Sustainable Design and Business Models in Textile and Fashion Industry

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Abstract Textile, clothing, and fashion (TCF) are one of the most unsustainable industries in the world. This challenges triple-bottom-line sustainability, thus calling for increased intervention by designing sustainable development. Several industrial sustainability models have addressed this issue, but they assume incremental improvements and growth while addressing global challenges. Thus, a sustainable business model perspective is required to think and go beyond these increments and reconceive radically how businesses should operate to drive system-level sustainability. In-line with 8 major sustainable business model archetypes existing, this chapter first contextualizes them in TCF industries and goes further to identify 5 key design elements (and underlying strategies) underpinning them. The knowledge of these key design elements (product, process, value network, relation, and consumption pattern), upholding a system thinking approach, will further assist both research and practice to strategically develop and improve the sustainable innovations and business models.

Keywords Sustainable design · Sustainable business models · Textile and clothing · Fashion

1 Introduction

Textile, clothing, and fashion (TCF) are one of the most polluting and resource-draining industries in the world, next only to oil, in terms of environmental impact (DEFRA 2008; Fletcher 2008). This is driven largely by environmentally unfriendly production practices, involving large-scale destruction of the ecosystem, viz. widespread use of chemicals in the production and processing of textiles and clothing, emission of harmful greenhouse gases, and other effluents followed by

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throwing of thousands of tons of textiles every year for either landfill or incineration. In addition, in order to meet the competitive pressures of current TCF industry, manufacturing is largely concentrated in low cost bases where there are neither stringent pollution controls nor regulations (Hethorn and Ulasewicz 2008), along with lack of compliance with social aspects such as fair labor and health and safety standards. Moreover, the TCF industries are one of the worst in terms of promoting materialism, increasing driven by a system of classical market economy, providing the basis for emergence of a throwaway society that is based on economies of scale, planned obsolescence of products, short product life cycle, and consequently ever-growing demand of consumers for new products and services (Mont 2008). This to a large extent has resulted in challenges to triple-bottom-line (TBL) sustainability by promoting "producers continue producing and consumers continue buying" (Fuad-Luke 2009), thus calling for increased intervention by designing sustainable development by understanding:

1. Increased effects in terms of TBL: economic, resource constraints, pollution, and social impacts.
2. Need for high degrees of material and resource efficiency.
3. Need for shifting from linear to circular or closed loop—why a focus toward circular economy (CE)

2 Sustainable Development

The demands for creating greater environmental and social value, while delivering economic sustainability, suggest the key to radically improve sustainable performance through sustainable development. Sustainable development is "development that meets the needs of the present without compromising the ability of the future generations to meet their own needs" (Brundtland Report 1987), thus implying needs to attain TBL sustainability. Sustainable development in TCF industries is an approach intended to minimize the "negative environmental impacts" of the current fashion system and, in turn, maximize the positive impacts (benefits) for the society all along the value chain, thus creating sustainable value (Gardetti 2016). To achieve sustainable development, several industrial sustainability models and frameworks are present, viz. industrial ecology, cradle-to-cradle, and The Natural Step (Evans et al. 2009). Aneja and Pal (2015) have further highlighted and compared eight major sustainable development frameworks and their strategic vectors in context to the textile industry. However, Bocken et al. (2013, 2014) points out the inherent shortcomings of these "industrial sustainability" models, as they are broadly underpinned by assumptions of incremental improvement and growth while addressing global challenges. Bocken et al. (2014) further state "to deliver long-term sustainability requires fundamental changes in the global industrial system, and this necessitates an integrated approach that goes beyond just ecoefficiency initiatives and reconceive how businesses operate."

For this, sustainable enterprises and their representative business models provide the potential for a new approach and can serve as a vehicle to drive societal innovation (e.g., poverty reduction and well-being), and along with preserve ecological integrity driven by technological innovation (Hart and Milstein 2003), thus leading to a system-level sustainability. Thus, sustainable business models (SBMs) provide a radical system-level perspective toward creating new systems.

In this context, this chapter will discuss the SBMs that uphold sustainability in the TCF industries, in accordance with the 8 key archetypes proposed in Bocken et al.'s (2014) (see Sect. 3). These archetypes are deemed integral in industrial systems for identifying and understanding the key design aspects or elements underpinning these SBMs, and how they are instrumental in leading toward sustainable development in TCF industries.

Hence, this chapter will include the following:

- Major sustainability archetypes and business models (in-line with Bocken et al. (2014) SBM archetype framework), in TCF industrial value chains,
- Key research and company-driven initiatives taken along these archetypes, and
- Sustainable design aspects/elements in these archetypes from a system thinking perspective.

3 Sustainable Business Models and Archetypes

Sustainable business models (SBMs) are defined by Bocken et al. (2014) as those that create significant positive and/or significantly reduced negative impacts for the environment and/or society, through changes in the way the organization and its value network create, deliver, and capture value (i.e., create economic value) or change their value propositions. Thus, they go beyond delivering just economic value to include solutions that generate environmental and social values as well (build on a TBL approach) for a broader range of stakeholders using both systems and firm-level perspectives (Lüdeke-Freund 2010; Stubbs and Cocklin 2008).

Bocken et al. (2014) have identified eight different categories of SBM archetypes, describing the underlying mechanisms and solutions that contribute toward designing transformational innovations. These SBMs include closed-loop business models, natural capitalism, social enterprises, product-service systems (PSSs), and other new economic concepts (Bocken et al. 2014) and are as follows:

1. Maximize material and energy efficiency,
2. Create value from "waste,"
3. Substitute with renewables and natural processes,
4. Deliver functionality rather than ownership,
5. Adopt a stewardship role,

6. Encourage sufficiency,
7. Repurpose the business for society/environment, and
8. Develop scale-up solutions.

The criteria for selecting and categorizing various examples to construct the eight archetypes are based upon a methodological framework by highlighting the similarities and differences and the constant comparison of these exemplar types, along with the constant comparison of low level codes (e.g., specific company innovations and initiatives) and higher-level codes as prescribed in Boons and Lüdeke-Freund (2013), viz. social, technological, and organizational innovations [see Bocken et al. (2014) for details].

The next section illustrates these archetypes, their key characteristics and design elements by using exemplar cases (evident in TCF industries), thus underpinning the sustainable practices of each SBM archetype. These cases must not be considered exhaustive but only representative of the major types of SBMs under each archetype and their design elements (Fig. 1). Real-world examples are used to depict these archetypes and SBMs.

3.1 Archetype 1—Maximize Material and Energy Efficiency

This archetype, in comparison with higher resource throughput and consumption, aims for maximizing material productivity and energy efficiency to lower the resource consumption by reducing the volume of resource flow (Stahel 2007). Implementation of such strategies encompasses concepts such as designing of ecoproducts, lean and clean production approaches, and waste reduction.

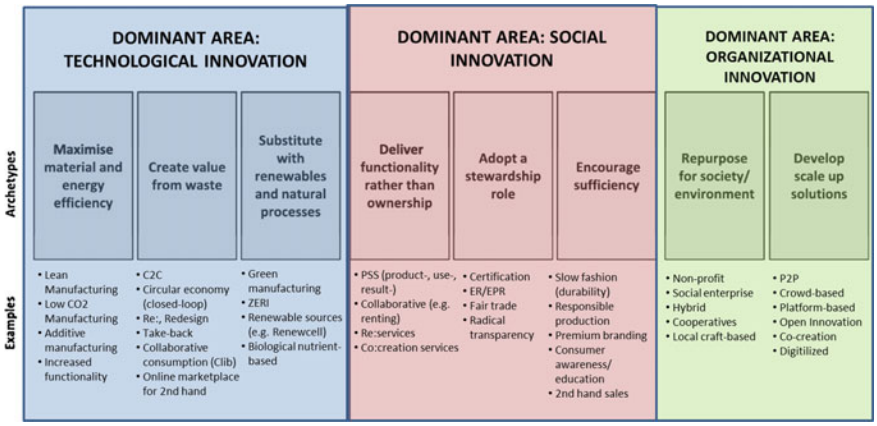

Fig. 1 SBM archetypes and business cases [adapted from Bocken et al. (2014)]

Considering the increasing volatility in the energy prices, ecodesign aims at improving the energy efficiency and resource effectiveness (closing the material loop) by implementing various strategies, viz. dematerialization or multi-functionality. From the marketing perspective, the current Ecodesign Directive set by European Union (EU) can be extended to cover design, in terms of both scope and markets covered (from energy-related products to all products and services). These products are focused toward limited usage of energy, reduced CO_2 emissions, minimized negative environmental impact through energy focus (De Groene Zaak and Ethica 2015), considering the fact that the product design and development plays a significant role in determining the environmental impact of textiles (accounting for nearly 80 % of the total) during various lifecycle stages (Norden 2015). Such ecodesign principles include not only the choice of the material but also the functionality of the product throughout the life cycle (effecting the environment in terms of water and energy consumption). For instance, Continental Clothing—a UK-based brand—has developed an EarthPositive Apparel that is 100 % organic with 90 % reduced CO_2. This reduced impact (an EarthPositive T-shirt saves around 7 kg of CO_2) is achieved through combination of low-impact organic farming, efficiency in manufacturing and transportation, and the use of renewable energy instead of the fossil fuel-based grid electricity.

