Enabling Circular Fashion Through Product Life Extension

D. G. K. Dissanayake

Abstract The concept of circular economy is gaining traction as an alternative way of overcoming sustainability issues embedded in the linear fashion system. Circular economy business models are established based on the concept that the resources are kept on using for a longer period. Extending product life, a key strategy of circular economy, aims to keep the product in use to the highest extent as possible through design and operational practices. This chapter offers a comprehensive overview of strategies that enables extending the life of a fashion product. Three major strategies of (i) design for long life, (ii) product service systems that enable collaborative consumption through repairing, exchange, rental and leasing services, and (iii) refashioning models which are facilitated by the producer, or consumer-based Do-It-Yourself (DIY) methods are discussed in detail, together with their pros and cons. This analysis provides useful insights for the designers, consumers and businesses to support the transition towards sustainable and circular fashion.

Keywords Circular fashion · Product life extension · Sustainable fashion · Collaborative consumption · Product service systems

1 Introduction

Fashion industry is a highly globalized and complex industry. Meanwhile, it is economically important due to its large scale of production and consumption. However, this industry contributes to create both environmental and social impacts by consuming resources, lands, water, chemicals, polluting the environment and creating social inequity [18]. Current fashion system, which is driven by 'take-make-use-throwaway' scenario, believes the resources are infinite [31]. In this linear system, raw materials are processed into products, which are thrown away after use. This is also known as the material economy where the environment is damaged and polluted

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by material extraction, material processing, consumption and waste dumping. This linear model has recently experienced not only the environmental pressure, but also an economic pressure due to rising prices of raw materials and depletion of resources.

Environmental issues occur at every stage of the fashion supply chain from fibre extraction up to the disposal of unwanted clothing. Natural fibres such as cotton are produced using massive areas of land, water and chemicals, whereas synthetic fibres such as polyester are extracted from fossil fuel [39]. Textile is categorized as the fourth highest impact category in terms of material consumption in EU after food, housing and transport [18]. Consumption of non-renewable resources in the textile industry is estimated as 98 million tons/year, and the input of fossil fuel feedstock is estimated to be reached 160 million tons by 2050 [19]. Total greenhouse gas emission of the textile industry was 1.2 billion tons of CO_2 equivalent in 2015 [41]. If the industry continues to operate in current status, it will intensify the resource scarcity and environmental pollution. Therefore, achieving sustainability in the textile industry is becoming increasingly important business strategy, yet remains challenging due to short production cycles and low utilization rates, which are mainly driven by fast fashion phenomenon. When the product life becomes shorter, energy, water and other resources used in the manufacturing process become wasted [43]. Extending product life is an alternative strategy to conserve resources and reduce waste generation.

Among all other stages in the textile supply chain, consumption and disposal practices of the consumers are very complex to understand and thus difficult to control. Frequent changes in fashion trends drive massive consumption and unacceptable disposal habits. Consumers do not pursue any emotional attachment or value for the goods that are fast produced and consumed goods, as they are meant to be disposable [13]. Quality of clothing is diminishing, and prices are falling, thus, clothing is increasingly becoming a throw away commodity. Global textile consumption reached 100 MT/year [54], and over 90 million clothes are end up in landfill [48]. Less than 1% of clothing is recycled back into clothing, and others are downcycled or thrown away. Around USD 100 billion worth of materials are lost every year due to landfilling or incineration of used clothing [19]. The amount of textile waste sent to landfill is continuing to grow as the consumption rises [9]. This planned obsolescence of premature clothing creates sustainability issues not only from the resource consumption viewpoint, but also due to the frequent environmental pollution created during production, consumption and disposal stages. These environmental issues are largely attributed to the consumer behaviour with regard to their consumption and disposal patterns [3]. Major sustainability initiatives taken by the fashion industry so far failed to address the consumption patterns as consumer interest on sustainability is not yet powerful enough to change their purchasing and consumption behaviours. To minimize the environmental issues associated with fast consumption and disposal habits, alternative ways of slowing down the purchasing and consumption patterns need to be emerged. Recent studies reported a notable shift towards these alternative consumption models, which are largely promoted by the concept of circular economy.

This book chapter has been arranged as follows. Section 2 briefly discusses the concept of circular economy, and Sect. 3 explains the relevance and importance of

circular economy in the fashion industry. Section 4 comprises a detailed investigation on the product life extension strategies, which include design for longevity, product service systems and refashioning models. Section 5 highlights the key challenges for adopting product life extension models and Sect. 6 concludes the chapter.

