Article

From Fibre to Fashion: Understanding the Value of Sustainability in Global Cotton Textile and Apparel Value Chains

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Abstract: Current sustainability frameworks and tools to assess and track social and environmental impacts of textile and apparel (such as life cycle analysis) along the chain, although important, provide a narrow focus on metrics (such as a reduction in inputs) or on economic value. This paper proposes a tailored method which combines value chain thinking with qualitative value mapping techniques to identify what sustainable value means and to whom, who benefits both in and beyond the chain (such as wider society, the environment, local communities), as well as opportunities to create sustainable value in the future. Results from interviews with stakeholders of a single connected cotton value chain demonstrate that this approach can identify sustainable value propositions specific to different actors in the chain, temperature-test whether stakeholders are willing to pay a premium price for sustainability efforts, and identify novel sustainable value opportunities that disrupt the chain. In addition to extending knowledge around sustainability in the textile and apparel industry, our contribution also lies in the development of a tailored tool which can be adapted and used for other value chains.

Keywords: sustainable value; sustainability; sustainable fashion; textile and apparel industry; value chain; cotton

1. Introduction

As concerns around sustainability grow throughout the fashion and textiles industries, more collaboration and partnerships along the value chain are required. A whole of supply chain perspective, from raw materials through to product end of life (disposal), is needed to understand sustainability within a connected chain. A way to do this is through a sustainable value chain analysis—a method based on following a single chain and mapping material and information flows, relationships and environmental impacts [1]. The global fashion and textile industries are made up of discrete but related industries such as fibre production, textile manufacturing, garment manufacturing and retailing, all of which face sustainability issues at every stage and with every fibre choice. Cotton is a case in point. At the fibre stage, cotton is the most used natural fibre globally. Grown in over 75 countries and employing approximately 250 million people, the cotton industry plays an important role in the livelihoods of people [2]. Cotton production is scrutinised by retailers, non-government organisations and consumers on issues such as water management, pesticide use and forced and child labour [2]. Sustainability issues continue beyond fibre production. Raw cotton is the first stage of the global cotton value chain, which includes the following phases: growing cotton, ginning (separating the cotton fibre from the seed and cleaning it), blending cotton from different regions or with manmade fibres (MMF) and spinning into yarn, textile manufacturing, garment manufacturing and retailing [3]. Environmental impacts and social aspects of a product's lifecycle can be assessed through the Lifecycle Assessment (LCA) and

Social Lifecycle Assessment (S-LCA), such as energy and water use, number of jobs created, and the positive and negative impact on consumers, local community, society and value chain actors [4–6]. Taking a lifecycle perspective, the post-purchase stages of consumer use, reuse or recycling and eventual disposal further add to the high environmental and social impact of the apparel industry [7]. Modes of production and consumption are linear, that is, proceeding from extraction of raw materials, through to use and disposal to landfill or incineration, resulting in significant textile waste from overproduction. Overall, fashion's supply chains are complex, opaque, and span multiple geographic regions, with negative environmental and social impacts occurring at every stage [8,9]. Non-government sustainability initiatives seek to drive action, such as putting sustainability goals on business agendas [10], standardising labour practices [11,12], omitting harmful chemical use [13], reducing carbon emissions [14], decreasing waste [15] and undertaking due diligence on risk of social and environment impacts in supply chains [16]. However, when it comes to the meaning of sustainability, definitions have been contested [17]. Although most actors can agree that environmental and social sustainability issues must be addressed, it is not clear what value may be derived from taking action, and who may capture this value. Added to this, fashion can be defined as a fast-moving consumer good tied to aesthetic values, hence how does this affect notions of value in value chain analysis?

The purpose of this study is to investigate the viability of a sustainable value chain analysis (SVCA) in the context of textile and apparel value chains, and this paper presents the development of a tailored tool to understand sustainable value creation in cotton fashion products. We developed the tool through a literature review and refined it through testing on a single cotton value chain. The literature review was undertaken to identify the various tools that can be used to determine sustainable value. The literature review draws on multiple perspectives, including Michael Porter's [18] value chain analysis (VCA) theory which has developed into sustainable value chain analysis (SVCA) [1,19]. Upon examination, the SVCA method provided a narrow focus on sustainability metrics (such as a reduction in inputs) or economic value based on what consumers are willing to pay. Another approach which considers sustainable value more broadly is the Cambridge Value Mapping Tool (CVMT) [20], used by firms to identify where sustainable value is created, destroyed or uncaptured, and areas for opportunity, as well as which stakeholders it has value to. However, the CVMT has been applied in industries which are not comparable to the highly complex, geographically dispersed nature of the global cotton value chain. A fusion of the SVCA and CVMT tool can be used to understand sustainability across the cotton value chain, and what it means to different actors in the chain. We propose a tailored method to examine sustainable value which involves 'following' the chain and identifying what sustainable value is, where it is captured, who it benefits both in and beyond the chain (such as wider society, the environment, and local communities) and opportunities to create sustainable value in the future. This tailored tool was tested through a pilot study of a connected Australian cotton value chain involving seven participants: two growers, one converter, three garment manufacturers/retailers, and one second-hand clothing retailer.

2. Literature Review

2.1. Sustainability, Fashion and the Cotton Value Chain

A common understanding of sustainability is meeting the needs of the present without compromising the needs of the future, and that a sustainable system would have dimensions of social, environmental and economic in balance [21,22]. Fashion is a trillion-dollar global industry which generates a plethora of economic, social and cultural value, yet also has significant negative environmental and social impacts. Culturally, fashion is a phenomenon which can be defined as a system of rapidly changing clothing styles, continually updated, whereby the new is valued over the old. Craik [23] adds that fashion is permeated by consumerism and consumer culture, and that purchasing goods is a way to communicate social value or status. Entwistle [24] (p. 28) explains that fashion is an aesthetic marketplace, by which aesthetics are not simply added on, but rather "is the

value". Fashions' aesthetics are constantly changing, and as aesthetics move on the value of the apparel declines, which is why there is a rapid turnover of apparel [24]. Entwistle [24] makes a further distinction that fashion is made up of both material value and immaterial value. Material value refers to the tangible elements that make a garment such as quality (fabric), haptic qualities, craftsmanship, price, scarcity/rarity, utility or functionality. Immaterial value refers to the highly symbolic meaning of clothes which is communicated through branding, style, as well as the design of apparel accounting for a fashion garment's market value. Geographer Louise Crewe [25] adds that value is created through production modes (such as artisanal, skill and craft), as well as specific sites of production (i.e., luxury products Made in Italy/France compared to low-cost, mass-manufacturing in China/India/Bangladesh/Cambodia). Value can be created through functional durability, style and design classics, which may in turn, increase the frequency and length of wear and transform the economics and value of clothing through changing consumption practices (i.e., buying less, more quality) [25].

Apparel value chains are made up of five segments, including raw material, yarns and fabrics, garment manufacturers, trade channels and retailers, all differing in location, technology, labour skills and conditions [26]. When considering sustainability in supply chains, a lifecycle approach which integrates all aspects of raw materials (cradle), through the stages of production, consumption and disposal (grave) in the value chain is required [5,27] (see Figure 1).
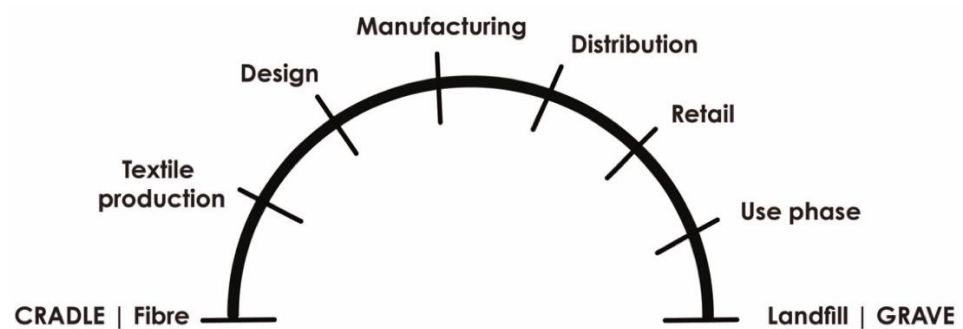

Figure 1. Stages of garment production, use and disposal from cradle (raw fibre) through to grave (disposal by user).

