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Designing for Circularity: Sustainable Pathways for Australian Fashion Small to Medium Enterprises

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ABSTRACT

Purpose

Australians consume twice the global average of textiles and are deeply engaged in a linear take/make/waste fashion model. Furthermore the Australian fashion sector has some unique supply chain complications of geographical distances, sparse population, and fragmentation in processing and manufacturing. This research examines how Australian fashion small to medium enterprises (SMEs) are overcoming these challenges to run fashion businesses built around core principles of product stewardship and circularity.

Design/methodology/approach

SMEs make up 88% of the Australian apparel manufacturing sector. This qualitative exploratory study included in-depth interviews with three Australian fashion SMEs engaged in circular design practice, and a focus group of 10 Western Australian fashion advocates of sustainability. Analytic coding and analysis of the data developed 8 distinct themes.

Findings

This study examines the barriers to CE that exist in the Australian fashion sector, and maps the practice of Australian SMEs with circular business models in overcoming these barriers. In CE innovation, Australian SMEs may have an advantage over larger fashion companies with more unwieldy structures. Employing design thinking strategies, Australian SMEs with a foundation of product stewardship and circular purpose are creating new systems of viable closed-loop business models and design processes.

Originality

The themes from this research contribute to the limited literature on circular innovation examples that link CE theory with practice in the fashion sector. The Model for Circularity maps the practice of 3 SMEs built around core principles of product stewardship and circularity in overcoming the barriers to CE in an Australian context, and may be used as a visual tool in education and understanding.

Keywords: Australian fashion, small to medium enterprises, Circularity Model

1. INTRODUCTION

Australians consume twice the global average of textiles and are the second largest consumer of textiles per capita worldwide (Carmichael, 2015). Recent investigations by the Australian Circular Textile Association (ACTA) on textile use in New South Wales indicate this statistic may be even higher (NSW Environmental Protection Authority, 2021). Australians are deeply engaged in a linear take/make/waste apparel supply chain characterized by trend-driven, low-priced, short-lifetime apparel (IBISWorld, 2019). With a lack of regulatory legislation on textiles and a national waste crisis, Australian charities are burdened with the costs of disposing of poor-quality clothing unfit for resale (Payne, 2016; Payne and Ferrero-Regis, 2019), and used apparel is exported abroad to developing countries at scale (Payne and Binotto, 2017). These issues are currently driving a growing sentiment amongst Australian stakeholders and leadership for a shift towards a circular economy (CE) and product stewardship (PS) in the sector (Australian Fashion Council, 2021; Department of Agriculture, Water and the Environment, 2021a).

Literature from Europe highlights the challenges of converting traditional supply chain systems to circular models, and the advantages of small to medium enterprises (SMEs) and start-ups in building them from scratch (Henninger, *et al.*, 2016; Hvass and Pedersen, 2019; Pedersen, *et al.*, 2019). Australian fashion SMEs comprise 88% of Australian apparel manufacturing (Miller, 2019) and their business models and strategies have the potential to influence larger companies and the wider sector (Goworek, 2011; Sandvik and Stubbs, 2019). They are therefore a significant group to consider for change to the take/make/waste fashion model in Australia. Internationally, SMEs are using design thinking strategies to reconsider clothing design, manufacture, and consumption and building innovative business models around the principles of CE (Andersen and Earley, 2014; Andrews, 2015; Henninger, *et al.*, 2016; Huynh, 2021; Hvass and Pedersen, 2019; Raebild and Bang, 2017; Sandvik and Stubbs, 2019).

Limited scholarly research linking CE theory and practice in the Australian fashion sector exists, and this paper endeavours to address this gap. Interviews with 3 owners of Australian circular fashion businesses and a focus group with 10 Western Australian fashion advocates of sustainability provides an Australian context. This research aims to identify the barriers to circularity in the Australian fashion sector, and map the practice of 3 Australian SMEs overcoming these barriers to run fashion businesses built around core principles of product stewardship and circularity. These insights may contribute to the growing discussion on pathways for change in the Australian fashion manufacturing sector.