2 Circular Economy

Circular economy gained traction during the last decade as a way of overcoming resource-intensive production and consumption models, while promoting the economic growth [26]. There are multiple definitions present regarding the circular economy concept, yet many of them explain somewhat similar idea, which emphasizes the importance of prioritizing the environment. Ellen MacArthur Foundation defines circular economy as a restorative or regenerative industrial system that shifts towards the use of renewable energy, eliminates toxic chemicals and waste, and aims for reusing of materials [20]. By analysing 114 definitions, Kirchherr et al. defined circular economy as 'an economic system that is based on business models, which replaces the 'end-of-life' concept with reducing, alternatively reusing, and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations' [33]. Bocken et al. [7] introduced three fundamental strategies of circular economy as follows:

(i) Slowing resource loops: this can be facilitated by designing the products for long use and also through product life extension by using service loops.
(ii) Closing the resource loops: this can be achieved through recycling, which closes the loop between post-use and production.
(iii) Narrowing the resource loop: this aims at using fewer resources than that are currently being used in the linear system.

Circular economy is often viewed as a waste management strategy [26], but circularity entails a broader life cycle approach than waste management. Circular economy aims at all the stages of product life cycle and considers alternative solutions to resource consumption including resource efficiency, better design and long use of products. Circular economy relies on three principles of (a) design out wastes, (b) keep products and materials in use and (c) regenerate natural systems [19]. However, most of these potentials of circular economy are less exploded. Implementing circular economy principles provides multiple benefits that represent three pillars of sustainability: economic, social and environmental. Economic benefits of circular models are mainly driven by the ability to restore the materials that are otherwise disposed in the linear system. Material circulation reduces the need of virgin material and resources and thus lessens the resource depletion and environmental pollution. Circular business models can open up new markets and revenue streams,

while creating new employment opportunities. In Europe, 3.4 million people are already engaging in circular economy activities, which include repair, recycling, rental and leasing [42]. Transition from linear to circular economy requires collaboration of various stakeholders in the business, together with new policies, investments and vast amount of innovations to change the way that products are being produced and consumed.

3 Circular Fashion

The need of changing current production and consumption patterns in the fashion industry became apparent in recent years. Circular economy is considered as a promising approach to make this shift. In a circular economy, fashion and textiles are kept at their highest value during use phase and re-enter the material cycle after the use, without ending up as waste [19]. European commission identified textiles (fabrics and clothing) as a priority product category in circular economy [18]. Circular economy contrasts with the traditional linear system and focuses on continuous reuse of products, materials and renewable resources [7]. However, circular economy initiatives in fashion business are yet to emerge at large [11]. Sustainability principles are given the priority than circular economy principles, yet, the goals of sustainability are open-ended, whereas circular economy is viewed as closed-loop system [25]. The urgency in adopting circular economy principles into the fashion business is urged to reduce environmental pressure.

The term 'circular fashion' is defined as 'a fashion system that moves towards a regenerative model with an improved use of sustainable and renewable resources, reduction of non-renewable inputs, pollution and waste generation, while facilitating long product life and material circulation via sustainable fashion design strategies and effective reverse logistics processes' [15]. Instead of linear take-make-use-throwaway model, circular economy focuses on a 'take-make-use-recycle' scenario. Moving from linear to circular economy requires multiple business models, design strategies, methods, tools and most importantly, new ways of thinking [7]. The requirement to adopt more environmentally benign strategies in the fashion industry is driving the industry towards circular fashion business models [10]. In a circular fashion system, clothes are used more often, allowing to capture the full value of the product, and reuse or recycle them after the first life to recover the materials [19]. Dissanayake and Weerasinghe [15] highlight four key strategies that can make fashion circular.

(i) Resource efficiency: narrowing the resource loop by reducing resource consumption and waste generation, while using renewable and sustainable raw materials.
(ii) Circular design: design fashion clothing to be used for longer period and/or for several life cycles, which may include design for longevity, design for

customization, design for disassembly, design for recycling, and design for composting.

(iii) Product life extension: keep the product in use for the maximum possible duration by offering quality products and introducing product service systems such as repairing, rental and leasing programmes.

(iv) End-of-life circularity: at the end of first life cycle, clothing can be reused, recycled or remanufactured.

Circular approach to fashion aims to develop more sustainable fashion system by maintaining the value of product as long as possible and designing the products to support circularity [43]. It provides a life cycle approach, in which the use of sustainable and renewable resources is emphasized to support renewable and regenerative systems. Water, chemicals and fossil fuel consumption in fibre production should be minimized [39], and environmentally harmful fibres should be replaced with sustainable, degradable or organic raw materials. Bio-based and renewable inputs are essential in the textile production process. Reduction of resource consumption can be achieved through advanced technologies such as waterless dyeing, energy efficient machineries and eliminating waste generation [15]. Product design can support circularity by avoiding fibre blends and using mono materials to enhance recyclability [52]. Products can be designed to be suitable for several life cycles, which are meant to be circulated in a closed-loop system in terms of reuse, remanufacturing or recycling [43, 47]. Moreover, circular fashion focuses on extending the product life and enhances the utilization rates, as discussed below.