A key characteristic of apparel supply chains is that many multinational brands and retailers do not own their own production facilities but rather engage in global sourcing. These chains are often described as being buyer-driven [28]. Buyer-driven commodity chains, as defined by Gereffi and Appelbaum [28], are those which do not make products, rather they design and market products which are often made through low-cost, decentralised production networks. This means that retailers are the dominant leaders in the chain and have a demand-pull relationship with the suppliers along the chain [29]. The outsourcing of processes has been identified as an obstacle for sustainability efforts as fashion's supply chains are global, complicated, opaque and hard to control [8,9]. There is intense scrutiny of the textile and apparel value chain with activity from every point, for example environmental impacts of production including textile waste, resource depletion, social issues around labour practices [30–34]; possible interventions to reduce impacts [35], approaches to sustainable material and garment design [36–38]; as well as challenges around supply chains visibility, traceability and supply chain risks due to outsourcing production [8,9]. Retailers sustainability practices and CSR reporting are increasingly scrutinised [34,39,40], and industry publications seek to hold retailers sustainability claims accountable [41–43].

Focusing now on sustainability in regard to the most commonly used natural fibre, cotton is grown in approximately 70 countries, with the largest producing countries including India, United States, China, Brazil and Pakistan [3,44,45]. The majority of cotton is sold in

the commodity market and, post-farm gate value chain members include: ginners, classers, merchants, mills, textile manufacturers and retailers, and industry organisations [46] (see Figure 2).
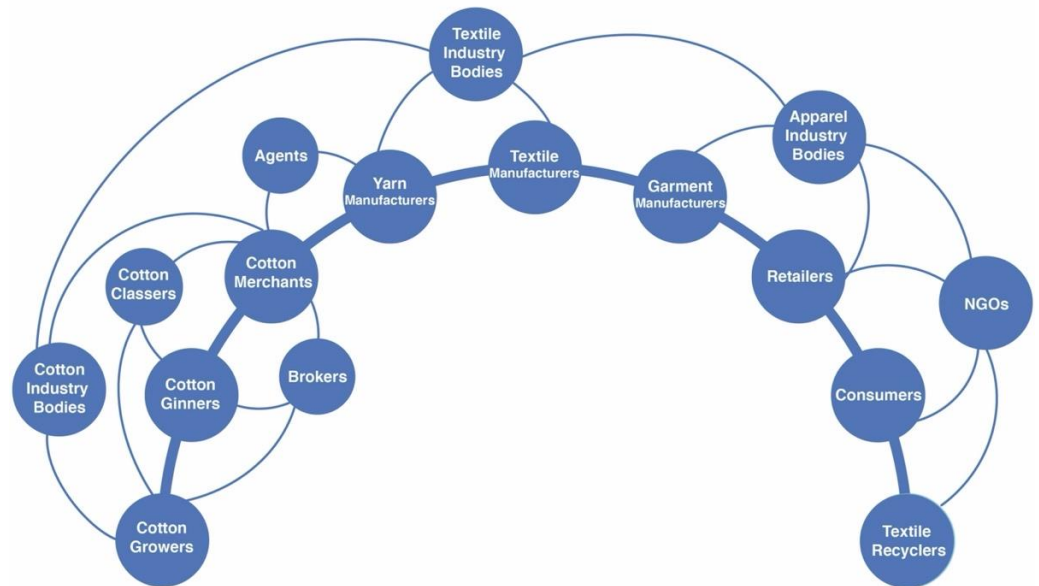
Figure 2. Key stakeholders and stages in the Australian cotton commodity value chain adapted from Payne, Mellick and Peterson [46].

A closer look at the Australian cotton industry reveals value chain dynamics. Australia is the third largest exporter of cotton, behind the United States and India, but the industry produces approximately 3% of the globe's cotton [47,48]. After the cotton is grown and harvested in Australia, it gets sent to an onshore gin where it is 'cleaned' of leaf and trash and the cotton lint separated from the seed. Merchants sell the resulting cotton lint to spinners overseas, and customers of Australian cotton are spinners, mainly located in China, Indonesia, Thailand, Korea, Bangladesh, Vietnam and Pakistan (ABARES 2014 in [48]). The majority of cotton is picked using a round bale harvester and a Radio-frequency identification (RFID) tag is attached to the cotton which can be used to track it from farm to the gin in Australia. However, cotton provenance becomes difficult to trace from the spinning stage where cotton is usually blended with cotton from other regions or with MMF to achieve the desired yarn specification. After the cotton is spun into yarn, it is woven or knitted into a textile, then made into a garment, and sold to consumers through retailers.

While every cotton producing country faces region-specific sustainability issues, the Australian cotton industry is faced with sustainability issues affecting the production of cotton, including environmental challenges such as drought conditions that may severely limit access to water; the need for 'socially-licensed' production where the wider society feel good about that industry's presence; as well as economic challenges around rising production costs, fluctuations in the price of cotton and consumer pressure to reduce inputs [49]. Production of Australian cotton both in 2019/2020 and 2020/2021 is approximately half of that in previous years due to drought conditions, and limited supply could result in customers of Australia cotton switching to cotton from other producing countries [50,51]. Global issues in cotton production are well documented, and include environmental and social concerns. Environmental issues include pest and pesticide management, water management, soil management, biodiversity, land use, energy and greenhouse gases (GHG) [2]. Social issues in other cotton producing regions include forced and child labour, workers' health and safety, equity and gender and farmer organisation [2]. Specific cotton sustainability programs have been established to assure cotton is grown sustainably, with cotton produced outside of these programs labelled conventional cotton. Examples of sustainable

cotton programs include Fairtrade Cotton, Organic Cotton and Better Cotton Initiative (BCI), and Australian cotton's myBMP program has been benchmarked to BCI [2].

Given the difficulty of tracking sustainability issues from farm through to garment and the complexity of the cotton value chain described above, it is important to note that every fibre faces a range of sustainability issues, noting that cotton is one of many fibres within the apparel and textile value chain, albeit the most widely used natural fibre. In summary, fashion products have a high cultural and symbolic value to end-users. As sustainability concerns grow around the impact at every stage of the garment lifecycle, there is a need to reach back and examine every phase of production, use and disposal. Reaching all the way back to raw fibre, the sustainability challenges associated with cotton demonstrate a need for shared understanding of sustainability and its value from all stakeholders.