2. LITERATURE REVIEW

2.1 *A system in crisis in an Australian context*

The supply chain of an average fashion product is one of the most complex, convoluted and lengthy among manufactured products (Sirilertsuwan *et al.*, 2019). A linear, cradle-to-grave, or take/make/waste manufacturing system (McDonough and Braungart, 2009) dominates the fashion sector. Short product lifecycles and planned obsolescence (McDonough and Braungart, 2009) cater to increasing consumer-demand for season-specific, trend-driven, low-priced, low-quality, and short-lifetime garments requiring frequent replacement (Birtwistle and Moore, 2007; Hvass, 2014, 2016; Niinimäki and Hassi, 2011). Defined as fast fashion (Gwilt and Rissanen, 2011; Hvass, 2016), this encourages a throwaway culture whereby many fashion consumers treat low price items as nearly disposable (Hvass, 2014).

An Australian Fashion Council report indicated Australia's fashion industry contributed more than \$27 billion to the 2020-2021 national economy, representing about 1.5%. It employs nearly 500,000 Australians, a higher rate than the mining sector (Australian Fashion Council, 2021). Australians buy an average of 27 kg of new textiles each year, second only to North America and double the global average (Carmichael, 2015). Recent investigations by the Australian Circular Textile Association (ACTA) on textile use in New South Wales indicate this may in fact be even higher, as much as 39kg (NSW Environmental Protection Authority, 2021). Australia's fashion retail sector is dominated by cheap imported goods from international retail giants, and consumers have increasingly embraced these goods, with the industry growing by 21% over the last five years (IBISWorld, 2019). An average Australian sends 23 kg of textiles to landfills annually (Australian Bureau of Statistics, 2013), 25% of Australian consumers dispose of clothing after one wear, and 41% throw unwanted clothes in the bin rather than repairing or recycling them (YouGov, 2017). Two million tons of unwanted apparel go to Australian charities daily, who struggle with the challenges and costs of disposing of poor-quality clothing unfit for resale (Payne, 2016; Payne and Ferrero-Regis, 2019). Only 10% of donated apparel is resold; the remainder is downcycled as rags, sent to landfills, or exported offshore (Craik, 2016; Payne and Binotto, 2017).

The environmental impact of consumption at such speeds and scale is pressing. Significant amounts of non-renewable resources, water, and chemicals used to produce, process, and transport textiles result in excessive and damaging carbon, water, and waste footprints (Fletcher, 2008; Hawley, 2009). Laundering of clothing in the consumer-use phase requires excessive energy and water and accounts for 20% of the micro-plastic flows into the ocean (Fletcher, 2008). Of the 780,000 tonnes of textile waste generated in 2018-19 by Australians, 93% was sent to landfill (Australian Government, 2020). The environmental issues of methane emissions and groundwater pollution from textile landfill waste (Fletcher, 2008; Hawley, 2009) are being exported abroad to developing countries, undermining their own textile and apparel production industries (Fontell and Heikkila, 2017; Payne and Binotto, 2017).

Reporting and recording the triple bottom line (TBL) of environmental, ethical, and financial sustainability (Ara *et al.*, 2019) is not deeply embedded in the values of Australian fashion companies (Walsh, 2009), and there are few incentives, municipal collection systems, or mandatory requirements for the waste management and recycling of textiles in Australia (Caulfield, 2009; Fleischmann, 2019). Australia currently lacks cost-effective processes and technologies to collect, sort, separate, and regenerate fibres and there is no legislation to guide its development (Fleischmann, 2019; Hvass, 2016). CSIRO's Circular Economy Roadmap for the Australian Government does not include textiles (CSIRO, 2021), and most state Circular Economy (CE) policies do not currently include strategies or action plans to address issues of textile waste (Commonwealth of Australia, 2018; Government of South Australia, 2017, Waste Authority Western Australia, 2019). Lack of government policy, regulation, incentives and infrastructure for collection, sorting and recycling of textiles, are significant barriers to CE (Fleischmann, 2019; Kazancoglu *et al.*, 2020).