4 Product Life Extension

Current nature of the fashion industry encourages frequent purchases and premature obsolesce of clothing, resulting a substantial loss of material value. This extremely fast-moving industry needs to be slowed down to reduce the environmental burden and resource consumption. Previous studies demonstrated that greater environmental benefits can be achieved by extending the lifespan of clothing and reusing them without disposal [36, 44, 57]. The aim of product life extension is to keep the product in use for a maximum possible duration, thereby extracting highest possible value of the materials and resources embedded in the product. Designing high-quality clothing and keep them wearing more often would be effective in capturing value and reducing resource consumption and environmental pollution [19]. This can be viewed as extending resource loops where the use phase is stretched through long lasting and timeless design, and by encouraging maintenance and repair [24]. Keeping product in use gives stronger environmental benefits than recycling, in terms of material value and the amount of resources and energy required for recycling operations. The ultimate goal of extending the product life is to reduce the demand for new resources and maximize the value of consumed resources. Key strategies that enable product life extension are discussed in below sections.

4.1 Design for Longevity

Design stage accounts for 80% of the environmental impacts of a fashion product [21]. Design for long use can reduce the requirement of virgin materials, energy and other resources, while keeping the waste away from landfills. On the other hand, consumers are becoming more demanding for high-quality products and customization experience [23], which can be utilized positively to develop long-lasting products. Consumer satisfaction is the major factor that decides the useful life of a garment. One of the fundamental reasons for the consumers to discard clothing is that they no longer look good. To satisfy the consumer, product needs to fulfil both instrumental performance and psychological performance [44]. Instrumental performance refers to the facts such as fit, quality and durability, while beauty and fashion trend can be considered as psychological performance [44]. Both of these factors must be embedded during the product development process to develop a long-lasting product. Designers have the power to embed these factors into the product because they have the ability to influence on the selection of materials, silhouette, manufacturing quality and styling [10]. Design choices that are made in this stage significantly determine not only the product life, but also the environmental impacts associated with the product [39]. Without simply looking at fashion trends, designers must consider how products are made, used and disposed, together with their impacts to the environment and the society. Better design can reduce the material cost and disposal expenses, while minimizing the resource use [20]. Design for low impact materials and processes that minimize the discharge of harmful chemicals, reduce energy and water consumption, and support the recirculation of resources are integral parts of circular fashion. Design can be simplified to reduce material consumption, and silhouette can be selected to facilitate the extension of product life by recovering the material for reuse or recycling [10].

'Design for durability' refers to physical durability of the product, which facilitates long life without any failure [7]. Material selection plays an important part in this scenario, in which the selection of a durable material can minimize the rapid waste generation and extend the product life beyond one cycle through reuse or recycling. Product should be resilient to wear and tear and should withstand abrasion and washing [39]. For instance, Candiani Denim, a denim mill based in Milan, manufactures premium denim that is made to last and could be recycled at the end of life [11]. Other ways of increasing durability could include the use of strong seams in construction and application of long-lasting dyes and prints [19]. Offering a warranty at the point of sale is an effective way to demonstrate the retailer's commitment to durability [19]. Durable products can attract the loyalty of the customers and boost sales.

'Design for attachment and trust' refers to emotional durability, in which the product is loved and trusted longer [7]. Designers must ensure the product offers emotional connection to the user as long as possible [22]. Fast fashion culture fuelled by frequent seasonal changes compels consumers to dispose garments more often. Careful selection of colours and timeless designs can help consumer to accept that

the product is not limited by seasonal fashion changes [39]. Timeless design is largely associated with its appearance. Timelessness can be achieved by designing fashionable products that do not go out of style quickly, simplifying the design or by incorporating historical context and craft practices [22]. Offering personalized products is another option to increase the emotional attachment to the product. In customizing process, customer becomes a co-designer by actively engaging in the process by providing personalized fit measurements and style alteration [14, 49]. This helps to improve customer's emotional attachment to the product, which enhances the product life in return. New technologies such as 3D body scanning and virtual prototyping are useful in product customization and better fit, while maintaining a low lead time. These digital technologies facilitate customer to analyse the styling, appearance and fit of the garment and suggest alterations, before the garment is being purchased [14].

Design for multi-style, adoptable and upgradable clothing can increase the product usability and delay the disposal [19]. Multi-style or convertible clothing means a particular garment can be worn in few different ways, for instance, a dress can be worn as a skirt by folding few lines. Convertible clothing is becoming more prominent with the increasing awareness through digital platforms. Various online tutorials, DIY videos and blogs are made available for consumers to demonstrate how a piece of clothing can be worn in few different ways. This concept is useful in reducing the number of purchases and increasing the utilization of clothes. Furthermore, garments can be designed to be adjusted for changing body sizes, which can delay the product disposal [15]. Russian label MUR makes adjustable clothing, in which garments are made for one size that can be adjusted for any body size using straps and ties.