2.2. Approaches to Analyse Value in Value Chains

Value is an ambiguous term and can mean utility or importance, or can be framed in economic terms such as the price that someone is willing to pay for a good or service [52]. Value in value chains is defined as the stages in transformation from a raw commodity into a product, with each stage adding economic value. In terms of sustainability and value, John Elkington's [21] 'Triple Bottom Line', also known as the '3P model', explains sustainability as profit (i.e., economic aspect), people (i.e., social aspect) and planet (i.e., environment aspect) must be balanced. Within the business context, long term growth can only be achieved if each aspect is incorporated equally, acknowledging that continued success is only possible if the environments on which all businesses rely upon are not depleted more than their ability to regenerate. Porter and Kramer [53] proposes the notion of shared value; whereby value should have a 'shared' benefit to both the chain and society. For example, clean waterways, reduced emissions and increased biodiversity have intrinsic benefits to both human and non-human life, and can also be considered 'natural capital' [54]. This paper takes a broad approach to defining sustainable value as the need for businesses and industries to create social and environmental value as well as economic value for their stakeholders, shareholders and the wider community [21,55,56]. While literature exists on definitions of sustainable value, the experience of how value chain members construct sustainable value has not been investigated [56]. Furthermore, literature around value-adding sustainability into the fashion supply chain is an emerging research topic and current research is not yet mature [57]. For example, Yang, Han and Lee [58] developed and tested mechanisms to co-create sustainable value between luxury fashion brands, customers and multiple stakeholders from four dimensions—information flow, main partners, material flow, and benefit and cost relevant to the environment and society. However, this framework was tested on secondary sources such as news releases and reports rather than empirical data. This demonstrates a need for in-depth empirical research, as well as the need to develop a framework to collect empirical data on sustainable value.

There are various tools available for understanding value in value chains. It was Michael Porter's [18] view that competitive advantage can only be achieved when whole chains work together to create value and improvements, rather than looking at stages of the chain in isolation. A value chain analysis (VCA) is used to explore the economics of a chain and focuses on aligning consumer value and chain efficiency by evaluating the flow of information and materials, and how relationships within the chain support this. VCA has been "endorsed" as a strategic process and method for agri-food chains to "create further value" [59] (p. 361). VCA have been undertaken on organic cotton [60], agri-food [61], Beef [62] and seafood [63] industry. Previous VCA studies have identified key target markets and consumer insights, business opportunities such as areas for better efficiency and resource management, understanding relationships between firms and being a catalyst for change and collaboration [59,61].

VCA has since been extended to include sustainable value chain analysis (SVCA), such as Bonney et al.'s [19] proposed agri-food framework, and Soosay et al.'s [1] case

study on Oxford Landing Wine chain. Focusing on Soosay et al.'s [1] SVCA case study combines Life Cycle Analysis (LCA) with VCA methods. An LCA is a process used to measure environmental impacts, such as energy consumption, water and chemical use, in the product lifecycle within a 'cradle to grave' or 'cradle to gate' system boundary [1,39,64]. Soosay et al.'s [1] SVCA research methodology focused on a single product (Oxford Landing Wine) from inputs to consumption. The study adopted an iterative process using qualitative and quantitative methods to examine consumer value, material and information flow, relationships and environmental impacts. Data collection involved consumer focus groups and an online survey for shoppers to identify attributes that consumers value, and value chain members were interviewed to understand supply chain dynamics, and carbon emissions from secondary sources were used to determine environmental impacts [1]. It should be noted that there is no established method in undertaking a VCA or SVCA. For example, Bonney et al. [19] says it may be possible to gather sufficient evidence on sustainability impacts through surveys, stakeholders focus groups and interviews if there is limited existing analysis on environmental impacts. Other VCA have utilised chain members' perceptions of what consumers value to determine value, rather than engaging with consumers as participants [60,62,63]. In these examples, SVCA is an incremental approach to including sustainability into the value chain, achieved by looking at what might be commercially viable to support and invest in. However, only looking at what consumers' value or on economic growth is a narrow consideration when it comes to understanding sustainable value in chains.

Another approach used to assess sustainable value is the Cambridge Value Mapping Tool (CVMT), which assists firms in an ideation process where value is mapped to various stakeholders, and from this, identify opportunities to create sustainable value into the business model [20]. Designed as a facilitated workshop with a group of representatives from across the stakeholder groups considered relevant to the business, the CVMT takes a qualitative approach to stimulating ideas and discussion around sustainable value creation (see Figure 3). Using the CVMT, participants firstly define the entity they are analysing (i.e., product or service of the business). Participants then identify areas where value is created in the current business model, areas where value is uncaptured (such as destroyed or missed value) and where new opportunities could be found [20] (see Table 1 for descriptions).
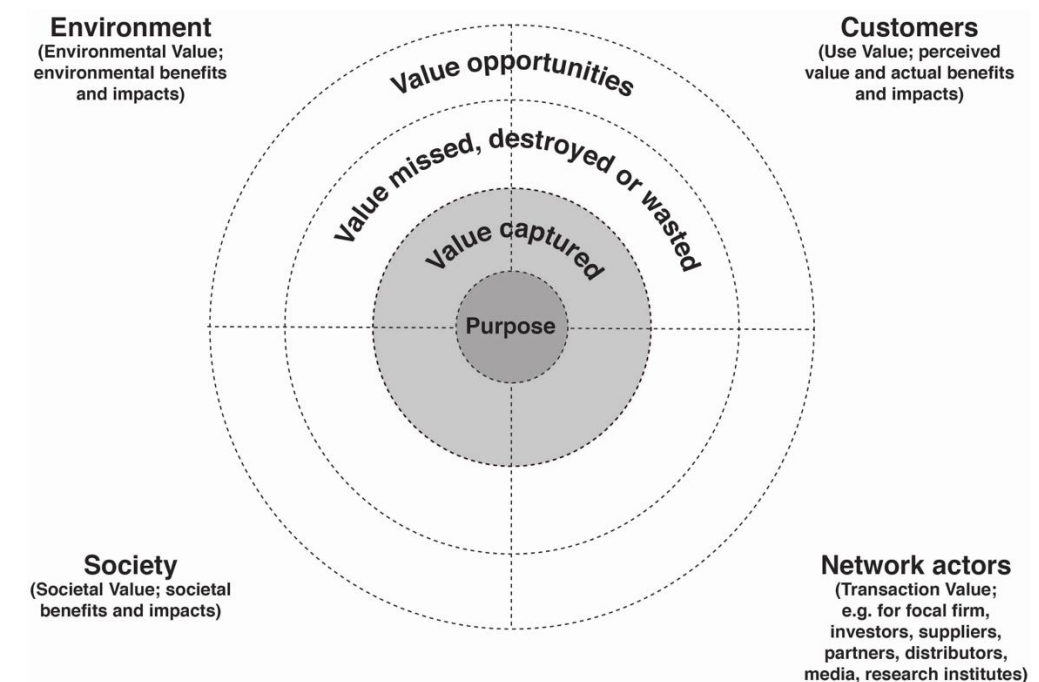

Figure 3. Cambridge Value Mapping Tool, Bocken et al. [20].

Table 1. Value concepts and their descriptions adapted from Bocken et al. [65].

Value Concept	Description
Value Captured	Activities that generate a return which could either be finance related, such as profit, or non-finance related such as efficient processes that lead to a reduction in inputs or strong relationships.
Value Uncaptured (Destroyed or Missed)	Value could be missed in activities which do not generate a return, such as inefficient processes. Value could be destroyed through wasteful activities, such as pollution and excess inventory.
Value Opportunities	Activities that could create new value, such as finding value in waste streams or collaboration to solve problems.

Value is mapped to multiple stakeholders' both in and beyond the value chain. Here, the stakeholders are the recipients of value. Suggested stakeholders include network actors (transaction/economic value) between value-adding stages, as well as aspects that consumers or value chain customers value (use value) where they receive an economic return. The CVMT expands the focus beyond economic value, and includes society (societal value) and environment (environmental value).