In practice, many forerunner companies have started working beyond ecodesign by embracing circular design principles, aimed to go beyond reducing the negative environmental impacts and succeed in creating a positive regenerative impact (De Groene Zaak and Ethica 2015). Gwilt (2014) illustrates using examples various concepts, such as mono-materiality, modular design, that have the potential to design for circularity. Use of mono-materials in products has been considered strategic due to the higher scope of recycling, which is lost in case of blends and also due to certain finishing steps adding contamination into the products. Gwilt (2014) highlights the need to experiment with different embellishment techniques, such as laser-cutting or needle-punching, which can provide detail without contaminating the fiber. This further creates degrees of modularity in the product which is beneficial for easy separation and recycling. Additive manufacturing in this context is a disruptive technology that can be explored in apparel manufacturing; recently, 3D laser printing technology has been used by fashion designer Iris van Harpen and architect Julia Koemer, in collaboration with a Belgium company (Materialise) to fuse small particles of plastic and print continuous surfaces without seams into laces. N12 is a ready-to-wear bikini collection made from 3D printed Nylon 12. Such innovations could be a game-changer in the global sports footwear market as well.

Modular garment design is yet another solution to develop a range of detachable features that can facilitate replacement or repair and in turn can reduce the effect on the environment in terms of water and energy consumption, as well as CO_2 emissions in the use phase. These conditional product design strategies are necessary to explore in terms of their environmental impact, as a logical route leading to circularity. At the usage stage, adding functionality reduces the total number of products in use and also enhances the active lifetime of each product. There are

different ways to increase this active use time of a product and largely falls under the Archetype 6: "encouraging sufficiency," discussed later.

Further from the process design perspective, lean and green manufacturing seeks to improve resource efficiency and reduce waste and emissions through product-process design.

3.2 Archetype 2—Create Value from "Waste"

In contrast to today's linear "take, make, waste" economic model, the concept of creating value from "waste" is underpinned by the idea of restoration rather than disposability, by designing and optimizing products, components, and materials for multiple cycles of disassembly and reuse.

Such closed material and energy loops imply that the materials are reused again, either as bulk material, or products, or as components through specific processes (or economic activities), such as refurbishment or recycling, thus influencing the essence of a circular economy (CE) through new ways of production, distribution, and consumption of goods and services (Ellen McArthur Foundation 2013).

Most important implications from "closing the loop" activities are the potential minimization of extraction of materials from nature and the reduction of waste emission to nature. Problems with extraction, such as resource scarcity, and with emissions, such as environmental impact, can potentially be solved. CE also builds on ideas of generating better economic performance with new (circular) business models along these closed loops that focus on selling services instead of products to product life extension (via remanufacture, resell, repair) to lower resource usage (Wijkman and Rockstrom 2012), thus having the potential to generate an economic growth between 1 and 4 % in many Western economies in the near future (ING Economics Department 2015).

Bocken et al. (2014) have highlighted several exemplar SBM types underpinning the central notion of this archetype, viz. circular economy, cradle-to-cradle, reuse, recycle, remanufacture, sharing, and collaborative consumption. It can be noted that all these exemplary types aim toward attaining various degrees of circularity, through various "closing the loop" activities, thus underpinning the concept of CE. The concept of CE goes beyond just recycling and encompass a holistic view toward "closing the loop" along the five major underlying business models: (i) circular supplies, (ii) resource recovery, (iii) product life extension, (iv) sharing platforms, and (v) product as service (ING Economics Department 2015). The inner loops (sharing platforms and product as service) provide the possibility to retain higher value of the original product predominantly centered on service design. Archetype 4 (Deliver functionality rather than ownership) provides detail of various approaches underlying these loops, e.g., shared ownership, peer-to-peer sharing, and collaborative consumption. However, such business models do create the opportunity to design products such that they ensure longevity, durability, ease of maintenance and repair, and if required upgradability (De Groene Zaak and Ethica 2015). This further

demands long-term relationship with clients/users (through access to service) and suppliers (by ensuring safe and healthy working conditions and fair wage), as can be seen in case of Mud Jeans, a Dutch Fashion House with strong focus toward "product as service" via leasing of its jeans to clients/users.

On the other hand, along the outer loops of product life extension, value could be maintained or created by repairing, upgrading, remanufacturing, or remarketing of products. In these loops, value is predominantly restored or added by sufficient rework on the products; hence, the original value retention of the product is low, thus demanding higher labor intensity to recreate "new" value (Stahel 2007).

Various reuse- and resell-based business models can be identified in the secondhand clothing sector. Pal (2015) has identified 8 different resell-based business model types in used clothing networks in Sweden, these are:

(i) Collection-based, like fashion retailers (with or without supply chain partners) engaged with take-back and "shwopping" schemes through their retailer shops, e.g., H&M in collaboration with I: Collect.
(ii) Direct reselling, when the retailers collect only its own brands and partly resell them through own shops, e.g., Swedish fashion brands such as Boomerang, Filippa K.
(iii) Business-to-business (B2B) reselling, when the retailers collect but sells to other actors in the chain, e.g., to secondhand retailers.
(iv) Charities, those have a hybrid business model and partly resells the collected clothes, e.g., Red Cross. In the Nordic countries, the charities are the largest collector of secondhand clothes and nearly 20 % of it is resold by them through their own shops while nearly 50–70 % is exported to various destinations (Eastern Europe, Asia, and Africa depending upon recovered quality).
(v) Secondhand retailers, function more or less the same way as the charities, except for the fact that they are totally commercially oriented. Similar to charities, they also engage in partnerships with various actors in the network, such as with fashion retailers, charities, and refurbishers, e.g., laundries.
(vi) Redesign brands, which have the potential to offer higher value-added used clothing through high degrees of redesign and reconstruction of the old clothes.
(vii) Reclaimers, which mainly collect and resell leftovers from fashion retailers, or sometimes fashion retailers do it themselves by selling through factory outlets, e.g., Branting is a Swedish brand which debrands its leftovers and sales them.

In most cases, reuse and resell business models account for reducing carbon footprint of new garment manufacturing and energy usage by displacing the production of "new." Swedish Environmental Protection Agency (2016) has identified the effects of such displacement, in terms of reduction in carbon footprints by about 1.5, 1, and 0.5 person equivalents/ton, and reduction in primary energy usage by 2.5, 1.75, and 1 person equivalents/ton, for substitution by factors of 1, 0.66, and 0.33 respectively.

The highest possibility for value creation can be achieved via remanufactured fashion, which aims at remaking used clothes through various redesign possibilities so that it at least equals to newly manufactured garments in terms of quality (Sinha et al. 2015). Many such initiatives have started worldwide and are predominantly led by niche and small-scale redesign brands. However, what differentiates remanufactured fashion from that of upcycling is the focus toward process industrialization compared to that being craft-based in case of upcycling design (Sinha et al. 2015). However, the desirability of remanufacturing fashion is high considering the degree of value addition, scope to create employment, and lower use of energy and material. Recent initiatives, e.g., Retextile (2016), in Sweden are working along this direction to develop redesign-make strategies and methodologies.

Another key aspect for initiating these circular loops based on product life extension pivots onto the reverse logistics operations of collection and disposition of the used products. Sorting or disposition is a key issue and also barrier to circularity of textiles and clothing, particularly due to complex blends of fibers and various degrees of contamination throughout the product life cycles. To ensure better recyclability, various ongoing initiatives aim at developing new mechanical and chemical sorting techniques. Mechanical sorting techniques include use of barcodes (for checking productivity of manual sorting, or price tagging), RFID (in retail stores and warehouse management), optical near infrared (NIR) for detecting fabric composition and color, e.g., Textile 4 Textile project (Alkazam 2013), and even robotics by integrating haptic and visual sensing, and recognition (CloPeMa 2015). One of the recent initiatives taken has been the FIBERSORT program using NIR spectroscopy, jointly undertaken by Valvan Baling Systems, Metrohm, Worn Again, Fairtex, Reshare, and Circle Economy. Such initiatives not only highlight the process innovation and design in activating circularity but also show how choice of right partners and collaborative networks play a crucial role in bringing together complementary expertise of the actors in several areas. The FIBERSORT project, in this regard, involves strategic partners such as Valvan for sorting machineries, Metrohm for NIR scanning, and Wieland Textiles for secondhand textile processing.

Similar initiatives can be seen in recovering value from end of a product life cycle through chemical recycling, e.g., UK-based Worn Again is developing a chemical textile to textile recycling technology and have partnered with retail brands such as H&M and Kering (Worn Again 2016); Finnish initiative called Relooping Fashion is in the process of closed-loop ecosystem based upon a cellulose dissolution technology to create new clothing out of recycled cellulose and involves various strategic partners along the value chain representing crucial operations such as collection, sorting and recycling, retailing, and distribution (ReLooping Fashion 2016). Pure Waste, a Finnish brand, and partner in the Relooping Fashion initiative, is involved in this process in developing clothes out of industrial wastes (cutting wastes and leftover of the manufacturing process), which is then sorted by color, refibred and finally spun into yarn (Pure waste 2016). Another innovative network-based initiative, the Dutch aWEARness, is taken by

various strategic partners such as ecofabric producers, workwear resellers, tracking, and tracing partners to deliver circular workwear to various resellers. Dutch aWEARness works as a circular supply chain content manager by maintaining a database with information about materials, includes a life cycle analysis, a purchasing and inventory management tool and a track and trace system, and in turn receives a service charge (Dutch Awearness 2016).