Fragmentation in the Australian fashion supply chain creates further challenges for this local industry sector, highlighted by supply issues during the global pandemic (Martinez-Pardo *et al.*, 2020). Australia is a primary global exporter of wool and cotton fibres, (Payne and Ferrero-Regis, 2019), however limited textile and garment manufacturing reduces opportunities for sourcing and production (Craik, 2016; Payne and Ferrero-Regis, 2019). A 2021 Australian fashion and textile industry survey indicated that while 88% of businesses designed their products in Australia, only 29% sourced materials from local suppliers (Australian Fashion Council, 2021). Sirilertsuwan *et al.*, (2019) demonstrate the significant role the proximity of manufacturing and textile suppliers plays in enhancing sustainability and TBL in the supply chain. The separated stages of design and manufacture in large, complex supply chains is a barrier to designing for sustainability and circularity (Sandvik and Stubbs, 2019; Sirilertsuwan *et al.*, 2019). Connected, collaborative, close proximity supply chains tend to be shorter, distributive by design and allow for transparency, fast replenishment, avoidance of currency fluctuations and reduced transportation costs, leadtimes and carbon emissions (Fontell & Heikkila, 2017; Sirilertsuwan *et al.*, 2019). Fleischmann (2019) suggests thinly populated areas, large distances and geographical isolation, particularly in regional Australia, create further challenges for innovative design, manufacturing practices and reverse logistics required to tackle issues of textile waste.

The recent ban on the export of waste to developing nations in the Asia-Pacific region has sparked a national crisis and increased interest in product stewardship (PS) and circular models of managing waste (Commonwealth of Australia, 2018; Fleischmann, 2019; Government of South Australia, 2017, State of Victoria, 2020). A sentiment is growing among Australian stakeholders and leadership for a shift towards a CE and PS in the sector (Australian Fashion Council, 2021; Department of Agriculture, Water and the Environment, 2021a). In 2021 the Australian Minister for the Environment hosted a Clothing Textiles Waste Roundtable with industry stakeholders, and has since added clothing and textiles to the Priority List for PS action between 2022 and 2025 (Department of Agriculture, Water and the Environment, 2021a). Furthermore, Australia's first textile recycling facility BlockTexx received local and federal funding in 2021 and aims to divert 4,000 tonnes of textiles from landfill through chemical fibre separation processing and recovery (Inside Waste, 2021).

2.2 Triple Bottom Line (TBL) and Product Stewardship (PS)

New sustainable fashion business models reconsider textile and clothing design, manufacturing, and consumption around the principles of TBL and PS (Fontell & Heikkila 2017; Hvass & Pedersen, 2019; Pal, 2017). Developed by John Elkington in the mid-1990's, TBL measures dimensions of social well-being, environmental protection and economic performance (Ara *et al.*, 2019; Slaper & Hall, 2011) and is part of a reframing of brand responsibility to the communities and environments in which they operate (Pal, 2017). Coupled with a mindset of product stewardship, companies grounded in TBL take responsibility for the entire product lifecycle, from upstream stewardship of resource extraction, textile manufacturing and product supply; to downstream stewardship of the destination of the product at the end of its use phase (Hvass, 2016; Pal, 2017).

2.2.1 Closing loops in Circular Economy (CE)

PS models that fully consider lifecycle at the front end of the design and innovation process, design for circularity. Walter Stahel first suggested the idea of an 'economy in loops' in 1976 (Sandvik & Stubbs, 2019, p366). Providing an alternative to the linear take/make/waste model, it instead maintains goods in an infinite cycle of reuse and recycling, reducing dependence on natural resources and preventing waste. McDonough and Braungart (2009) call this cradle-to-cradle design. In a restorative and regenerative circular fashion economy, the value of clothing, textile, and fibre is maintained in a continuous cycle of use and regeneration, providing benefits for business, society, and the environment (Hvass, 2016; Pal, 2017). The redirection of textile waste from incineration or landfills is achieved through reverse logistics to capture, sort, regenerate, and remanufacture new products of value (Goldsworthy, 2014; Pal *et al.*, 2016; Sandvik and Stubbs, 2019).