2.3. Factors Required for a Sustainable Value Chain Analysis for Apparel

As this study aims to undertake a holistic examination of sustainability perspectives and issues arising across the cotton value chain context, a closer examination of both SVCA and CVMT is required as both methods have strengths and weaknesses. Firstly, the SVCAs' emphasis on defining operational processes (i.e., material flow, information flow) and notion around value determined by the consumer focuses narrowly on metrics that aim to reduce inputs or increase economic value. Following the SVCA method and scrutinising which activities add value or are wasteful along the chain might aid some actors in the chain and not others. For example, cotton growers might create sustainable value through maintaining the environmental health of the farm; however, they might not capture the economic value for these practices as they are removed from retailers and consumers downstream. The CVMT takes a broader reference to sustainable value, and seeks to measure transaction (economic) value, use (consumer), as well as societal and environmental value within business models, which aligns with Porter and Kramer's [53] notion of shared value. A strength of the CVMT is in asking participants about how sustainable value is created along the chain, as their knowledge could give insights that might reimagine the supply chain or avenues that the industry could explore beyond reducing inputs. The CVMT does not look at the difficulties of implementing value opportunities, and therefore asking participants to identify any challenges to assess their practicality and feasibility should be considered.

Secondly, and noting the increasing focus on recycling textiles as identified in The Pulse of Fashion Report [42], this study needs to extend the boundary of the study beyond retailing and consumption to include the end of life phase, and investigate any opportunities for the cotton industry in this space. As SVCA considers up to the point of purchase by the consumer, including the end of life dimension is a point of difference in tailoring a SVCA for long, complex supply chains of consumer products, such as garments. While the CVMT does not explicitly mention the end of life, it could be added into the map under environmental value.

Finally, SVCA data collection involves a complex iterative approach, which Soosay et al. [1] noted the amount of time and resources required to undertake a VCA/SVCA could be an obstacle. Ease of use and facilitation was a consideration in the design of the CVMT, with the circular form offering prompts to discuss value concerning multiple stakeholders. However, Bocken et al. [20] noted that the CVMT method presents a logistical challenge in gathering a group of participants to represent the stakeholders together, which is the case when considering the globalised nature of the textile and apparel industry. The CVMT could be adapted to the

SVCA approach of interviewing value chain members along a single chain from start to finish to collect qualitative data in textile and apparel value chains, such as cotton.

To conclude, strategic responses to sustainability are required as organisations and industries have to prove they are sustainable and responsible in order to maintain competitive market access. However, this can only be achieved if businesses develop a good understanding of the value of sustainability through the eyes of all stakeholders. While there is lots of activity through scholarship and in industry, a holistic approach to understanding how whole chains can work together to create sustainable value is needed. The SVCA and CVMT are two tools which can be used to analyse sustainability in value chains; however, on close examination, there were challenges in applying these tools in the textile and apparel value chains. We propose a fusion of the two approaches to follow the SVCA method of following single value chains and interviewing members at each stage using the CVMT to stimulate ideas and perspectives on sustainable value.

3. Methods

3.1. Tailored Tool

The purpose of this study is to investigate the viability of a sustainable value chain analysis (SVCA) in the context of cotton fashion products. SVCA used a mixed-methods approach, while CVMT studies highlighted that workshops with value chain members played a crucial part in data collection and analysis [1,20]. Perceptions of values from across the chain will inherently offer multiple perspectives that cannot be captured through quantitative methods. Therefore, there is a need to collect, converge and analyse value chain perceptions to make sense of sustainability and its value. Weighing up the above findings from literature and past studies, a qualitative approach was taken in the research design which follows the SVCA method of 'walking' the chain of an Australian cotton product, noting this is feasible method to collecting qualitative data through interviews on the geographically dispersed global cotton value chain. Research participants were selected based on their position in the chain, starting from a single grower, to cotton marketing and ginning firm/s, progressing to off-shore agent and spinning mill, textile and garment manufacturer, through to an Australian retailer. Conducting interviews with stakeholders in the Australian cotton value chain is an appropriate strategy to "understanding" value chain perspectives [66] (p. 24) and gain a "depth of meaning" [67] (p. 124) around perceptions of sustainable value and finding consensus around issues. Participants were interviewed using the CVMT tailored to Australian cotton stakeholders identified in literature (see Table 2). A positive element of this qualitative method is that it can be scaled up or down depending on the size of the chain and willingness of the participants. The purpose of the method is to understand perspectives on sustainable value; therefore, the number of responses can be flexible.

Following from Bocken et al. [20] four kinds of value of transaction, use, social and environmental, we turn now to looking at how these forms of value apply within the context of fashion specific to cotton products, i.e., fast moving, aesthetic goods, in textile and apparel supply chains. Transaction value is generated between value chain actors. Here, value is measured in economic or monetary terms, but also can relate to benefits such as market access [20]. In the apparel and textile value chain, economic value is generated through a series of value-adding activities that turn a raw material from a yarn into a garment that is then sold to consumers. In the context of cotton value chains, these stages could include growers, classers, ginners, merchants, textile manufacturers, retailers, consumer, textile disposal and non-government or industry organisations.

Table 2. Cotton stakeholders and proposed forms of value.

Value Category	Stakeholders	Sources
Transaction Value	Proposed that transaction value (i.e., economic value) will be valued by the following value chain stakeholders: Growers [1], Classers [1], Ginners [1], Merchants [1], Textile Manufacturers [1], Garment Manufacturers [1], Retailers [1], Consumers [1], Textile Disposal [1,2] and Non-Government Organisations [1]	[1] Payne, Mellick and Peterson (2017) [46] [2] The Pulse of Fashion Report (2018) [42]
Use Value	Proposed that the above stakeholders will value cotton's use qualities such as, but not limited to: Haptic Qualities [3], Functional Durability [4], Emotional Durability [4], Traceability [2], Fibre Quality [5]	[2] The Pulse of Fashion Report (2018) [42] [3] Entwistle (2009) [24] [4] Crewe (2017) [25] [5] International Cotton Advisory Committee and Food and Agriculture Organisation (2015) [2]
Societal Value	Proposed that the above stakeholders will consider societal value to include, but not limited to: Promoting Labour Rights and Standards [5], Worker Health and Safety [5], Equity and Gender [5], Local Community [6], Public [6], Government [6]	[5] International Cotton Advisory Committee and Food and Agriculture Organisation (2015) [2] [6] Porter and Kramer (2006) [53]
Environmental Value	Proposed that the above stakeholders will consider environmental value to include but not limited to: Promoting appropriate chemical use such as Pest and Pesticide Management [5], Water Management [5], Soil Management [5], Biodiversity [5], Land Use [5], Energy Use [5], Organic Crops [5], Genetically Modified Organism (GMO) Crops [5], Waste [2], End of Life [2]	[2] The Pulse of Fashion Report (2018) [42] [5] International Cotton Advisory Committee and Food and Agriculture Organisation (2015) [2]

Note: Superscript number indicates information source.

Use value is forms of what customers value which could be tangible, such as utility of a good, or intangible such as comfort or suitability [20]. As mentioned earlier, value emerges through aesthetic and personal connections to clothing [25]. Crewe [25] adds that spaces and places in which apparel is made can also add value, therefore the specific type of production or output of cotton (i.e., provenance of cotton, branding, traceability, farming practices such as organic cotton) might influence what consumers are willing to pay (economic value). Use value can also consist of haptic qualities [24], functional durability and emotional durability [25]. In terms of cotton's material value, the Mistra Future Fashion Report [44] identified cotton's technical (durability and strength) and comfort (such as breathability) properties are unrivalled by other MMF or natural fibres. The perspective of value chain customers must also be considered, such as fibre quality [2]. The Pulse of Fashion Report [42] identified the ability to trace production to the origin of materials is an important factor, so there is a need to ascertain the value of traceability.