Compared to recent recycling cellulose projects and initiatives, synthetic fibers have been recycled for a considerable longer time. Returnity is a 100 % recyclable polyester fabric licensed by Dutch aWEARness, used for making workwear and interior-furnishing. By adopting a cradle-to-cradle (C2C) design guideline, the product is said to reduce CO_2 impact by 73 %, waste management by 100 %, and water use by 95 % compared with cotton (Perella 2015). Similar products, e.g., Econyl, have been developed by Interface, world's largest modular carpet manufacturer, by reclaiming discarded fishing nets, by entering into a collaborative supply chain partnership with Net-Works enables local residents to collect discarded nets and sell them back into a global supply chain for issuing a second life (Net-works 2016).

In addition, various design strategies address the aspect of planned obsolescence by slowing down the rate of depletion of resources and by optimizing the product life span. Packard (1963) categorized these design strategies for addressing obsolescence of technology, quality, and desire. While *design for reuse/upgrading/easy maintenance/easy replacement* aims at tackling technology obsolescence in a multitude of ways, e.g., designing in module for easy detachment and reattachment, *design for remanufacturing* comprises of design for easy disassembly and assembly. Sinha et al. (2015) highlight a generalized remanufacturing fashion process that is elemental in supporting efficiency and effectiveness of reverse supply chain by meeting scale, speed, and quality issues. Furthermore, strategies for product durability that addresses obsolescence of quality include design for more robust products, while timeless design and degrees of customization ensure extension of product life span by reducing obsolescence of desire (Mont 2008).

Indeed, tight component and product cycles of use and reuse aided by product design create positive opportunities for CE. This further distinguishes CE from linear economy which loses large amounts of embedded materials, energy, and labor. More importantly an integrated systemic view of the whole system is required to design "value from waste."

3.3 Archetype 3—Substitute with Renewables and Natural Processes

Currently, the growth-oriented motives of a globalized throwaway society have constantly depleted the Earth's resilience by creating a decrease and imbalance in the natural capital. Rockström and Klum (2012) have highlighted this as the

"quadruple squeeze" where 60 % of the key ecosystem resources are utilized in support of human well-being, thus rapidly eroding Earth's resilience potential. Global Footprint Network (2014) measures have shown that the ecological footprint of production and consumption in terms of the Earth's regenerative capacity has increased from little <0.5 in 1960 to 1.5 Earths currently, and by 2050 we will need 2.3 Earths. Such "business as usual" (BAU) would result in severe resource scarcity in the near future. Thus, substitution of fossil fuel-based energy and resource systems by renewable materials is a key to achieve impact reduction on the Earth and environment. Several strategic frameworks and concepts such as Blue economy, Zero Emissions (ZERI), Biomimicry, and The Natural Step are concerned with the potential for creating environmentally benign industrial processes and live within current resource constraints, by making better use of renewable resources (green manufacturing) or drawing inspiration from processes occurring in nature (biomimetics) (Aneja and Pal 2015; Bocken et al. 2014).

The term "green" manufacturing in textiles and apparel can be looked at in two ways (Green Technica 2012):

1. manufacturing of "green" products, particularly those using renewable resources and energy systems or resources having reduced environmental impacts, and
2. "greening" of manufacturing—reducing pollution and waste by minimizing natural resource use, recycling and reusing what was considered waste, and reducing emissions.

In this context, green textile innovation is a broad area of innovation, ranging from replacing chemical dyes with organic/benign dyes in textile production, through to more radical changes such as the emerging field of "green chemistry" that seeks to utilize naturally occurring processes in place of traditional industrial processes. Textile production utilizes diverse chemicals, dyes, and finishes at all stages which are harmful to the environment and health, and its globally dispersed nature makes matter worse by posing a big challenge in stipulating requirements and regulations. LAUNCH Nordic is an initiative taken by Nordic countries to promote use of environmentally friendly materials (based on cleaner manufacturing and green chemistry) in fashion and textiles as one of their focus (LAUNCH Nordic 2016). Under this theme, the initiative focusses on innovations in: (i) optimizing existing technologies and approaches within the closed-loop manufacturing, green chemistry, and recycling/reuse; (ii) reducing the toxic/chemical impact at various points in the value chain, e.g., through use of green chemistry; and (iii) exchanging manufacturing information and data (LAUNCH Nordic 2016). For instance, under this initiative, Novozymes in Denmark is exploring new uses for enzymes in textile production which can reduce a textile's environmental impact and improve the durability of finished products, resulting in reduction of consumption of water, energy, and chemicals (Norden 2015). The initiative also provides scope for new collaborations between LAUNCH global partners and multi-nationals worldwide, e.g., IKEA, Novozymes, and Kvadrat to drive system innovation and help scale sustainable innovations in materials (LAUNCH Nordic 2016). Another aspect of

"greening" the manufacturing process is by operating without emissions and waste. Zero Emission Research Initiatives (ZERI) is a research initiative proposed to cascade nutrients, materials, and energy so that our production and consumption systems are designed in such a way (ZERI 2013). On similar lines, Detox campaign (launched in 2011) mobilizes global clothing brands and their suppliers to eliminate toxic water pollution and release of hazardous chemicals from their supply chains and products, and presently includes 19 international fashion companies, e.g., Nike, H&M, and Zara. Overall, the fundamental principles of this campaign are as follows: (i) zero discharge of all hazardous chemicals (wastes and production emissions or later "losses" from the final product), (ii) prevention and precautionary actions toward the elimination of hazardous at source through substitution with sustainable alternatives or even product redesign, and (iii) full transparency by brands and their supply chains and public disclosure of information about hazardous chemicals used and discharged (GreenPeace 2016). Detox Outdoor initiative is a similar open campaign taken by Greenpeace to challenge big outdoor brands to eliminate per- and polyfluorinated chemicals (PFCs) and other hazardous chemicals from their entire production and become Detox Champions (Detox Outdoor 2016).

Further green products can be innovating biological nutrient-based renewable resources aimed at generating a bioeconomy through greater use of renewable biomaterials instead of finite resource elements. In textile production, many alternative sources of raw materials have been explored to replace conventional materials having slow regenerative rate or longer replacement cycle. For example, research is being conducted in the Nordics to look into alternatives for cotton by using chemical wood pulp or recycled biobased textiles (Bio Innovation 2016). Re:newcell is a Swedish innovation start-up which aims at recycling and transforming a high cellulosic portion fabric into recycled dissolving pulp ("re:newcell pulp") which can then be used for commercial textile production (Re:newcell 2016). Further, new green fabrics, materials, and practices are constantly explored to pave the way in TCF manufacturing sector. Sustainable Technology in Nettle Growing (STING) is a collaborative project between the company Camira, Defra (Department for Environment, Food and Rural Affairs), and De Montfort University to develop textile material made out of stinging nettle leaves (Green Product 2014). Many other biocomposites, created through combination of biobased fibers, such as kenaf, hemp, flax, jute, with polymer matrices are also essential in creating biofiber–matrix interface and novel processing.

Beyond, green sustainable or alternative products and processes, learning from and replicating nature to find solutions for answers to various problems related to our quest for new products, processes, or technology, have been for a long time and is termed as "biomimicry" or "biomimetics" (Vincent et al. 2006). Biomimetics incorporate principles that rethink our approach to materials development and processing and hence promote sustainability by reducing ecological footprint (Eadie and Ghosh 2011). Natural systems are inherently energy-efficient and adaptable, hence to be sustainable, textile fibers and products must emulate this feature. Further, the increasing demand for fibers worldwide has driven the use of new and innovative products, to be met largely by using renewable resources and through

efficient recycling; however, high number of polymers in fiber structure makes it immensely difficult, at times, to eventually recycle the product. Biomimicry in textiles, in this regard, considers recyclability and aims at reducing the number of polymer types we tend to use.

3.4 Archetype 4—Deliver Functionality Rather Than Ownership

This archetype emphasizes servitization and product-service systems (PSSs) (Tukker 2004), wherein functionality and access are valued more over ownership of the product. Services are provided to satisfy users' needs aimed at increasing the active lifetime, single or multiple, of each product. In some cases, the service providers retain the ownership of the product entirely through its lifetime, only offer the usage (performance, functionality) of the product against a fee, and are termed as use-oriented (UO) PSSs. Various rent- and lease-based business models have emerged in TCF sectors in the recent years. VIGGA and Katvig are Scandinavian children's clothing brands based upon such lease-based subscription business model. For instance, VIGGA charges a subscription fee of roughly € 48 per month with a subscription period ranging between 3 and 27 months to receive 20 pieces of clothes. MUD Jeans is a pioneering example of the leasing business model; the member pays a fee of € 25 one time to receive a pair of jeans in return, followed by a payment of € 7.5 on a monthly basis for 12 months. After 12 months, the user receives an email from MUD Jeans prescribing 3 options: "keep them," "switch them," or "send back." While in the first case the user keeps the jeans pair, in the second option he/she pays a switching fee of € 10 for the first month and sends back the old jeans to receive a new pair in return. In the third case, the user sends back the jeans to receive a € 10 voucher to use anytime later (Mud Jeans 2016). Such UO-PSS models have the potential to change the consumption patterns by reducing the need for product ownership, and in addition incentivize the manufacturers and brands in developing products that last longer through various "design for …" approaches, e.g., "design for upgradability" and "design for reparability."

