overcome this limitation to operate in circular economic system, in case of company, for smaller brand lack of resources such as time or capacity makes it difficult to measure carbon emissions. Moreover, responsibility of taking sustainability measures comes upon small team. The company 18 (Sustainable men wear) are putting efforts to use natural fibres to make biodegradable clothes as circular economic practice. Although, this product can produce the same amount of CO2 emission as compared to non-biodegradable products. In the case of Company 15 (Outdoor Apparel), focuses on long life of products with use of technical fibres. The strategy used is the durability of clothes, for example: they use a good quality recyclable nylon to manufacture clothes and this nylon can be reused by many customers in many seasons. The perspective of Company 2 (Children Clothing) suggests that the environment is the focus of scavenging consumers idea of sustainability. The decisions taken in one phase may cause undermining impacts on other stages. For instance: Production in Turkey with organic cotton may increase the cost by 10 -30%. In this case, moving the production unit to Bangladesh to manage the cost of using expensive material can be a solution.

6.2 Make phase

In this stage fashion brands are involved in producing garments. It incorporates design and manufacturing phases [38, 39]. The challenge in Sweden fashion industry is fast fashion which follows a business model in which style is given more preference than sustainable practices. In the case of company 9, fast fashion customers prefer fashionable looks of garments over the matter of sustainability. Furthermore, price is a major problem as fast fashion has low price clothes and to produce long lasting clothes require increasing the price to improve and quality, design, and durability.

Independent fashion businesses focus on reputation than on cost based upon design. This long-term plan contributes to circularity as customers invest in their clothes for long term use rather than disposable clothes. As in the case of Company 8 (Designer Womenswear, Stockholm) and Company 12 (Independent fashion, Stockholm) the circular fashion is buying a garment based on one's preference and use to for a long time by one or many consumers. It lessens the competition of cost.

A new development of business model in case of Company 18 (sustainable menswear) came into light in which a brand offers continuously a part of its collection along with seasonal collection. It helps to provide clothes best to the terms of fit, quality, lasting, and designing. Permanent collection gives an opportunity to work carefully on each garment and to understand the details of supply chain.

Although brands focus more on make phase than take phase. They focus on the quantification and improvement during production phases. On the contrary, in case of Finland an alternative option "do it yourself" was introduced which gives flexibility to customers to choose their own fabric, thread, embellishments to design their own clothes with the selection of their own fashion kit to limit the use of cloth along with the opportunity to wear your own creativity. Another alternative suggested "customised design participation" in which customer finds pieces of clothes in shelves instead of complete dress or the shop offers two services either to choose components to make one's own garment or work with their designer to have your own specific garment. Third is, to avail the fashion house services by setting any specific theme for dress instance casual, party dress etc., provide one's size and the fashion house is responsible to provide you the dress with minimal clothing consumed in the dress. All these strategies were to reduce landfill waste and increase cloth durability [38].

6.3 Waste phase

According to company 1, all the companies strive to make efforts to utilize waste in an efficient manner to promote sustainable consumption practices and minimize waste. They find ways to practice reuse, clothes rental, recycle, or repair models. Companies' initiative to practice clothes recovery programs more such as take back programs, clothes repair, educating about circular economy and environmental impacts by textile industries, more customer friendly instructions such as washing clothes with cold water, dry clean less. Some companies are involved to launch their own brand specific recycling programs.

The companies starting their own clothes recycling problem face technological barriers. Besides many companies accept willing the practice of resale and rental of clothes such as in the case of Company 3 (Children's Clothing) a recovery program for renting new-born clothing, and also the parent can sell or buy second-hand clothing. The problem with small companies is the limited staff to handle the work needed to accomplish the tasks to be done in the in-house recovery programs. In the case of Company 7, (Designer Menswear and Womenswear), the large fashion brand does not collect old garments in their store. They make premium, durable quality products and know a lot of customers sell their own brand name products. In the case of Finland, mend and remake of cloths was prioritised in terms of practicality and also the environmental advantages whereas youth was more inclined towards cloth rental, return cloth schemes and exchange [38]. Another solution was "advisory service" for instance shop offers this service online and in-store to offer suggestions to customers to use their dresses in innovative ways besides to utilize the already possessed items to restyle the garments. The advisory service may visit the house of customers to assist them to manage their closet in the best way.

7 Conclusions

In case of Italy, more research is needed upon the sustainable consumption of clothing as this could be an important factor in the hinder dance of circular model [39-41]. Firstly, it's important to implement circular economy and pay attention in all the aspects of the supply chain including consumers, manufacturers, designers, managers and final disposal [42,43]. Secondly, more studies are needed on specific segments, for instance rental clothing. Thirdly, new research could validate the hypothesis made in this study. Finally, an international comparison with other countries in terms of similar challenges faced in case of circular economy could be made, having as starting point this paper.

In case of Sweden, the investigation in future scope directs optimism related to circular economy and fashion sustainability as with the passage of time companies adopt more sustainable practices. Although, we still need to have a better perspective in terms of capitalization and waste being utilized with the principals of circular economy.

Based on the present review, future perspective goes in the favour to have policies, collaboration in the favor of circular economy particularly related to the environmental impacts such as resource depletion, climate change and the space to dump the waste.

The case study of Italy depicts that social and environmental sustainability are adopted by young businesses as they consider it a promising value. Also, the companies WRĀD, Dress You Can and Candiani in Italy are willing to accept the business models and practices which align circular economy. However, Gucci still follows the conventional paradigm, yet it is making small steps to fit with circular economy. All things considered, circular economy goals are achievable with dedicated efforts and innovative directions along with the introduction of hybrid models that can upgrade the existing models in the context of circular economy.

However, the case study of Sweden illustrates the limitations faced by fashion industry may be reduced with the implementation of circular economy principles. The need for proper interventions in the phases of take and make is necessary to reduce the environmental impacts regarding waste. The focus should be on the integration and implementation of waste but in the supply chain of circular economy. Nonetheless, the fashion industry has a complicated supply chain system in which one decision may impact other decision in the next stages. Therefore, we need to have a balanced approach of incorporating sustainability and circular economy throughout all the phases. Despite, all the efforts still there are no proper implementation of circular economy principle in fashion industry, probably due to the hinderances related to costs, preferences, trends, in the fashion industry but still the steps taken by companies make the idea of circular economy conceivable in practical ways.

The investigation reveals two important perspectives. First is to deal with external limitations from consumers behaviour, garments outlook and style. Second is the collaboration with local industries concerning policies and regulations on circular economy or sustainability. More research is needed to assess the progress of Swedish fashion business with the alignment of circular economy.

From the present review, it is clear that there are common problems implementing the circular economic principles in clothes recovery, in each segment in the supply chain system. In the case of luxury fashion brands circular economy does not seem to be useful as in both cases the brands discard their prototype clothes. Despite the efforts to the acceptability and adoption in one segment or all the segments of the textile fashion industry yet extensive efforts are needed to meet the huge gap integrating circular economy and environmental impacts.

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