Section 2.1 identified the environmental and social issues of gravest concern within the textile and apparel industry. These may be reframed as issues in which the chain needs to further explore under societal and environmental value. Societal value could relate to employee issues, such as labour rights and standards, health and safety and equity and gender [2]. Applying Porter and Kramer's [53] notion of shared value, other stakeholders could include the local community, public and government. Environmental value could relate to chemical use (such as toxic dyes used to dye textiles and pesticide use on farm), water management, biodiversity or animal welfare, land use, energy use (such as greenhouse gas emissions), as well as organic and genetically modified crops (GMO) [2].

The Pulse of Fashion Report [42] also highlighted the issue of textile waste at every point along the chain, as well a lack of reuse and recycling options post-consumer textiles at the end of their life.

A visualisation of the diagram in Figure 4 was used as a prompt to assist participants as a map of the interview to guide different forms of value, whether it is captured, uncaptured, opportunities and challenges.
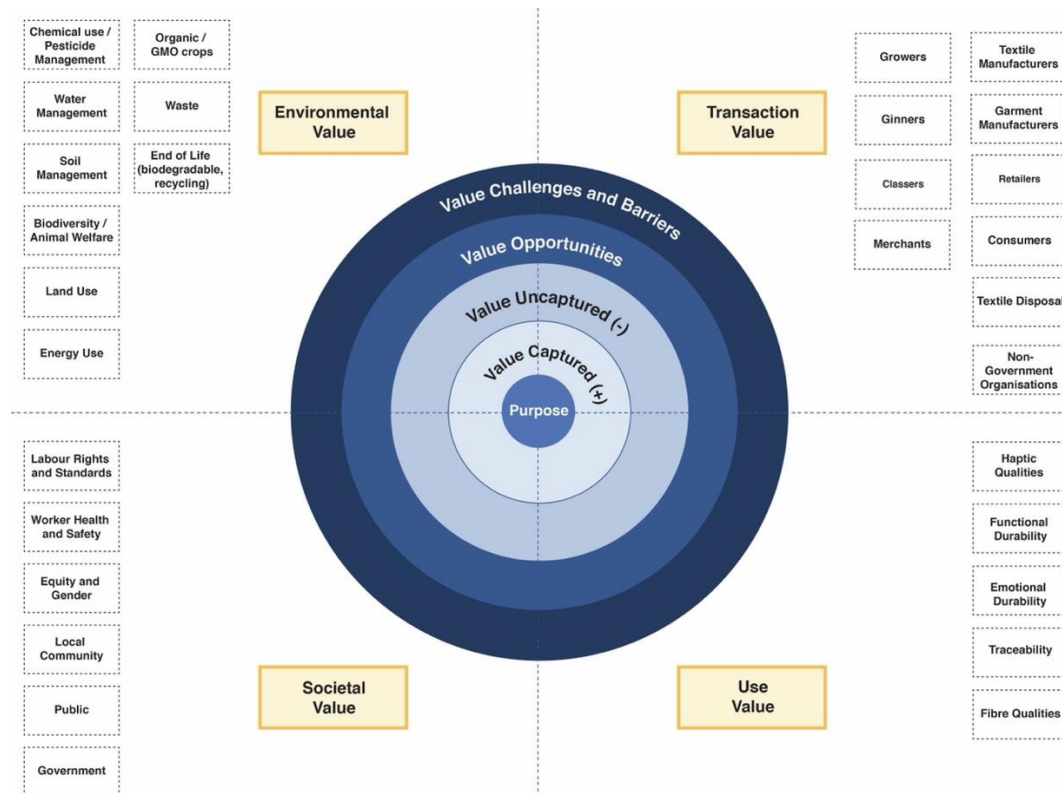

Figure 4. Adapted version of Cambridge Value Mapping Tool from Bocken et al. [20] tailored to cotton stakeholders.

3.2. Data Collection

A pilot study was undertaken between March and June 2019, and involved a total of four main stakeholder groups and seven participants:

1. Cotton growers (Participants GR01 and GR02) located in southeast Queensland, Australia.
2. Converter (Participant TE01) based in Brisbane, Australia.
3. Garment manufacturers/retailers (Participants RE01, RE02 and RE03)

    a. RE01—using Australian cotton, located in Canberra, Australia.
    b. RE02—using Australian cotton, located in Sydney, Australia.
    c. RE03—considering using Australian cotton and engaged with Australian cotton industry bodies, located in Melbourne, Australia.

4. Second-hand clothing retailer (Participant EN01)—not directly tracking Australian cotton but engaged with Australian cotton industry bodies, located in Melbourne, Australia

Participants have been anonymised through code names due to the commercial sensitivity of this study. This study received university research ethics committee approval for human research (ID no. 1900000034). All interviews were in English, digitally recorded and transcribed verbatim. Interviews ranged between 1 and 3 h, which accounted for a total of ~11.5 h. No one refused to participate, but due to time constraints the cotton ginner, yarn manufacturer and textile manufacturer could not participate.

3.3. Approach to Analysis

In qualitative research, participants are "purposive actors" who present multiple realities which are informed by their own "underlining ideas, meanings and motivations" [66] (p. 17). Therefore, this analysis is informed by a relativistic approach whereby it is hard to find an objective or single 'truth' [68]. The data were analysed using a deductive approach where interviews were coded based on sustainable value categories (transaction, use, society and environmental) and types of value (captured, uncaptured, opportunities and challenges) [67,69,70]. Insights were identified based on participants' responses to sustainable value categories and types of value, focusing on areas in the value chain where Australian cotton can build sustainable value and with which stakeholders [67,69,70]. Analysing insights from interviews enabled the team to build 'thick description' around where sustainable value is captured, uncaptured, value opportunities and challenges in the Australian cotton value chain [71] (see Figure 5), namely the experiences of participants revealed texture, richness and nuance well beyond the publicly available value chain information. The qualitative analysis software NVivo 12 (QSR International, Melbourne, Australia) was used for this coding process.
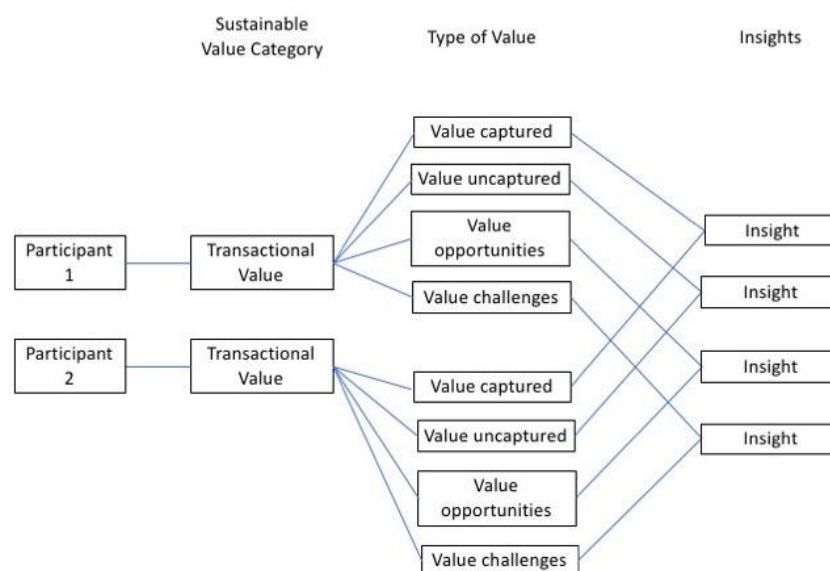
Figure 5. Coding and data analysis diagram.