In the renting model, many clothing brands have launched this new concept, such as Uniforms for the Dedicated (under the concept "The Collection Library"), Fillipa K ("Make it Last"), Rent-a-Plagg ("Are-360"), among others allowing customers to rent key pieces from current collections—primarily special occasion wear such as suits, dresses, and accessories. Several online retailers, like Rent the Runway, Le Tote, etc. have also ventured into such rental schemes, by renting out designer labels under various rental schemes (fees and return periods) and additional services (e.g., free drop-off, style, and mix-match suggestions).

In contrast, many brands have launched services facilitating product life extension, through repair and maintenance services and/or by selling a durable product through warranty. Nudie Jeans, for example, is a Scandinavian denim brand which offers its customers free in-store repair services which contributes largely to the sustainability image of the brand. For consumers who are unable to visit the store are offered free DIY repair kits. In these PSSs, the ownership lies with the customer; however, such servitization schemes aim at extending the product lifetime and durability and are called product-oriented (PO) PSSs.

In connection, collaborative consumption is also an important movement changing the consumption landscape based upon the idea of sharing and collaborating to meet certain needs, products, and services. In the TCF industries, collaborative or sharing business models are mushrooming in the recent years, e.g., online marketplaces like ThredUp, which allows peer-to-peer selling of secondhand clothing, swapping platforms like Swapstyle, which enables people to swap fashion worldwide, and local Swishing parties where people share clothes from their own wardrobes. In this regard, clothing or fashion libraries have emerged largely in the scene, which are subscription-based service that allows people to share wardrobes (Pedersen and Netter 2015).

Overall, such servitized SBMs offer and build a unique relationship with the consumer/user which enhances the brand loyalty and consumer insight. Renting/leasing activities work best either for durable and high-quality products (e.g., workwear, denims) or for seasonal products (e.g., kids wear, maternity wear) mainly because consumers/users find it cheaper than buying while the companies can rent/lease out the product multiple times against a fee (Circle Economy 2015). Repairing services, on the other hand, are particularly attractive for garments that easily experience wear and tear and are expensive (e.g., outdoor gear and jeans). Sharing and swapping activities are particularly favorable for clothes which have crossed the end-of-use period during a single lifetime, either permanently or temporarily, yet holds a potential for usage in subsequent lives.

These SBMs do not require immediate attention toward design strategies, however, in long-term calls for product design for durability, and new partnerships in the network for supporting the value recovery processes, e.g., repairing and washing or end-of-life recycling. VIGGA, for instance, collaborates with an external recycling facility where the baby clothes no longer fit for circulation (roughly after 82 weeks) are transferred to recycle the fibers.

The fundamental change brought but various SBMs representing this archetype are in terms of reducing the material throughput and resource consumption patterns in the industrial system, and enhancing durability and longevity by increasing the active usage time of the product through reparability, upgradability, etc. (Reim et al. 2015). However, it is uncertain whether PSSs are truly ecoefficient—renting or leasing may not tend to displace purchase of newer products—unless being considered simultaneously with other archetypes, for example, "creating value for waste," as in case of sharing of secondhand clothes or recycling (Bocken et al. 2014).

3.5 Archetype 5—Adopt a Stewardship Role

Along this archetype, companies engage in undertaking corporate stewardship, meaning a role to ensure positive impact on the health and well-being of the stakeholders (society and environment).

Typically, the consumer pays a price premium to fund the benefits of such stewardship role executed by manufacturer or retailer along the supply chain. Upstream stewardship activities incorporate choice of supplier and production system to deliver ethical and sustainable business practices, such as fair labor wages, corporate citizenship and community development, and environmental protection. In the TCF industries, brands and retailers increasingly show upstream stewardship by reconfiguring their networks to ensure accredited suppliers and production processes.

One exemplar of exercising stewardship is through third-party certification schemes which are availed to show compliance to set standards and be transparent to the consumers about the production and supply chain operations. Numerous ecolabels are available in the market (e.g., EU Ecolabel, Nordic Ecolabel, Swedish Bra Miljöval, Bluesign, GOTS (for organic textiles), Ökotex (for harmful chemicals, etc.) aimed at facilitating, supporting, or monitoring sustainable practices in sourcing and production (Pal 2014); in addition, individual companies have developed their own labels, e.g., H&M Conscious (Norden 2015).

From the process level, such standards and ecolabels like Bluesign® system drives toward sustainable textile production through management of "Input Stream" from raw materials to chemical components, to eliminate harmful substances from the beginning of the manufacturing process and set and control standards for an environmentally friendly, safer production (Pal 2014). This ensures that the final textile product meets very stringent consumer safety requirements worldwide, but also provides confidence to the consumer to acquire a sustainable product. On the one hand, Bocken et al. (2014) highlight that such stewardship strategies can generate greater brand value and potential for premium pricing and Norden (2015) states that this is not yet certain in the TCF sector.

The Higgs Index is a widely accepted tool developed by sustainable apparel coalition (SAC) that measures the environmental and social impact of fashion supply chains. Fashion brands, such as H&M, Patagonia, Adidas, Asics, Coca-Cola Company, New Balance, Nike, and Puma, as a member, can self-assess their sustainability efforts throughout a product's entire life cycle and design their scoring scale to communicate a product's sustainability impact to consumers and other stakeholders (Pal 2014; Sustainable Apparel Coalition 2016). SAC through its alliance actively strives to measure and benchmark sustainability performance and achieve environmental and social transparency that consumers are starting to demand, hence advocate responsibility.

In connection, public green procurement of textiles and apparel is yet another initiative taken at the EU level to determine and guarantee the import of higher amount of resource-efficient products those meeting certain quality parameters

based upon the European standards that are commonly used throughout the industry. Currently, this is set as a voluntary guideline by EU to procure 50 % based upon green procurement criteria but is aimed to be a directive in future (Norden 2015). Similarly, a Nordic guideline and cooperation on green procurement is set to be launched in 2016 to stipulate criteria for ecolabelling, environmental management, reuse, and the durability of textiles. This considerably demands network configuration and collaboration, as for example, the initiative will promote the joint initiative between the ecolabelling organizations and the industry to develop marketing ideas, collaborative relationship with manufacturers and brands who aim to have the ecolabel on their products, and also with producers and subcontractors.

Along the supply chain, such certifications, standards, and ecolabels are supposed to enhance visibility and radical transparency about environmental/social impacts. For example, Nike through Fair Labor Organization (FLA), an NGO, openly shares the results of the audits of its suppliers including disclosure of its factory details for maintaining degrees of transparency. Further, it has developed a Sourcing and Manufacturing Sustainability Index for assessing the strategic performance of its sourcing and publishes it in yearly Corporate Social Responsibility (CSR) report. Similarly, Nudie Jeans through its Web site shares the complete production guide which includes details of its suppliers, locations, audit reports, production capacities, and conditions. In addition, it discloses information about CSR, by publishing the code of conduct, social report, brand performance check report, etc., publicly through its Webpage. Many other fashion brands and designers have started to get associated to ethical and fair trade fashion; for example, the Ethical Fashion Initiative is a project initiated by the International Trade Centre aimed at responsible fashion industry by linking high-end fashion designers such as Vivienne Westwood, Karen Walker, Marni, and Stella McCartney with marginalized artisans in a number of African countries (Smith and Newman 2014). This ensures a number of benefits: Workers earn a living wage, are offered dignified working conditions, and minimize impact on the environment (Ethical Fashion Initiative 2016).

From the retailers' frontier, another way to show stewardship is through "choice editing," which refers to how brands and retailers cut out environmentally offensive products and introduce real sustainable choices on the shelves for their mainstream consumers (Sustainable Consumption Roundtable 2006). Various strategies followed are, such as (i) removing products from commercial consideration, or (ii) making products expensive to use, which directly impacts the consumption and aims to only provide sustainable products in the market. Choice editing also incorporates editing out or replacing product components, processes, and business models in partnership with other actors in society such as policy-makers (WBCSD 2008). Adidas Group, for example, takes a proactive step to control its globally dispersed supply chain and actively edit the environmental impact, by supporting its suppliers in order to reduce their environmental impact by developing training

materials, technical guidelines, and workshop tailored to each supplier's special need (WBCSD 2008). Teijin, on the other hand, has shifted its focus toward editing of business process model by developing a recycling system for polyester (under its ECO CIRCLE program) which reduces energy and resource use, CO_2 emission, and waste. Such a closed-loop recycling business is established in partnership with a global network of companies that collect polyester garments for recycling and advocate the development and marketing of products containing recycled polyester (Teijin 2016; WBCSD 2008).