4.2 Product Service Systems (PSSs) and Collaborative Consumption

Product service systems enable companies to sell the product together with the service. They contribute to the dematerialization of the economy by reducing material and energy consumption [6]. PSSs allow consumers to move from unsustainable consumption patterns to more sustainable consumption. Manzini et al. [40] defined a PSS as a 'business innovation strategy offering a marketable mix of products and services jointly capable of fulfilling a client's needs and/or wants – with higher added value and a smaller environmental impact as compared to an existing system or product. A major element of a PSS is that a consumer's need is met by selling utility instead of providing a product. In essence the right of product ownership is shifted from a client to the producer or service provider' (p. 30). PSSs decouple the economic success from material consumption and thus reduce the environmental impact associated with traditional retailing models [5]. PSSs can be categorized into three types: product-oriented PSS, use-oriented PSS and result-oriented PSS [56]. In product-oriented PSS, product is sold with a service contract, which may include

free maintenance, repair, upgrading and substitution services over a defined period of time [40]. When the contract period is over, the producer may take back the product. Use-oriented PSS offers product sharing options without transferring the product ownership [1]. In result-oriented PSS, a result or competency is sold instead of a product [6].

PSSs are viewed as one of the major drivers of a circular economy. According to Brandstotter et al. [8], PSS tries to reach the goals of sustainable development in following ways.

Economic: economic advantages for the producer by shifting from production to service provision and for the user by only paying for consumed services.

Social: a wider group of people can access inexpensive services without the need of buying costly equipment. PSS also has potentials towards a bigger labour market as a service provider.

Environmental: by reusing and recycling products instead of wasting resources and energy for producing new ones, the environmental pollution can be reduced.

PSSs bring new level of relationship between the consumer and the retailer. Consumers are facilitated to move away from traditional product ownership and benefit from more 'flexibility', 'freedom' and 'accessibility' [40]. Meanwhile, PSSs enable fast replacement of fashion clothing without polluting the environment or creating demand for new products. On the other hand, a systematic shift to PSSs enables companies to gain profits while reducing the environmental issues created by the demand for new materials. Manzini et al. [40] explained the organizational benefits of PSSs as:

(i) New market development: product differentiation to offer of a new product service mix, or access markets that are unable to afford the costs of individual product ownership.
(ii) Increased flexibility: respond more rapidly to changing consumption market.
(iii) Cost reduction: reduction of prices of the product through higher systemic efficiencies.
(iv) Longer-term client relationships: new level of client relationships that result in longer-term profits.
(v) Improved corporate identity: to respond to the demands and be 'responsible and transparent'.
(vi) Improved market and strategic positioning: because of 'green consumerism' and existing and future environmental legal requirements/or restrictions, e.g. extended producer responsibility, resources taxes, environmental performance labelling and standards, and specific international agreements.

Collaborative consumption business models are enabled by means of PSSs and are based on the concept of sharing economy. Belk [4] explained the concept of sharing economy as the 'acquisition and distribution of a resource for a fee or non-monetary compensation'. In collaborative consumption, goods and/or services are shared by a group of people through swapping, trading, lending, borrowing, renting or leasing options [45, 50]. Herein, product ownership is not fully transferred to the consumer, instead, a temporary access is granted for the period of consumption. That means the

product usage is emphasized rather than the ownership [37]. This makes a clear difference between the 'consumption' and 'use', where retailers keep the ownership and provide the customers with use function. The term collaborative consumption is used interchangeably with PSSs. However, Belk [4] argues that collaborative consumption does not involve a transfer of ownership, and therefore that excludes swapping models. In contrast, Park and Armstrong [45] explain that collaborative consumption can be described into two modes: utility-based non-ownership and redistributed ownership. Utility-based non-ownership includes rental and leasing schemes where product ownership is not transferred, and redistributed ownership means the transfer of ownership with the product through activities such as swapping, auction or resale [45].

Technology and digital platforms have enabled collaborative consumption moving from local communities to global market places [29]. Online rental provides useful and convenient access to fashion items with affordable prices [55]. Those digital platforms provide customer an opportunity of browsing wide range of options and choose the best for an affordable cost. Collaborative consumption also brings many sustainability benefits, such as maximizing the usage of a product and delaying disposal. Increase in usage can reduce the premature obsolescence. In customer point of view, sharing eliminates the product ownership cost of the consumer, where actual cost of the product is shared among users. This concept also provides access to luxury fashion and a range of product choices [20, 37]. Collaborative consumption is undoubtfully changing the way we consume fashion. Various forms of PSSs and collaborative consumption models are discussed below.