4. Results

In this section, we discuss the pilot study results, segmented into types of value as follows: captured value, uncaptured value, value opportunities and value challenges. Each segment identifies insights which emerged through interviews around sustainable value categories following the prompts of transaction value, use value, societal value and environmental value.

4.1. Characteristics of the Chain

The chain examined consists of the following stages. Two cotton growers (Participant GR01 and GR02) at the same farm use the services of a ginner to separate the cotton lint from the seed and trash. The gin presses the cotton lint into a 227 kg bale and this bale is then supplied directly to a textile business, the owner describing themselves as a converter (Participant TE01). The converter then orchestrates the production of the baled cotton into single origin cotton yarn and fabrics through liaising with a spinner in the United Kingdom and textile manufacturers in Australia to dye and knit or weave the cotton into a fabric. The converter then receives the knitted and woven textiles and distributes to independent designers/entrepreneurs who market as 'Australian grown cotton' (Participant RE01, RE02 and RE03). The second-hand clothing charity retailer (Participant EN01), although

not directly receiving these specific goods, already collects cotton goods for reuse and recycling and has an existing connection with Australian cotton's peak industry body, and is committed to industry circularity. These value chain interactions are mapped in Figure 6 below.
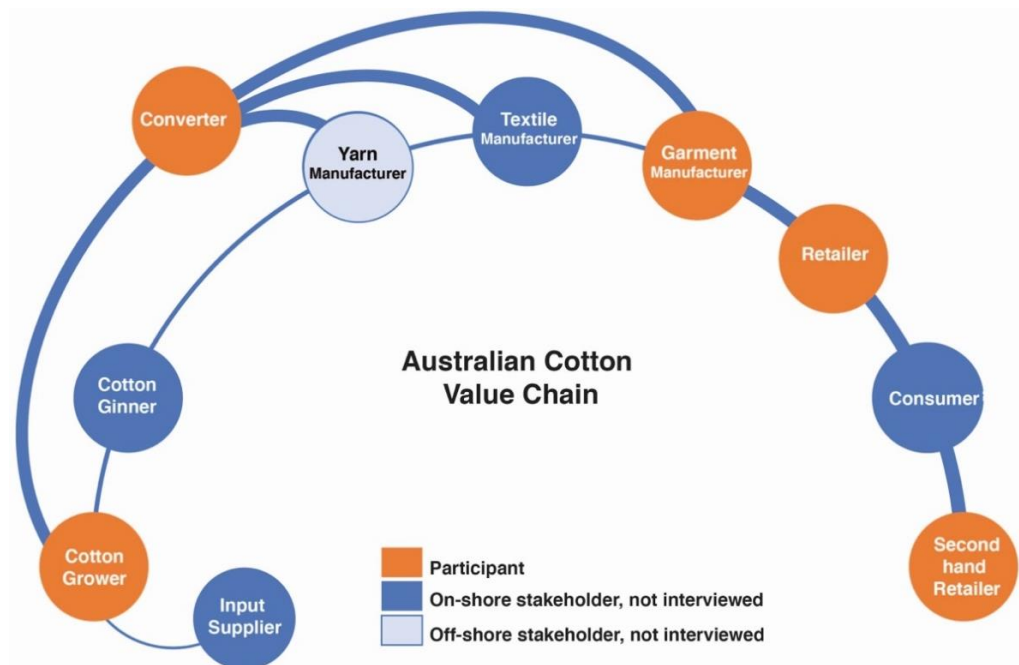
Figure 6. Map showing participants in pilot study on niche Australian cotton value chain.

What is distinctly different about this niche Australian cotton value chain (Figure 6) when compared to the Australian cotton commodity value chain (Figure 2), is that the role of the on-shore Australian cotton merchant and classer has been removed. Both the ginner, yarn manufacturer and textile manufacturer were not available to be interviewed at the time of study. No participants were partaking in the BCI program at the time of the interview, although the growers were in the process of becoming accredited through the myBMP program.

4.2. Captured Value

In this section, we identify participant perspectives on where they were able to capture value. The structure of this chain captured significant economic value, as the converter estimated that they have "doubled the value per kilo of fibre" compared to raw cotton (TE01). TE01 said this was achieved through coordinating the raw cotton as it is turned into yarn and then selling this directly to garment manufacturers, in turn "taking out the traders". TE01 said this created a "more financially efficient supply chain" compared to "the traditional method", which they described as:

> "Retailer specifies to garment maker, I want this, they might specify the fabric, they might tell them the mill in Italy they want it from but that garment maker has to buy that fabric and own that fabric and then add the value of the garment manufacturer on to it. So, if you then specify a yarn, that yarns got to be bought by the fabric manufacturer, maybe that's a weaver or knitter. Maybe that is sold to the dyer. Maybe then the dyer is selling that to the you know, all of these people going to take the margin [...] So we're trying to turn that on its head."

Attached to the cotton is the story of a family-run farm that uses small amounts of inputs (i.e., water, chemicals). The growers saw the ability to trace the cotton back to their farm as part of their "intrinsic value" (GR01). The converter said this model also

created more financial security for the growers compared to the selling cotton on the commodity market:

> "We're taking out being trade exposed because we're creating a market based on the story rather than selling bales of cotton to the international market of cotton spinners [. . .] So, the idea is to create a model where the value is in the origin and the story and the quality as opposed to the price of bale and exchange rate that day."
>
> (TE01)

The growers and converter competitive advantage was in offering this story to garment manufacturers/retailers who market products as 'Australian grown cotton', as well as the ability to purchase high quality fabric in small quantities:

> "I really connected with them because I find it quite hard being a small business, being able to afford really great quality fabrics. And obviously quality is all part of my label and why people buy into it."
>
> (RE01)

> "I think [our supplier] already has a very interesting proposition in that she gets as I understand it she gets her cotton all from the one farm. And that kind of single origin story is really really powerful."
>
> (RE02)

Each participant spoke about their commitment and reputation for sustainability practices. Starting with the growers, they collected and analysed inputs applied during the season (water and chemicals predominantly), which assisted farmers' ways to improve soil health and longevity of the farm, which in turn increased yields (and therefore profit). Beyond the farm, GR01, GR02 and TE01 were undertaking an LCA on water use and carbon emissions. Here, the value of tracing the cotton back to their farm and capturing LCA data was in distinguishing their single-origin cotton from conventional cotton and making credible sustainability claims (such as the water used in making a t-shirt). For example, TE01 estimated that one of their Australian cotton t-shirts used "less than 30% of the global average use of water [. . .] including dyeing". Visual storytelling was another approach used to create social value, as it connected people to the farm compared to data on paper:

> "I've got some really powerful pictures that show the total volume of say the synthetic inputs versus the picked bale, which just shows how efficient it is. Some of that stuff just blows away figures on the paper [. . .] When you say yeah, there is frogs and snakes in the paddock that matters more than any data about soil performance. You know it is that storytelling."
>
> (TE01)

Here, value is created through building sustainability information packages for key customers at different levels of sustainability interest through visual storytelling and LCA data. This also demonstrates the agility of the converter to communicate sustainability up and down the chain.