Additionally, clothing brands and retailers undertake downstream stewardship by implementing extended responsibility even after selling away the product. Unlike many sectors, e.g., waste electrical and electronic equipment (WEEE) where such responsibilities are mandatory and are set under environmental producer responsibility (EPR) directives, in textile and clothing, no country except France has a mandatory EPR scheme. However, to ensure greater responsibility from the brands and retailers importing garments, a proposal is drawn up in some Nordic countries, to ensure some sort of "polluter pays principle" commitment (Ekvall et al. 2014). This includes planning for and, if necessary, paying for the recycling or disposal of the product at the end of its useful life. This may be achieved partly by redesigning products to use fewer harmful substances, to be more durable, reusable, and recyclable, and to make products from recycled materials. For retailers and consumers, this means taking an active role in ensuring the proper disposal or recycling of an end-of-life product. Implementation of such EPR schemes in TCF sectors are mend to implement an extensive system where the importers execute responsibility in take-back schemes for collection of used/waste textiles and clothes. Such stewardship role through exercising EPR schemes, mandatory or voluntary for showing individual and collective responsibility, is expected to increase the potential for recycling and reuse of textiles and also generate scope for new SBMs and have been increasingly prioritized in EU and Nordic Region (Ekvall et al. 2014). Carefully designed EPR schemes can provide various incentives and upstream effects to the stakeholders, for example, rebates on producer participation fees, reductions in the use of certain chemicals during the production of textiles, designing for a longer life, and avoiding fiber mixes to allow easier recycling at end of life (Ekvall et al. 2014; Lindhqvist 1992).

3.6 Archetype 6—Encourage Sufficiency

Encouraging sufficiency actively seeks to reduce or moderate rate and volume of consumption, thus leading to a fundamental change in the Western economic model based on market economy, throwaway paradigm, and planned obsolescence (Bocken and Short 2016; Jackson 2009; Mont 2008).

Drivers of such business model innovation for sustainability lie in "curbing demand through education and consumer engagement, making products that last

longer and avoiding built-in obsolescence, focusing on satisfying 'needs,' rather than promoting 'wants' and fast fashion, conscious sales and marketing techniques, new revenue models, or innovative technology solutions" (Bocken and Short 2016).

Bocken and Short (2016) further highlights that such sufficiency-based business model innovations adopt varied value creating logic, as specified above and together with other SBM archetypes can be seen as a holistic strategy to reduce overconsumption and production leading to a sustainable future. This certainly goes beyond the commitments of earlier stated ecoefficiency-based business models (e.g., saving energy and materials, green economy, and circular economy) which may facilitate rebound-effects where efficiency gains lead to more consumption (Bocken et al. 2014; Druckman et al. 2011).

Sufficiency being embedded through the holistic design of the business model across all aspects of business focusses in many ways toward product design changes to enhance durability, reparability, and longevity (Bocken et al. 2014; De Groene Zaak and Ethica 2015). Many luxury brands, for instance, offer timeless design and high degrees of craftsmanship and promote "slow fashion" which ensures diverse practices of supporting local manufacturing, durable or timeless product designs, reuse activities, and slow consumption (Fletcher 2010; Fletcher and Grose 2012). Apart from paying a high premium price which in most cases reflects upon high degrees of artisanal production and high-grade materials, consumers also develop a strong emotional attachment with the product, thus instigating longevity in usage. This has the potential to eschew fast fashion trends. Other luxury and slow fashion brands, apart from contributing to sustainability along other archetypes, have been able to generate their timeless design profile vis-à-vis improved ethical practices and improving traceability to embed sufficiency. In the recent year, particular attention has been shown in research frontier toward investigating sustainability and luxury together, considering their striking similarity. The Center for Studies on Sustainable Luxury (Center for Study of Sustainable Luxury 2016) in Argentina is one such research group that explores how luxury brands could represent the greatest positive contribution to people and planet by creating "deeper," "more authentic" meaning of "luxury" to motivate social and environmental performance.

From the social perspective, many luxury and slow fashion brands have embraced ethical practices to communicate sufficiency. People tree, for instance, is a UK-based slow fashion fair trade brand working closely with textile women artisan groups from Bangladesh to help them meet environmental standards, promote ethical sourcing and social value creation, vis-à-vis ethical consumption of hand woven and natural dyed products—thus eliminating built-in obsolescence. As mentioned above under Archetype 5, the Ethical Fashion Initiative promotes responsibility along the fashion value chain by ensuring a number of benefits to the workers, e.g., earning a living wage, dignified working conditions and minimum impact on the environment and on the other hand communicates this added value and quality brought by artisanal production (Ethical Fashion Initiative 2016) to

promote "buy less for more" concept. Larger companies, such as Patagonia and Nudie Jeans, take much more diverse efforts in communicating sufficiency through their business. Patagonia, for instance, engages with activities for moderating sales by organizing manipulative consumer marketing campaigns, no sales incentives, choice editing, etc. One way of communicating their unique business model has been via their "don't buy this jacket" campaign intending to encourage people to consider the effect of consumerism on the environment and purchase only what they need (Ekvall et al. 2014). In addition, Patagonia's "Common Threads Initiative" supports "reduce, repair, reuse, and recycle" activities emphasizing the waste hierarchy. Partnerships with iFixit teaches customers how to repair their gear to increase the useful life of products under the "Buy Less, Repair More" campaign (iFixit 2015), while that with online marketplace e-Bay supports and encourages reuse of secondhand Patagonia clothing once unrepairable. This promotes diverse value creating logic, while follow-on repair services yields long-term customer relationships and trust, leading to loyalty and reputational benefits, collaboration with online marketplace renders a strong resale value of used product, thus encouraging customers pay premium price. As mentioned above, Nudie Jeans similarly encourages sufficiency along its eco-cycle initiative (Nudie 2015); Nudie Repair shops help its customers to repair worn out jeans free of charge or give back the jeans totally, which is then washed and repaired and put back in the shop as a secondhand item for sales (Pal 2016). Likewise, smaller designer-led initiatives have also emerged in the scene in the recent years which promote sufficiency by offering value regaining services. Both online and physical platforms and initiatives have been launched which offer redesign or repairing solutions as pay-per services or completely free of cost, or educational awareness through lessons. By embodying multiple mechanisms within the business model, these SBMs render sufficiency along with. For example, Dream and Awake is a small designer-led initiative in Sweden that collects or buys old vintage clothes from the market and redesigns, photographs, and finally sells them through mobile studios. It also involves with organizing redesign workshops with wearers in providing designs, facilities, and equipment to help them redesign their own clothes (Pal 2016). This way, it drives redesign service-oriented initiative to encourage people to mend their garments and extend their use value thus potentially slow down the replacement cycle.

In general, the argument whether reuse and sales of secondhand clothes contribute positively toward sufficiency is dichotomous. Bocken and Short (2016) highlight that sales of secondhand goods may incentivize owners to take more care of the products to ensure higher secondhand value; however, Ekvall et al. (2014) in contrast claim that the displacement effect may be negligible considering that most of the time the secondhand garments donated to charities are not priced or when disposed via take-back schemes are valued by a reward mechanism which may instigate newer purchases. However, some luxury secondhand shops (Affordable Luxury, Beyond Retro) unlike the other resale arrangements run for profit, where individuals can leave their garments for sale, and then split the profit with the

consignment shop. This can increase levels of reuse by making use of the large amounts of clothes which are hanging unused in wardrobes by giving them a value.

3.7 *Archetype 7—Repurpose the Business for Society/Environment*

Social enterprises and social businesses are those which prioritize social and environmental benefits rather than the economic profits, by incorporating a "social profit equation" into the business model (Bocken et al. 2014; Yunus et al. 2010). Social business was defined by Nobel laureate Professor Muhammad Yunus as "the new kind of capitalism that serves humanity's most pressing needs" (Yunus 2007).

Between for-profit and nonprofit business approaches, social enterprises are driven by the fundamental purpose of delivering social and environmental benefits primarily, however, not overlooking the economic aspect of it. The benefits are mainly in terms of creating self-sustaining business operations by either: (i) focusing on businesses dealing with social objectives only, or (ii) by taking up any profitable business (so long as it is owned by the poor and the disadvantaged) who can gain through receiving direct dividends or by some indirect benefits (Yunus 2007).

On the one hand, various charity organizations fundamentally work along the nonprofit concept in the secondhand clothing sector by solely committing to collection of used clothes from Western countries and arranging donations for humanitarian purposes in under-developed nations and for emergency responses in crises regions. Red Cross, Salvation Army, and Oxfam are the large charity organizations working globally to take part in such activities.