4.2.1 Repairing

Repairing is defined as a product-oriented PSS where functionality and durability of the product are guaranteed through maintenance and repair [2]. In order to reduce the level of purchase and disposal, consumers are required to maintain their clothes by upgrading or repairing them. Many consumers do not show an interest towards repairing their clothes, because purchasing a new item found to be cheaper than repairing. Consumers are more likely to repair clothes if they are expensive or valued in some way [35]. Apparel brands such as Patagonia, Eileen Fisher and Filson are promoting circular fashion by encouraging consumers to purchase high-quality clothing that can be repaired, rather than replaced [13].

Retailer-driven repairing services are emerging, where consumers can bring their clothes to the store and get them repaired, either free of charge or at a cost [15]. For instance, Nudie Jeans offers free repairs to all Nudie customers by maintaining repair shops within the store and also provides repair kits for their customers [12]. Patagonia facilitates repairing clothes either in-store or as DIY (Do-It-Yourself). Guidance for own clothing repair is provided through IFIXIT tutorials online, which includes step-by-step guide to repair various items [46]. Norwegian fashion company Livid Jeans offers first time repair service when purchasing a garment [34]. In this type of business model, customers expect the retailers to sell long-lasting products

with access to repair. By providing repair services, retailers can retain customer loyalty and thereby boost sales [13], while in-store repairing service can open up new revenue stream and employment opportunities.

Other than retailer initiatives, independent repair shops are evolving, which facilitate cloth repair and organize various related events such as sewing skill workshops. For instance, the Renewal Workshop (USA) collects used clothing from various brands, repairs and resells them. Through repairing, the company diverted 20,000 pounds of clothing from U.S. landfills in 2016 alone [13]. Clothes Doctor (UK) offers full repairing service package to the customers including delivery and return facilities [15]. Furthermore, emergence of repair cafés is witnessed in recent years, which helps to boost the community interests on clothing repair [13]. The Repair Café Foundation in Netherlands sets up various cafés where people can gather and learn how to repair [17]. This type of community repair workshops provides an opportunity for consumers for social gathering and collaborative work, thus replacing the pleasure of shopping. Moreover, repairing own clothes can develop an emotional attachment to the product, thereby extending the lifespan of clothing. Such events also develop deep connections with the society and the environment, while providing knowledge exchange opportunities [13]. Gribblehirst Community Centre in Auckland conducts monthly repair workshops for public free of charge and invites professionally trained menders to assist the participants to repair their clothes [17].

4.2.2 Peer-to-Peer Exchange

Peer-to-peer exchange is not completely a new phenomenon. Exchanging clothes between family members and friends has long existed. As consumers became more aware of the sustainability issues associated with clothing disposal, this exchange model is expanded beyond family to community and strangers. Consumers tend to buy clothes but end up without wearing or one-off use due to various reasons such as fit issues, dislikes, changing body size and no longer fit for the purpose. Clothes exchange is found to be one of the best informal ways to get rid of such unwanted clothing without putting pressure on the environment.

Peer-to-peer exchange is enabled through cloth swapping or buy and sell options. This can be viewed as a collaborative consumption with redistributed ownership. Swapping means people meet in person or online to exchange their clothes, without making a monetary transaction [29, 45]. Unwanted, yet still usable garments are given out and consumers receive other fashion items in exchange. While it's a non-monetary exchange, a fee may be paid to access the event or as a membership fee of the facilitating company [29]. Unlike in rental or leasing models, product ownership is redistributed in swapping [37]. Moreover, instead of swapping, consumers can sell their unwanted clothing and buy another second-hand clothing that are sold by others in the same platform. This allows consumers to continuously upgrade their wardrobes through exchange and remove unwanted clothing. Through peer-to-peer exchange models, garments are kept on using for longer and multiple times without discarding them. This delays the purchase of new garments, as consumers get an

opportunity to renew their wardrobes without a cost involvement. Clothes swapping events are heavily advertised in public places such as pubs and using social media and gaining an increasing consumer attraction. Apart from that, clothes swap 'apps' are becoming popular where consumers can download the app, upload the pictures of pieces they want to swap and pick items they would like to have. These apps also allow consumers to buy and sell used clothing for an affordable price. United Wardrobe, Vinted and Swancy are few famous example apps that facilitate clothes swap, buy or sell, and millions of customers are already using such app facilities for clothes exchange.

Retailers have shown an interest to organize cloth exchange events to provide an opportunity for their customers to exchange unwanted garments [37]. Swapping has been converted to a profit-oriented business by companies such as Clothing Exchange and Trend Sales by providing a platform for consumers to buy, sell or swap clothes though a subscription fee. Users can post items online and negotiate prices or swap by agreeing shipment terms [27]. Share Your Closet is another platform where consumers can borrow clothing free of charge, and the lender earns points which could then be used to borrow another item. Users can keep the garment until others want to borrow.