Garment manufacturers/retailers mainly spoke about their attention to environmental practices across the lifecycle of the chain. For example, RE01 garments are made from zero-waste patterns where no scraps go to landfill. They described this approach as having two benefits, firstly as a "more sustainable" design and secondly, the aesthetic "works nicely" with their label (RE01). Participant RE02 only produces garments on demand and in turn, "do not sit on dead stock". They also repurpose textile offcuts as "another fabric that you can choose [. . .] or we make zero waste totes" (RE02). Manufacturers also spoke about the importance of their garments longevity, and cotton was chosen because of its durability: "The longer we wear the clothes that we own, the better it is for the planet. And you know, we do build things to last, and cotton lasts" (RE02). To improve the use phase, all retailers said they made garment styles in classic colours (black, white, navy) and

had product stewardship schemes such as free repairs to keep garments in use for longer (RE01, RE02, RE03). Some retailers implemented experiences which enabled consumers to emotionally connect with clothing. For example, in RE02's business model, consumers made design decisions around fabric or style of garment, finding that consumers:

> "have a much greater emotional connection to the clothes than just something you buy off the rack [...] What we tend to find is they like to keep it so rather than replace it they look to repair it."

Turning to end of life pathways, participants were trialling garment take-back schemes and piloting domestic and commercial composting options which leverage cotton's ability to biodegrade (RE03, TE01). Finally, EN01 estimated 70% of donations are sold through their stores and they also created value through engaging with consumers to change their purchasing behaviour by keeping clothing in use for longer through mending, repairing, donating or buying second-hand.

A key characteristic of this chain was the strong relationship between the converter and growers, built around shared similar values and commitment to sustainability practices, or as TE01 described it as "this meeting of like nerdiness". Relationships between the converter and the garment manufacturers were effective and based on trust, accountability and good communication. For example, RE01 said "everyone is quite accountable which is really good", and RE02 said "I know what [TE01] tells me about [the single-origin cotton] and I communicate that to our customers".

In terms of whether there was tangible economic value to be captured from sustainable practices, participants said that consumer value lay in quality and aesthetic value of the product:

> "Having a story isn't simply enough. People will pay for stories, but they won't pay that extra bit, unless it is a quality product as well."
>
> (GR01)

> "[Customers] need to like lots of other things about the piece and then to find out that it's Australian cotton is a really nice bonus."
>
> (RE01)

> "The reason [customers] come to us is that when we guarantee it going to fit their body .... It just so happens that the right that we produce is the most environmentally friendly way of doing it."
>
> (RE02)

In terms of traceability and the single-origin story of the cotton, participants said that consumers and retailers were not willing to pay extra for it:

> "I think it allows us to tell a great story but I don't think people [consumers] are prepared to necessarily pay more for it for us."
>
> (RE02)

> "They [retailers] love the idea of it and they want it, are they going to pay for it? No."
>
> (GR02)

Therefore, while consumers highly regarded participants' positive environmental and social efforts, the primary reason for purchasing their products was due to the quality of the yarn/fabric and fit on the body or aesthetic of the apparel.

4.3. Uncaptured Value

Manufacturers identified not knowing how to access Australian cotton was an area of uncaptured value, which RE01 pointed out was only possible through meeting TE01 at a networking function: "you know, if it wasn't for doing the program I probably would not have met [TE01]". Growers discussed the value of sustainable cotton identity programs,

and noting the growers were in the process of becoming BCI accredited at the time of the interview, they said it was unclear if BCI delivered a premium:

> "You can't get BCI credits unless you go through the myBMP process [...] but then you can't sell the credits separately so then you're not getting any value as a grower for growing BCI, for being BCI certified."
>
> (GR02)

Sustainability messaging around cotton was an area of uncaptured value, particularly around water use. For example, RE02 said "water is the elephant in the room in the cotton industry" and even curtailed consumer desire to buy Australian cotton:

> "I have had people say they would never buy Australian cotton because of the water. [...] There's a stat which says on average a t-shirt takes something like 2700 litres of water to produce. Whereas our supplier has calculated that cotton takes something in the range of about 800 litres. That's right thirty percent or even less of the water input cost which is pretty phenomenal and if more cotton is grown that way the world might be in a better place."
>
> (RE02)

As mentioned above, the LCA study on this value chain demonstrated that their Australian cotton used less water than conventional cotton. RE02 adds that the industry needs "to get much better at communicating the fact that it uses the least amount of water in the world". Growers also noted that information about water use can be difficult for consumers and retailers to understand, and needed to be translated into "comparative figures" or terms they can make sense of:

> "I put a statistic out recently that there is more water used in producing a KG of chocolate then there is of cotton. That resonates with people because that is something that they can compare like with like. 'I never thought about that.' 'That's actually not that bad.' You've got to put it into terms that, or values that means something. If you talk about we use 3000 million megalitres of water a year that makes people go, that scares people."
>
> (GR02)

Another area of uncaptured value identified was the lack of local manufacturing, which as Participants RE02 pointed out, not having a spinning mill in Australia destroyed value:

> "[the converter] has to send the Aussie cotton to England to get spun to then re-import it to have it knitted in Melbourne [...] And then that basically means that you know, we send out raw materials and we import value added product and it just seems crazy."
>
> (RE02)

Lastly, local infrastructure to deal with textile waste was identified as another significant area of uncaptured value. Currently, 30% of EN01's second hand clothing donations are unsaleable (damaged or soiled) and these are purchased by an offshore Ragtrade provider who sends them into alternative value streams (rags, fuel blocks, grey markets). However, EN01 described this relationship as largely transactional and not a "long-term solution". EN01 also identified a lack of data on what exactly is being donated, such as fibre types, colours and brands, which is information that could be feedback to retailers and used as "an indicator that there's something not going right with that particular product" (EN01).

4.4. Value Opportunities

Opportunities for growing demand of Australian cotton were identified further up the chain in product innovation for end-users (consumers). Participants GR01 and GR02 recognised that while growing high-quality fibre certainly adds value, future economic

opportunities lay in identifying different value-adding avenues for cotton, as well as exploring opportunities in "non-conventional [areas]" beyond apparel, including in building materials, and as a 3D printed bandage, noting cotton's characteristics making it ideal for novel value-added products: "there is no more pure form of cellulose than cotton" (GR01).

Participants TE01 and RE02 suggested investing in cotton seed technology to mimic qualities in manmade fibres could create use value, such as wrinkle-resistant/non-iron fabric that is easy to print onto digitally:

> "It's about the other things people need to use cotton. It's like digital printing on cotton. The reason polyester is so ubiquitous—it's so damn easy to print . . . the sublimation. So people are choosing polyester because of that, not because they like polyester."
>
> (TE01)

> "[Customers say] I love everything about the shirt you've made me but I have to iron it all the time. If that wasn't the case, that would be better, whilst maintaining 100% natural fabric."
>
> (RE02)

Noting public perceptions and sentiment around cotton and water use as mentioned above, TE01 said there is a need to shift perceptions so consumers "feel good" about buying cotton:

> "They love it, but they kind of feel like it's a guilty pleasure right now. [. . .] If people are educated, if they're really sustainability hardwired: 'I almost feel guilty I think about buying cotton or enjoying cotton'. But they like it, they prefer it may be to bamboo or viscose or whatever."
>
> (TE01)

There is an opportunity to leverage relationships with retailers to amplify sustainability messages as they saw themselves playing a pivotal role in communicating the growers' sustainability story to customers and the general public: "That's an opportunity for us to actually talk about how fantastic Aussie cotton is on those input costs and on the yield" (RE02). RE01 suggested fuelling interest of Australian cotton through developing local markets and "mak[ing] those connections between the fabric suppliers of the designers". RE01 also noted that "Woolmark has done a really great job" engaging with emerging designers at university or TAFE through competitions, and "Australian cotton could do the same" to grow usage and demand, while also explaining the fibres' sustainability benefits (i.e., durability, biodegradability). TE01 suggested to branch out and engage with people who are 'not the usual suspects', such as fashion media "influencers", about cotton production and sustainability:

> "They're the bubble that encouraged the next designers. They're the bubble that the next generation of product developers are learning from. And some of those product developers will end up in Hong Kong in London in New York."
>
> (TE01)

Growers also thought the sustainability "stories need to come from the growers" as this is more genuine than statements from industry bodies, and "resonates with people a lot more" (GR02). Another opportunity area was in on-shoring spinning production and "locking in the integrity here" (TE01) to ensuring traceability, quality control and ethical production of cotton in Australia:

> "Controlling [cotton] once it's yarn is so much easier because no one cuts the yarn batch, because it won't dye evenly, so all of the ethics get locked in when you make the yarn and label it, or tag it or whatever."
>
> (TE01)

RE03 said if there was a spinning mill in Australia they would be more "inclined" to use Australian cotton, as traceability "technology is good enough to ensure to guarantee 100% Australian cotton is being returned". Participant TE01 added that if a local mill was to be established, it would need to "twin" spinning virgin fibre and recycled fibres, as this could buffer "the peaks and troughs of harvest quantities which are going to ebb and flow much more because water is going to be less reliable".