However, these organizations are increasingly being noted to run a hybrid business model, whereby two business entities coexist, one operating as a traditional for-profit business, but using part of the profit stream to finance a second not-for-profit enterprise (Bocken et al. 2014). For instance, in the secondhand clothing sector, Salvation Army has developed its trading arm called Salvation Army Trading Company Limited (SATCoL) which processes the donated clothes and exports it to buyers in Eastern Europe; Oxfam International (an exported-oriented subsidiary of Oxfam) on the other hand exports 50 % of its total collection to West Africa to traders in those markets, thus creating business opportunities (Brooks 2013). Similarly, Fretex is company managing textile collection operation in Norway and is owned by The Salvation Army. Fretex International, jointly owned by Fretex, Norway, and Myrona, Sweden, is the wing that generates business opportunities by exporting part of the collected garments to Africa and Asia. Sometimes such operating models are classified by charities as social businesses, defending the profit-making export orientation, by organizing

value-added activities locally in poorer countries. Oxfam, for instance, has established a pilot local processing enterprise in Senegal called *Frip Ethique* aimed at generating local employment (Brooks 2013). However, there are a lot of rising criticisms against this trade as underlying business motives and transactions are often not publicized and are concealed back-stage in contrast to the foregrounded charitable acts of donation (Brooks 2013). On the other hand, there are small fashion social enterprises with diverse social fundaments, such as supporting recovering addicts, refugees, and aging. The North Circular is a UK-based producer of luxury knitwear that uses a local network of talented home knitters (mostly aging woman) to mobilize localized production (The North Circular 2016), while Who Made Your Pants?, an UK-based Lingerie brand, employs and supports women refugees from the Southampton area. Set up as workers' cooperative, it is funded by small grants and revenue and any profit made is returned to the business and any leftover is shared between the members and democratically agreed good causes (Reddy 2014).

On a systems level, such social and/or hybrid business models integrate business with varied stakeholders through participatory approaches, which may include nontraditional approaches (e.g., collaboration between for-profit and nonprofit organizations or with the local community) or new organizational designs (e.g., hybrid structures).

Interorganizational collaboration in this regard has emerged very strongly to shift from the fundamentals of ego-centric business models to more altruistic collaborative business models (CBMs). CBMs in this context refer to a value creating system or network where multiple organizations that might differ in type (industry, public research, nonprofit), their position in the value chain (manufacturing, service, etc.), and industry and work together to create and capture value at the systemic level, more than the value created and captured for each stakeholder (Breuer and Lüdeke-Freund 2014; Rohrbeck et al. 2013). In a smaller level, the charity organizations have collaborated with fashion retailers to organize collection and take-back schemes, with logistics providers for easy in situ collections and distributions, and sometimes with reprocessing organizations like laundries. Fretex for instance cooperate with major retailers like Lindex in Sweden for collection, and also with Norwegian Postal Service to provide the possibility to consumers to discard their old clothes in specially designed bags. Major fashion retailers and brands, for example, have either organized secondhand sales business on their own (especially brands, e.g., Fillipa K, Boomerang) or in collaboration with global sorters like I: Collect, as done by H&M. Any financial profit made through such initiative is utilized for social and charitable activities. For example, H&M donates 0.02 euro to a local charity organization for each kilogram of clothes.

Another aspect of such socially driven business enterprises and cooperatives is the aspect of localness and upliftment of local community. Several initiatives have

already originated in Asia and Africa aimed at empowering women and driving community forward. As mentioned earlier, SEW and Sidai Designs are some exemplar cases of fashion social enterprises as well, providing sustainable employment to Tanzanian women by selling their designs and/or ethically manufactured collections through several retailers in the UK, USA, and Australia (Smith and Newman 2014). While on the one end, ethical fashion as mentioned above creates opportunity for established fashion houses to execute corporate stewardship and on the other provides scope for development of a local manufacturing industry in poorer countries by upholding marginalized artisanship.

3.8 Archetype 8—Develop Scale-up Solutions

Beyond the traditional view on scaling-up businesses through product-process optimization and standardization, widespread implementation of SBMs requires alternative thinking on scalability. Currently, even though various SBMs have emerged in the scene with positive impact, they are mostly small scale or niche. As in other industries, TCF industries face the same challenge in terms of scaling-up sustainable business models and ideas. Although large firms (manufacturers and retailers), e.g., H&M, G-Star, are in the forefront of driving sustainability, these initiatives are still in their infancy compared to mainstream business models. For instance, H&M in cooperation with I:Co has entered into a take-back arrangement to collect used clothes from consumers, but the extent is of the order of 7600 tons (in 2014), compared to the amount of clothing sold worldwide every year ($\sim$150 million tons) or disposed-off. New start-ups and small businesses undertaking the more radical innovations are also at a niche or small scale. Thus, the need to scale-up SBMs to a global mainstream level is of utmost importance. Bocken et al. (2014) provide many exemplary cases underpinning this archetype, out of which many can be seen to be emerging strongly in the TCF sector, viz. peer-to-peer (P2P), crowd-based, platform-based, open innovation, cocreation, and digitalization.

Collaborative business models in this context provide a scope for rapid scaling up and include various exemplar cases, such as crowd-sourcing/crowdfunding and open innovation. Collaborative networked organizations (CNOs) tend to open up their boundaries to provide opportunities for other businesses to thrive (Saebi and Foss 2014). Such collaborations can be the basis for cocreating products or for crowd-sourcing ideas. Such cocreation spans from passive involvement of users, as in niche e-commerce for pretailing, to mass customization to active user involvement, where the users are also involved as "inventors." Threadless is an online community of artists and an e-commerce Web site based in Chicago, which involves such "inventive" users by putting designs created and chosen by the online

user community to a public vote. A week later, the top-scoring designs are reviewed by the staff to put into production each week and are finally sold worldwide. Designers whose work is printed receive 20 % royalties based on the net profits and $250 in Threadless gift cards. Such crowd-sourced business model attains scalability through its innovative network and active engagement with the user community. Many similar online crowdfunding start-ups, such as Out of X, Carte Blanche, and Cut on Your Bias, are aimed at demand management by the use of system, software, and other communication channels.

In a value network context, such crowd-sourced models and CNOs can be open platforms assimilated through information technology (IT) tools to integrate producers, suppliers, and customers along various activities (Liu et al. 2014; Romero and Molina 2011). Such multi-sided platforms act as an intermediary between sellers and buyers as in case of online marketplaces, thus connecting multiple stakeholders, third parties, and consumers. Open Garments is an EU-funded research initiative based upon such open innovation concept where: (i) a virtual user consumer community designs, configures, orders, publishes, shares, and even sell individual garments; (ii) an open manufacturing-based flexible network of production units (mainly microenterprises) produces customized physical goods; and (iii) a knowledge-based manufacturing service provider (MSP), which is the open platform, acts as a service provider in between (Open Garments 2009). Such open innovation platforms, apart from redefining the collaborative format (where users are designers), also attempt to change the consumption pattern by radically influencing the production model. Mina et al. (2014) explain that the service innovators as a central component of such platform of interactions (e.g., Web-based collaboration platforms) support both upstream and downstream activities and are responsible for building the infrastructure to connect other stakeholders, third parties, and consumers.

On the other hand, such platforms can be also at the P2P level as in case of Web-based swapping platforms, e.g., Kleiderkreisel offers online platform-based sales and purchase services for used clothes. It further offers its members social networking and communications to promote collaborative consumption and swapping through the creation of a platform-based community. Such platforms for P2P interaction aim at either value cocreation or collaborative consumption.

4 Sustainable Design Elements

The core notion of sustainable design is uphold by systems thinking (Evans et al. 2009), aimed at creating a sustaining industrial system based upon product, process, and facility design, for enhancing the well-being of nature and culture while

generating economic value (McDonough and Braungart 2002). The traditional perspective of sustainable design encompasses the intention to "eliminate negative environmental impact" through manifestations of renewable resources, ecoefficiency, etc., thus impacting the environment minimally. In-line with Tischner and Charter (2001), this encompasses the aspects of repair and refine, thus emphasizing the notion of "[…] modifications to existing products, with some movement toward increasing the eco-efficiency of existing products."

However, beyond the "elimination of negative environmental impact," sustainable design must create meaningful innovations that can create a dynamic balance between economy and society, intended to generate long-term relationships between user and object/service. Tischner and Charter (2001) propose that this addresses a redesign approach, especially in the use of new technologies and materials to reduce the environmental impact of products. Managing such innovations from a value network perspective fosters cross-industry partnerships such that different actors can cultivate their strengths such as regional presence, customer and market access, legislative power, infrastructure competencies, and know-how (Breuer and Lüdeke-Freund 2014; Calia et al. 2007). Niinimäki and Hassi (2011) further highlight the need to focus on both production and consumption, as a system in whole, for creating sustainable development. Hence, this requires *rethinking*, or a radical change in mind-set, and it can offer breakthroughs for new lifestyles, the ways of living and doing things, as well as approaches to fulfill consumer needs in a more sustainable manner. This approach leads to strategic innovations for generating SBMs and is underpinned by design for sustainability in any industrial system along 5 key design elements:

1. Product design,
2. Process design,
3. Value network design,
4. Relational design, and
5. Design of "new" consumption pattern.

Table 1 shows a breakdown of the SBMs discussed under each archetype (in Sect. 3) into their corresponding design elements.