4.2.3 Rental and Leasing Services

Renting or leasing clothes instead of purchasing is a feasible option to slow down the resource loop as that reduces the requirement of virgin material and resources. This is known as use-oriented PSS where selling the use or availability of a product is not owned by the customer [2]. In operating rental or leasing services, fashion libraries are maintained instead of retail shops, where consumers can rent or lease fashion clothing from the library. Consumers can either perform short-term clothing rental by making a one-off payment, or use a subscription-based model to rent more than one garment during the subscription period [19]. Short-term rental model is suitable to meet short-term needs of the consumer, avoiding a permanent purchase for a one-off requirement. For instance, someone can rent an evening dress for a special occasion on short-term rental basics, as the consumer believes that it is wasteful to purchase a garment to wear only one time [45]. Houdini Sportswear offers high-quality performance sportswear for a week or for the weekend at a cost of 10–25% of its retail price, which is an attractive alternative for the customers who need quality clothing for an affordable price [19].

Subscription-based model allows customer to pay a flat fee for a pre-defined period and obtain a continuous service, which means the customers can frequently change their wardrobe while keeping up with latest fashion trends, yet without increasing the resource consumption [15]. This is an attractive and cost-effective method for consumers as an alternative to frequent purchase of new items and also to gain access to luxury items that they may not be able to afford otherwise [19, 45]. Rent the Runaway (RTR) is a popular rental service which allows consumers to rent luxury designer clothing at a flat monthly price. Multiple clothing items can be rented using

this subscription-based model. RTR is committed to sustainability by introducing reusable bags for delivery and return of clothing, and a toxic-free cleaning process [51]. Dress You Can, an Italian fashion rental retailer based in Milan, offers online and offline rental services for women, which includes dresses, shoes and accessories for special occasions [11]. The company gives access to an exclusive wardrobe of designer clothing at an affordable price. This business model is supported by three suppliers, i.e. (i) the consumers supplying unwanted personal items and clothes; (ii) well-known fashion brands that supply vintage or seasonal clothes and (iii) young and emerging designers who provide their collections with lower fixed costs [11].

Rental or leasing business model does not transfer the ownership of the garment to the consumer; instead, the ownership stays with the service provider, who is responsible for maintaining the garments including repair and distribution [3]. The main difference between rental and leasing models is the time duration, where leasing services allow customers to keep clothing for a longer period of time than that of a rental service. For instance, MUD Jeans offer 'lease a jeans' option that includes repair services. Customer can lease the jeans for 12 months and decides to keep beyond the leased period, swap with a new pair of jeans or return at the end of lease period [19]. In rental or leasing models, producer remains as the owner of the product, and therefore, the producer has to ensure that the product lasts for a long life in order to rent or lease the product multiple times. This way, the producer postpones the disposal of existing products or manufacturing of a new product [40]. Therefore, comparing with a traditional product, those products which are made for PSS must have better product quality in terms of materials and construction, and a longer lifespan than their traditional counterparts. Returning the product after use requires new level of customer-retailor relationship based on trust. This new level of relationship can be used to improve the product and service by obtaining customer feedback at the point of return. Customers' comments on fit and quality can be fed back to the manufacturing process to improve durability and customer satisfaction, leading to a long-lasting relationship with customers [19].

Rental and leasing models are proven to be profitable for certain clothing segments, where high profit margins and lower rental prices can be achieved if product is rented several number of times [19]. Retailers can satisfy customer needs with a fewer number of garments, decreasing new product being manufactured and entering to the market [34]. These models allow consumers to access designer and luxury clothing for an affordable price, which may not otherwise accessible. Rental and leasing models can also eliminate the burden of ownership for the consumers and thus repair and maintenance work [37].

4.3 Refashioning Models

Refashioning is a strategy that disassembled used clothing, restyling and reassembling them to make new clothing. Refashioning unwanted clothes is useful in extending the product life beyond one cycle and to divert waste from landfilling.

Currently, around 1% of used clothes are recycled back into clothing, which implies a substantial loss of resources [19]. Increasing consumer awareness regarding environmental impacts of clothing disposal can help them to rethink and redesign their clothing rather than throwing them away due to fit issues or becoming out-of-trend. Refashioning garments are increasingly facilitated by the producer, independent designers and through Do-It-Yourself (DIY) models. Refashioning is found to be a better option to extend the product life and recovering the embedded value of the materials, comparing with other end-of-life options such as recycling [16].