In terms of textile waste and sustainability practices, EN01 said there is room for more information sharing between "consumers, post life, waste, retailers, manufacturers" to understand "what worked, what didn't work, what we can do to improve it and how things kind of ended up". EN01 said this could inform decisions in the fibre, textile and garment design process, as well as pathways for end of life. Finally, EN01 said they saw opportunities in investing in local, circular approaches around textile waste which "would have the ability to have a benefit to not only the environment but the economy and employment and infrastructure".

4.5. Value Challenges

Scale and financial viability were identified as the biggest challenges. Participant TE01 talked about the difficulty in finding local and overseas suppliers willing to process small quantities of cotton. Participant RE01 said the financial side of sustainability is challenging and costly: "to be more sustainable takes more time, which is always going to cost your business more". Looking at textile waste opportunities, EN01 said it would take "huge capital investment" to support local infrastructure for collecting data on textiles, as well as finding local value streams for recycling textiles.

5. Discussion

The purpose of this study was to investigate the viability of a sustainable value chain analysis (SVCA) in the context of cotton fashion products, which are highly symbolic goods in global textile and apparel supply chains. A tool to achieve this was developed based on a literature review of value in value chains, coupled with a review of specific value in textile and apparel. This study confirms that a fusion of the SVCA [1] and CVMT [20] can be used to understand sustainability across the cotton value chain, and what it means to different actors in the chain.

Insights from the pilot study identified that this chain is characterised by strong and effective relationships. The structure of the chain captured significant economic value through taking out the traders and instead a converter coordinated the delivery of a competitively priced, single-origin, high-quality yarn to garment manufacturers. Garment manufacturers and retailers valued the single-origin story of the cotton, which is in line with Crewe's [25] notion that value is created through production modes and sites. Namely, this Australian cotton was grown on a family-owned farm which captured environmental value through their use of low inputs (water and chemicals predominantly). This single-origin story was captured through visual storytelling and credible sustainability claims with LCA data, which appealed to different levels of stakeholder interest. Garment manufacturers discussed their attention to the lifecycle of the chain. For example, designing for longevity through using durable fibres and textiles, and classic garment styles and colours, the value of which, a point that Crewe [25] highlighted in the literature, was in increasing the frequency and length of wearing clothes. Garment manufacturers also implemented product stewardship solutions, such as free repairs, take back schemes, repurposing or composting pre-consumer and post-consumer cotton waste. These practices which assist a more circular approach to textiles is an area that will continue to be a point of focus in fashion, as identified in The Pulse of Fashion Report [42].

The tailored tool could be used to temperature-test who values sustainability, and what value they place on it (i.e., willingness to pay more). Here, sustainability practices did not necessarily translate into economic value as consumers valued the quality of the fabric, fit on the body and aesthetic of the garment, which is consistent with Entwistle's [24]

(p. 28) idea that aesthetics "is the value" of the fashion. Nevertheless, participants created value through demonstrating to industry and consumers' alternative ways to manufacture clothing which retain the value of environmentally friendly practices and ethical production, while maintaining a viable business without comprising economic progress. Through asking participants about how sustainable value is created and where it is uncaptured along the chain, their industry knowledge gave insights and consensus around key issues. For example, there was a focus on environmental value in terms of water use in cotton production and negative consumer perceptions lead to problems with marketing 'Australian cotton'. Opportunities were mainly identified further up the chain to grow Australian cotton awareness through collaborations with local universities, emerging designers and fashion media, as well as amplifying sustainability information about the Australian cotton industry to retailers and consumers. Other novel opportunities that would disrupt the chain were pathways and infrastructure for local manufacturing such as spinning and textile waste recycling. However, these would require huge financial investment.

Turning to the strengths and weakness of the tool, a key strength was in the development of a method and approach which proposes another way of understanding sustainable value beyond LCAs and VCAs which focus narrowly on metrics (such as a reduction in inputs) or on economic value. Another strength of the tool was in adapting the CVMT to cotton stakeholders identified in the literature. Participants talked about their relationships with other value chain members, as well as social and environmental practices or issues. Noting this research is context-specific, future research would have to consider adapting stakeholders and environmental and social issues relevant to their business and value chain. After the first interview, the structure was refined so that participants talked through all the types of value (captured, uncaptured, opportunities and challenges) one stakeholder group at a time. This was effective in stimulating participants lateral thinking and keeping to the scheduled interview time. When asked how the participants felt after the interview, most replied that the tool made logical sense and they did not feel drained or fatigued.

An area of weakness was unclear terminology. At times the terms 'captured' and 'uncaptured' value was not easily understood by participants, and other terms such as 'benefit' (referring to captured) and 'impact' (referring to uncaptured) were used instead. Suggested stakeholders outside of the CVMT categories could be broader and less cotton-specific, which might have allowed for participants to identify other stakeholders outside of the cotton chain. Interestingly, it was hard for participants to identify where value was uncaptured at different stages. Instead participants focused on challenges and issues that directly impacted their position in the chain, which does limit the insights from the tool.

6. Conclusions and Scope for Further Research

In conclusion, this study has endorsed that a fusion of the SVCA and CVMT can be used to understand sustainability across the cotton value chain, and what it means to different actors in the chain. This study presents a new perspective on sustainable value by 'asking' actors specifically what they value and why, and converging these insights to better understand the entire chain. The tool enabled the researchers to identify sustainable value propositions specific to different actors in the chains, temperature-test whether stakeholders are willing to pay a premium for sustainability efforts, and identify novel sustainable value opportunities that may disrupt the supply chain.

Limitations to this study include being tested on one chain in the Australian context of cotton production, noting Australia is a small producer in comparison to other cotton-producing markets. Due to the small volume of fibre used in this value chain, it is hard to know the sustainability impact of this chain and whether its strategies would work in a larger mass-market supply chain who arguably have significant sustainability impacts due to their scale. While this research can contribute to a better understanding of sustainable value in cotton value chains, findings cannot be representative of the Australian cotton industry. There are some aspects of the findings that can be generalised, such as the Australian cotton value chain map; however, this may be different in other cotton regions.

The second limitation is the sample size of the pilot study and that two participants were not materially connected to the chain, although were networked closely within the industry. The next steps of this study would be to further test the tool's efficacy by extending to a mass-market high street brand that uses cotton which can be tracked through all the value chain stages. Although beyond the scope of this paper, there is also an opportunity in future research to include a qualitative component based on specific issues that participants identify. For example, the amount of textile waste at different stages/across the chain to understand the size and scale of the issue. Finally, the methodology does not consider issues such as financial stability and financial flows, all of which impact how value is captured and could be considered in future research.

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