Nonrepresentation under any particular design element for an archetype does not mean that those archetypes are devoid of or not underpinned by a suitable design strategy, but merely shows that those elements are not the key aspects underlying the design of the archetype. Further, these design elements (and strategies) under an archetype are not mutually exhaustive and in most cases are integrally related to other design elements (and strategies), thus adopting a systemic perspective. In addition, some of the archetypes are overlapping (e.g., Archetype 2: "Creating value from waste," and Archetype 4: "Deliver functionality rather than ownership"); hence, some of the exemplar SBM cases along with their underlying design elements (and strategies) cannot be uniquely categorized under one archetype.

Table 1 SBM archetypes along 5 design elements

Archetypes (*major initiatives*)	Design elements				
	Product	Process	Value network	Relational	Consumption pattern
Archetype 1 *Company-driven initiatives* (*Clothing Continental*), *Materialise*	✓ • Ecoproduct design (dematerialization or multi-functionality) • Circular/regenerative design (e.g., mono-materiality, modular design) • 3D printing	✓ • Lean for waste reduction (higher efficiency) • Cleaner Production (use of renewable sources) • Additive manufacturing	✓ • Collaboration between designers, engineers, and developers		
Archetype 2 *FIBERSORT, Relooping Fashion, Worn Again, Pure Waste, Dutch aWEARness, Returnity, Econyl, Net-Works*	✓ • Design for longevity, durability, ease of maintenance and repair, and if required upgradability • Redesign-make (e.g., easy disassembly and assembly) • Cradle-to-cradle • Robust design • Timeless design • Customized design	✓ • Repairing, upgrading, remanufacturing • Sorting techniques and fiber separation processes • Recycling process and technology	✓ • Reverse logistics (e.g., for take-back schemes) • Collaborative networks based on complementary process expertise (for "closing the loop" activities/operations) • Circular supply chain system and information management • Inclusive business networks	✓ • P2P interaction • Long term with clients/users through access to service • Ethical supply and CSR	✓ • Sharing (use oriented) • Collaborative (P2P) • Product as service • Reduced obsolescence of desire and extended product life span
Archetype 3 *LAUNCH Nordic, ZERI, Detox campaigns, Bio Innovation, Re: newcell, STING*	✓ • Green product design (e.g., green chemistry, biobased) • Regenerative products • Biomimetics	✓ • Green and benign manufacturing • Zero waste and emission processes	✓ • Private–public collaborations for complementary process expertise	✓ • Transparency through manufacturing information sharing • Collaborations between global partners and multi-nationals	

(continued)

Table 1 (continued)

Archetypes (*major initiatives*)	Design elements				
	Product	Process	Value network	Relational	Consumption pattern
Archetype 4 *Company-driven initiatives* (*MUD Jeans, Nudie, VIGGA, Swapping platforms, online marketplaces, renting and leasing*)	✓ • Product-service instead of product • Design for durability, upgradability, reparability, …	✓ • Repairing, upgrading, and maintenance	✓ • Collaborative network of partners for supporting value recovery processes	✓ • Long term with clients/users through access to service • P2P interaction	✓ • Sharing (use oriented) • Collaborative (P2P) • Product as service • Reduced obsolescence of desire and extended product life span
Archetype 5 *Sustainable Apparel Coalition, Ecolabel initiatives, Company-driven initiatives, The Ethical Fashion Initiative, ECO CIRCLE*	✓ • Circular/regenerative design	✓ • Input stream management • Green public procurement • Process editing	✓ • Reconfigured network of accredited suppliers and production processes • Joint initiatives (e.g., between industry and certifiers) • Inclusive business networks • Network of partners for supporting value recovery processes	✓ • Upstream stewardship through supplier compliance and governance • Upstream stewardship through transparent communication • Collaborative relationship with manufacturers and brands • Downstream stewardship through EPR	✓ • Choice editing

(continued)

Table 1 (continued)

Archetypes (*major initiatives*)	Design elements				
	Product	Process	Value network	Relational	Consumption pattern
Archetype 6 *Company-driven initiatives (e.g., Patagonia, Nudie, People Tree, luxury and slow fashion brands), Center for Studies on Sustainable Luxury, The Ethical Fashion Initiative*	✓ • Design for durability, reparability and longevity • Slow fashion	✓ • Local or artisanal production • Repairing, upgrading, and maintenance	✓ • Local value network • Collaborative networks (for "closing the loop" activities/operations)	✓ • Consumer education and engagement • Emotional attachment with product • Transparency of ethical practices and traceability	✓ • Satisfying "needs" rather than promoting "wants" • Reduced obsolescence of desire and extended product life span
Archetype 7 *Charity-driven hybrid businesses, Social business-driven, Yunus Centre, Fashion social enterprises*			✓ • Inclusive business networks • Promoting local value networks • Cooperatives • Collaborative networks between industry, public research, nonprofit	✓ • Local community development	✓ • Extended product life span (after end of use/end of life) • Ethical consumption paying premium
Archetype 8 *Company-driven initiatives (e.g., Threadless, Cut on Your Bias), online marketplaces, Open Garments, Swapping platforms*	✓ • Product cocreation, Crowd-sourced design		✓ • Collaborative open and flexible networks • IT-enabled integration of producers, suppliers and customers	✓ • Passive to active user involvement • P2P interaction • Social networking	✓ • Cocreation • Collaborative (P2P)

5 Concluding Remarks

The literature and practice of innovations for sustainability is gaining increasing momentum amidst the ardent need for designing a sustainable society and economy. The TCF industries being the most resource draining and socially unethical in nature call for increased attention. Despite this, as Bocken et al. (2014) highlighted, both knowledge and industrial practices are fragmented and thus need subsequent categorization to make the ongoing and future initiatives more streamlined and impactful. This chapter uses the archetypes proposed in Bocken et al. (2014) (aimed to categorize and explain SBMs) as the starting point, in context to TCF industries, and goes further to identify the key design elements underpinning these SBMs (along the archetypes). The knowledge of these key design elements, upholding a system thinking approach, will further assist both research and industry to strategically develop their SBMs by (i) identifying which design elements need further intervention or modification, (ii) how to enhance sustainability impacts by combining design strategies from other archetypes, and (iii) how to enable a business model change subsequently to derisk the innovation process.

References

Alkazam (2013) Textile science & engineering automated sorting technology from t4t can help improve recovery and efficiency. J Text Sci Eng 3(3):3–5

Aneja A, Pal R (2015) Textile sustainability: major frameworks and strategic solutions. In: Muthu SS (ed) Handbook of sustainable apparel production. CRC Press, Boca Raton, pp 289–306

Bio Innovation (2016) Etablera närodlad textil i Sverige [Establish locally produced textiles in Sweden]. http://www.bioinnovation.se/projekt/narodlad-textil-i-sverige/. Accessed Apr 2016

Bocken NMP, Short SW (2016) Towards a sufficiency-driven business model: experiences and opportunities. Environ Innov Soc Transitions 18:41–61

Bocken NMP, Short SW, Rana P, Evans S (2013) A value mapping tool for sustainable business modelling. Corp Gov 13(5):482–497

Bocken NMP, Short SW, Rana P, Evans S (2014) A literature and practice review to develop sustainable business model archetypes. J Clean Prod 65:42–56

Boons F, Lüdeke-Freund F (2013) Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. J Clean Prod 45:9–19

Breuer H, Lüdeke-Freund F (2014) Normative innovation for sustainable business models in value networks. Paper presented at the XXV ISPIM conference—Innovation for Sustainable Economy & Society, Dublin, Ireland

Brooks A (2013) Stretching global production networks: the international second-hand clothing trade. Geoforum 44:10–22

Brundtland Report (1987) World commission on environment and development: our common future. Oxford University Press, UK

Calia R, Guerrini F, Moura G (2007) Innovation networks: from technological development to business model reconfiguration. Technovation 27(8):426–432

Center for Study of Sustainable Luxury (2016) http://lujosustentable-eng.org.ar/. Accessed Apr 2016