Refashioning of used clothing is facilitated by various channels. Sustainable designers convert the concept of refashioning into a new circular business model, where used clothes are collected, redesigned and resold [16, 28]. User engagement in refashioning their own garments is increasing as they prefer to restyle their unused clothing and wear them again. Participatory redesign workshops are emerging, in which users can bring their unwanted clothes and redesign them with the support of experts. In participatory design workshops, users are guided and instructed by expert designers to redesign their garments. These workshops may provide both restyling knowledge and sewing skills, depending on the facilities available. Various online platforms are emerging recently that demonstrate consumers to refashion their clothes based on DIY model, which is also known as Design-It-Yourself [30]. A growing number of independent designers are actively engaging in these web platforms in educating general public to refashion their wardrobe. For instance, Scratch and Stitch is an online platform that provides DIY tutorials and inspires consumers to refashion various clothing items, while keeping up with latest fashion trends [53]. Elizabeth made this, Fashionista, Trash to Couture and Cotton and Curls are few more famous online blogs that publish DIY tutorials, with a growing number of followers. DIY videos and tutorials have also become famous through social media sites. Many inspiring videos, tutorials and blogs are posted in social media such as Facebook, Instagram, YouTube, and Pinterest that users can follow and get inspired to transform their unwanted clothes to new fashion items. This model can be further expanded by retailers providing DIY tutorials in their company websites including patterns of the original styles and refashioning options for some selected styles. Retailers can also team up with independent designers who already run online platforms and direct their consumer base to get inspired and convert their unwanted clothing into useful pieces, thereby extending the garment life beyond one cycle.

In the current linear system, garments are not designed to be refashioned or remanufacture; thus, introducing new design strategies that support refashioning garments at the end of first life cycle can be a new design innovation. Garments should be designed in a way that they can be disassembled easily, redesigned and reassembled. Design for disassembly is a strategy that is useful to incorporate in the design process for the garments that are expected to be refashioned. Garments should be simple in design that assembled minimum number of component parts with relatively large fabric pieces in each, in order to facilitate easy disassembly and redesign [16]. Moreover, selection of appropriate fabrics that can be used beyond one season is required to sustain this strategy.

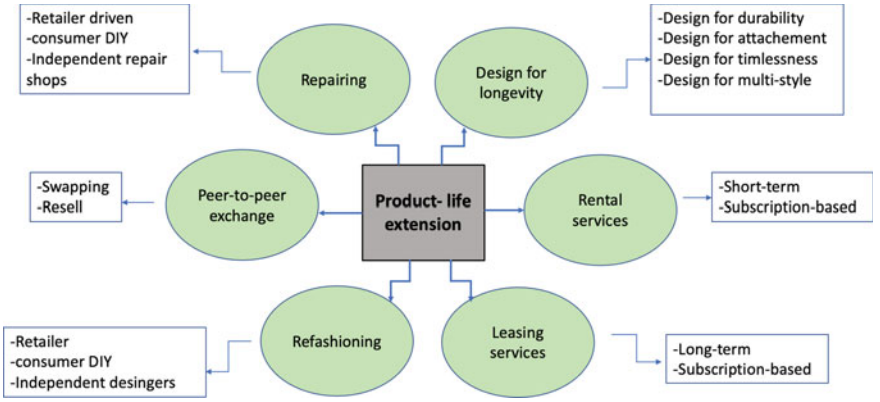

Fig. 1 Product life extension models

Figure 1 summarizes the types of product life extension models and their features, as discussed in this chapter.

5 Challenges for Adopting Product Life Extension Models

One of the main challenges contributing to negative perception of PSS models is the lack of trust in the provider [1]. Trust issues are closely associated with the quality, durability, hygiene issues and the other services provided. Lack of trust may hinder consumer interest on a particular PSS. For example, customer is unable to touch or feel the quality and durability of the product when using online rental services. This can lead to a performance risk where the product does not meet the consumer's functional expectation [38]. Customers' previous experience regarding the quality and durability of the products offered by the provider plays a vital role in selecting a product again from the same provider. Hygiene issues are associated with the customers' negative emotions towards an already used garments, which may include the factors such as how it has been used, cleaned and maintained [32]. Lack of awareness of the cleaning process may act as a barrier to accept PSS models [38]. In general, consumers are reluctant to exchange clothing, mainly due to hygiene issues. Sharing usually happens between family members or friends, rather than among strangers [4].

Another challenge is seen as the cultural shift required for the consumes 'having a need met as opposed to owing a product' [2]. Consumers may not be interested about ownerless consumption [2], and thus, convincing them to be a part of this model would be challenging. Marketing has a key role to play in this regard. For example, rental models should be attractive, fashionable and cost effective than the linear consumption model [19]. Significant challenges for rental models include lack of consumer awareness, social acceptance and inadequate regulations [55]. Starting

from high-end segments would be useful for rental models as that can increase the brand value while developing consumer trust and relationship, which ultimately help to expand the model to mass-market segment [19]. However, consumers may rent or lease garments in order to enlarge their wardrobe, while practising the conventional purchasing patterns parallelly [12]. In that case, the environmental benefits may not be achieved as expected.