Circle Economy (2015) Service-based business models and circular strategies for textiles. In: SITRA (ed) Amsterdam
CloPeMa (2015) Clothes perception and manipulation. http://www.clopema.eu/. Accessed Nov 2015
DEFRA (2008) Sustainable clothing roadmap briefing note. Dec 2007
De Groene Zaak, Ethica (2015) Boosting circular design for a circular economy. In E. C. K. P. i. Practice (ed)
Detox Outdoor (2016) http://detox-outdoor.org/en/campaign/. Accessed Apr 2016
Druckman A, Chitnis M, Sorrell S, Jackson T (2011) Missing carbon reductions? Exploring rebound and backfire effects in UK households. Energy Policy 39:3572–3581
Dutch Awearness (2016) http://dutchawearness.com/chain-management/. Accessed Apr 2016
Eadie L, Ghosh TK (2011) Biomimicry in textiles: past, present and potential. An overview. J R Soc Interface 8(59):761–775
Ekvall T, Watson D, Kiørboe N, Palm D, Tekie H, Harris H, … Lyng K-A (2014) EPR systems and new business models: reuse and recycling of textiles in the Nordic region. In Norden (ed) TemaNord, ISSN 0908-6692; 2014:539. Copenhagen
Ellen McArthur Foundation (2013) Towards the circular economy. Economic and business rationale for an accelerated transition, vol 1. Ellen MacArthur Foundation
Ethical Fashion Initiative (2016) http://ethicalfashioninitiative.org/. Accessed Apr 2016
Evans S, Bergendahl M, Gregory M, Ryan C (2009) Towards a sustainable industrial system. With recommendations for education, research, industry and policy. http://www.ifm.eng.cam.ac.uk/uploads/Resources/Reports/industrial_sustainability_report.pdf. Accessed Apr 2016
Fletcher K (2008) Sustainable fashion and textiles: design journeys. Earthscan, London
Fletcher K (2010) Slow fashion: an invitation for systems change. Fashion Pract 2(2):259–266
Fletcher K, Grose L (2012) Fashion and sustainability: design for change. Laurence King Publishers, London
Fuad-Luke A (2009) Design activism: beautiful strangeness for a sustainable world. Earthscan, London
Gardetti MA (2016) Cubreme® and sustainable value creation: a diagnosis. In: Muthu SS, Gardetti MA (eds) Green fashion, vol 1. Springer, Singapore, pp 1–23
Global Footprint Network (2014) http://www.footprintnetwork.org/en/index.php/GFN/page/world_footprint/. February
Green Product A (2014) Nettles in textiles. https://www.gp-award.com/en/produkte/nettles-textiles. Accessed Apr 2016
Green Technica (2012) Renewable energy & clean technology: keys to a revitalization of US manufacturing & job creation. http://cleantechnica.com/2012/04/15/green-manufacturing/. Accessed Apr 2016)
GreenPeace (2016) The detox campaign. http://www.greenpeace.org/international/en/campaigns/detox/water/detox/intro/. Accessed Apr 2016
Gwilt A (2014) A practical guide to sustainable fashion. Bloomsbury Publishing, London
Hart SL, Milstein MB (2003) Creating sustainable value. Acad Manag Executive 17(1):56–69
Hethorn J, Ulasewicz C (2008) Sustainable fashion, why now? A conversation about issues, practices, and possibilities. Fairchild Books, New York
iFixit (2015) Patagonia care & repair. https://www.ifixit.com/patagonia. Accessed Apr 2016
ING Economics Department (2015) Rethinking finance in a circular economy: financial implications of circular business models. The Netherlands
Jackson T (2009) Prosperity without growth: economics for a finite planet. Earthscan, London
LAUNCH Nordic (2016) Nordic: textiles. http://www.launch.org/challenges/nordic-textiles#readmore. Accessed Apr 2016
Lindhqvist T (1992) Extended producer responsibility as a strategy to promote cleaner production. Paper presented at the proceedings of the invitational seminar, Trolleholm Castle, Sweden
Liu CH, Chen M-C, Tu Y-H, Wang C-C (2014) Constructing a sustainable service business model: An S-D logic-based integrated product service system (IPSS). Int J Phys Distrib Logistics Manag 44(1–2):80–97

Lüdeke-Freund F (2010) Towards a conceptual framework of business models for sustainability. Paper presented at the ERSCP-EMU conference, Delft, The Netherlands
McDonough W, Braungart M (2002) Design for the triple top line: new tools for sustainable commerce. Corp Environ Strategy 9(3):251–258
Mina A, Bascavusoglu-Moreau E, Hughes A (2014) Open service innovation and the firm's search for external knowledge. Res Policy 43(5):853–866
Mont O (2008) Innovative approaches to optimising design and use of durable consumer goods. Int J Prod Dev 6(3/4):227–250
Mud Jeans (2016) http://www.mudjeans.eu/lease-philosophy/. Accessed Apr 2016
Net-works (2016) http://net-works.com/. Accessed Apr 2016
Niinimäki K, Hassi L (2011) Emerging design strategies in sustainable production and consumption of textiles and clothing. J Clean Prod 19:1876–1883
Norden (2015) Well dressed in a clean environment: nordic action plan for sustainable fashion and textiles. In N. C. o. Ministers (ed). Copenhagen
Nudie (2015) http://www.nudiejeans.com/reuse/#/nudie-jeans-good-environmental-choice/ (14 Aug 2015)
Open Garments (2009) http://www.open-garments.eu/approach.html. Accessed Apr 2016
Packard V (1963) The waste maker. Penguin, London
Pal R (2014) Sustainable business development through designing approaches for fashion value chains. In: Muthu SS (ed) Roadmap to sustainable textiles and clothing. Singapore, Springer
Pal R (2015) EPR-systems and new business models for sustained value creation: a study of second-hand clothing networks in Sweden. Paper presented at the 15th AUTEX world textile conference, Bucharest, Romania
Pal R (2016) Sustainable value generation through post-retail initiatives: an exploratory study of slow and fast fashion businesses. In: Muthu SS, Gardetti MA (eds) Green fashion, vol 1. Springer, Singapore, pp 127–158
Pedersen ER, Netter S (2015) Collaborative consumption: business model opportunities and barriers for fashion libraries. J Fashion Mark Manag 19(3):258–273
Perella M (2015) New fabrics make recycling possible, but are they suitable for high street? The Guardian. http://www.theguardian.com/sustainable-business/sustainable-fashion-blog/2015/jan/22/fabric-recycling-closed-loop-process-high-street-fashion. Accessed Apr 2016
Pure waste (2016) http://www.purewaste.org/company/about-us.html. Accessed Apr 2016
Reddy J (2014) UK fashion social enterprises support recovering addicts, refugees and ageing. The Guardian. http://www.theguardian.com/sustainable-business/sustainable-fashion-blog/uk-social-enterprise-fashion-support-refugees-women. Accssed Apr 2016
Reim W, Parida V, Örtqvist D (2015) Product–service systems (PSS) business models and tactics—a systematic literature review. J Clean Prod 97:61–75
ReLooping Fashion (2016) http://reloopingfashion.org/. Accssed Apr 2016
Re:newcell (2016) The business concept. http://renewcell.se/. Accssed Apr 2016
Retextile (2016) http://retextile.se/en/home/. Accssed Apr 2016
Rockström J, Klum M (2012) The human quest: prospering within planetary boundaries. Langenskiöld, Stockholm
Rohrbeck R, Konnertz L, Knab S (2013) Collaborative business modelling for systemic and sustainability innovations. Int J Technol Manage 63(1–2):4–23. doi:10.1504/ijtm.2013.055577
Romero D, Molina A (2011) Collaborative networked organisations and customer communities: value co-creation and co-innovation in the networking era. Prod Plan Control Manag Oper 22 (5–6):447–472
Saebi T, Foss NJ (2014) Business models for open innovation: matching heterogenous open innovation strategies with business model dimensions. Social Science Research Network (SSRN). http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2493736 (22 July 2015)
Sinha P, Muthu SS, Dissanayake G (2015) Remanufactured fashion. Springer, Singapore
Smith J, Newman M (2014) Fashion can create sustainable employment for marginalised women. The Guardian. http://www.theguardian.com/sustainable-business/sustainable-fashion-blog/fashion-social-enterprise-sustainable-employment-women. Accessed Apr 2016

Stahel W (2007) Resource-miser business models. Int J Environ Technol Manage 7(5/6):483–495
Stubbs W, Cocklin C (2008) Conceptualizing a sustainability business model. Organ Environ 212:103–127
Sustainable Apparel Coalition (2016) http://apparelcoalition.org/the-coalition/. Accessed Apr 2016
Sustainable Consumption Roundtable (2006) Looking back, looking forward: lessons in choice editing for sustainability. http://www.sd-commission.org.uk/data/files/publications/Looking_back_SCR.pdf. Accessed Apr 2016
Swedish Environmental Protection Agency (2016) Environmental benefit of reuse and recycling
Teijin (2016) Closed-loop recycling system ECO CIRCLE. http://www.teijin.com/solutions/ecocircle/. Accessed Apr 2016
The North Circular (2016) http://thenorthcircular.com/about-us. Accessed Apr 2016
Tischner U, Charter M (2001) Sustainable product design. In: Tischner U, Charter M (eds) Sustainable solutions: developing products and services for the future. Greenleaf, Sheffield, pp 118–138
Tukker A (2004) Eight types of product-service system: eight ways to sustainability? Experiences from SusProNet. Bus Strategy Environ 13(4):246–260
Vincent J, Bogatyreva O, Bogatyrev N, Bowyer A, Pahl A-K (2006) Biomimetics: its practice and theory. J R Soc Interface 3(9):471–482
WBCSD (2008) Sustainable consumption facts and trends: from a business perspective. World Business Council for Sustainable Development. http://www.wbcsd.org/pages/edocument/edocumentdetails.aspx?id=142. Accessed Apr 2016
Wijkman A, Rockstrom J (2012) Bankrupting nature—denying our planetary boundaries. Routledge, New York
Worn Again (2016) http://wornagain.info/about/press-coverage/. Accessed Apr 2016
Yunus M (2007) Social business. Yunus Centre. http://www.muhammadyunus.org/index.php/social-business/social-business. Apr 2016
Yunus M, Moingeon B, Lehmann-Ortega L (2010) Building social business models: lessons from the Grameen experience. Long Range Plan 43:308–325
ZERI (2013) What is ZERI? http://zeri.org/ZERI/About_ZERI.html. Accessed Aug 2014