A PSS includes of tangible products and intangible services. Implementing PSSs is likely to be more complex for the businesses due to limited experience in terms of pricing, designing and delivering the PSS and also the associated risks [2]. This may also include lack of know-how in service design methods and management systems [40]. Effective logistics systems are required for delivery and return services, together with digital tracking systems to locate the product [19]. Operational cost for logistics management can act as a barrier towards the transition. Collaboration with existing delivery services could bring the cost down for the PSS provider. Apart from that, disruptive innovations such as clothes swapping can have negative impacts on business, as consumers may slow down the rate of purchasing high street fashion and consider exchanging their wardrobes [29]. On the other hand, uncertainty of quality and availability of sizes act as barriers for effective swapping [29].

PSSs have the potential to open up new markets and business opportunities. Retailer owned repair services can bring up a new business model, create employment opportunities and generate a revenue stream. However, the success of such PSS depends on the culture of the population [6]. Consumers in fast fashion culture are not emotionally attached to their clothes and hence do not motivate to extend their lives through repair [13]. They also prevent from repairing their clothes as they are not interested to wear the same garment for long time [1]. For the countries that cost of labour for repair or refashioning is more expensive than new clothes, operating such business models would be challenging [19]. Some retailers encourage consumers to repair their own clothing and provide facilities such as repair kits. However, previous studies reported that lack of repair skills and the time availability may discourage consumers to undertake repair services [13, 35]. Apart from that, clothing repair is considered as women's work and a sign of poverty [13].

Refashioning may not be preferred by some consumers due to the 'patchwork like' look in the refashioned garment [1]. Refashioning also needs time, effort and skill of the consumer, together with an emotional attachment to the product. Moreover, redesigning a garment is largely restricted by its original design, construction and the availability of usable area of fabrics [16]. Consumers find this as a difficult task, which needs creativity and time. They may prefer to get the pleasure of a shopping experience and the ownership of a new product, rather than working with an old piece of clothing. Apart from that, fashion consumption is mostly driven by the psychological needs of the consumers such as identity, personality, wealth and the social status. Extending the life of same product would not fulfil their emotional requirements. In that context, consumers may tend to ignore the quality and durability of products and select fast replacement option to fulfil their emotional needs.

Table 1 summarizes the key challenges present in each of the product life extension strategy, in consumer point of view.

Table 1 Challenges for using product life extension strategies

Product life extension strategy	Challenges
Design for longevity	– consumer interest on fast fashion – frequent changes in fashion trends – psychological needs of the consumer
Repair	– attachment to the product – repair skills – time and facilities needed
Rental/leasing	– hygiene issues – trust of the provider – quality and durability issues – absence of physical inspection in online rental schemes
Swapping	– hygiene issues – quality and durability issues – lack of trust on the previous owner
Refashioning	– time, skill, and facilities needed – lack of emotional attachment to the product – quality of the garment – design limitations – psychological needs of the consumer

In order to overcome challenges faced by the product life extension models, consumer awareness regarding the environmental benefit of such systems must be raised. Previous studies suggest that eco-minded consumers are willing to pay higher prices than the market average for a sustainable product. However, product life extension models are cheaper to use than purchasing a new garment, which could ideally attract a wider consumer base. Product cost is shared in collaborative consumption, and by using design strategies such as longevity and refashioning, product can be used for a longer and multiple time. These types of consumer cost saving strategies should be backed by heavy marketing campaigns, emphasizing their environmental credibility. Changing consumer mindset is the promising approach towards the success of product life extension models.

6 Conclusion

This study offers a holistic examination of the product life extension strategies that move fashion industry towards circular economy. It is worth understanding that

collaborative fashion consumption is evolving, and more business opportunities and revenue streams are generating around that. Collaborative consumption increases the product utilization and brings sustainability benefits by reducing the requirement for new materials and delaying the waste generation. That also helps shifting consumers from frequent buying habits to alternative methods of consumption. The benefits of a circular fashion system create a win–win situation for both the retailers and consumers, yet significant challenges remain in adopting circular business models. New approaches should be developed to overcome barriers to operationalize PSSs, support collaborative consumption and other product-life extension scenarios such as repair and refashioning. For the successful implementation of PSSs, design for circularity must be embedded in the firm's business strategy. Design method enables product to have durability, timelessness, personalization, repairing and refashioning capabilities. Customer satisfaction is critical to sustain PSSs, and therefore, a successful PSS must incorporate customer feedback loops and continuous improvement strategies. Ultimately, circular economy encourages consumers to buy less, but better quality and increase the utilization rates. It also shifts the societal thinking on how clothes are bought and consumed.

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