McDonough and Braungart (2009) refer to two different cycles for closing loops: biological and technical. In a fashion context, biologically based products are designed for biological circularity, re-entering the loop through composting or anaerobic digestion to regenerate living systems and renewable resources for the economy (EMF, 2017). Technical cycles recover and restore textile waste to generate new fibres and yarns (EMF, 2017). The retention of textile value for as long as possible in both cycles before closing the textile loop is achieved through reuse, repair and remanufacture (Niinimäki, 2019). Biological and technical cycles can be combined by separating fibres from blended materials (e.g., polycotton), sending biological matter through the biological cycle (cotton) and technical matter (polyester) through the technical cycle (Niinimäki, 2019). Niinimäki (2019) suggests that biological cycles are not currently an option for most clothes; the logistics of composting at scale is complex, and composite fibres and textiles can leach toxic substances into the soil. However, the use of petrochemical-based synthetic materials (recycled or otherwise) in the technical loop also contain toxic chemicals and microplastic pollution that inevitably leaks into the environment (Rissanen, 2020). Mechanically recycled polyester fibres lead to a degenerated and down-cycled open-loop product, and chemical recycling technologies are currently limited in scale (Sandvik and Stubbs, 2019; Ballie and Woods, 2018). Furthermore, recycled polyester from PET plastic bottles (rPET) redirects plastic away from the successfully closed-loop bottle recycling industry (Rissanen, 2020).

Goldsworthy introduces the element of speed to these loops, suggesting fast closed-loop cycles may be more appropriate for the trend-driven, planned obsolescence of the fast fashion sector; in contrast to the long loops emphasizing durability, user engagement and emotional longevity that are commonly advocated in literature on CE in fashion and textiles (Earley and Goldsworthy, 2015; Goldsworthy, 2017). Goldsworthy asserts that accelerating the product cycle from the end-of-life phase of a fast fashion item through lean, clean, closed-loop production technologies into a high quality new material may in fact be less detrimental to the environment (Goldsworthy, 2017). Designing for durability and material longevity is appropriate where garments are to be kept in use for longer periods of time: 'whilst some strategies may be more relevant for the mass market and high street fashion (short-life), others will be focused on more niche, SME brands' (Earley and Goldsworthy 2015).

2.2.2 Extended responsibility and Product Service Systems (PSS) in CE

Assumptions of continued economic growth, production and consumption underpin the fashion sector (Niinimäki *et al.*, 2020), but rethinking output is as critical as rethinking inputs (Ballie and Woods, 2018). Overproduction and underuse of clothing are key underlying problems (Huynh, 2021). New demand-led and made-to-order models (Berg *et al.*, 2019; Sandvik and Stubbs, 2019) and product service systems (PSS) such as rental, repair, sharing and resell business platforms (Fontell and Hekkila, 2017; Niinimäki *et al.*, 2020; Pal *et al.*, 2016) are changing production processes and consumption behaviours. PSS systems are the least complex way for this sector to reduce its environmental footprint, displacing resource extraction involved in the production and distribution of new clothes (Goldsworthy, 2014; Hvass, 2016; Sandvik and Stubbs, 2019). PSS and recycling engage consumer values in a lifecycle-focused strategy aimed at extending user responsibility and creating closed loops (Hvass and Pedersen, 2019; Niinimäki *et al.*, 2020), whereby an engaged consumer becomes a resource supplier and co-creator of fashion products (Hvass, 2016; Pal, 2016). Digital technologies are evolving to support these demand-led and PSS models; enabling fitting and customisation, rapid demand-driven production, customer-centric communication, sorting of clothing, and digital sharing, repairing and reselling platforms (Huynh, 2021). Huynh (2021) suggests SMEs and new startups are leading innovation in digital technologies and radical business model innovation.

2.2.3 Design thinking and the role of SMEs

International research has demonstrated that drop-in solutions of production efficiencies, sourcing less environmentally-impactful virgin materials, and recycling come from a mindset of maintaining production volumes, profits and growth (Fletcher, 2010) without requiring transformative change to the linear supply chain. Rather than converting an existing supply chain, transformative action

involves new knowledge, procedures, and a philosophical underpinning of the business model (Andersen and Earley, 2014; Henninger *et al.*, 2016; Hvass and Pedersen, 2019) to embody the whole product lifecycle, from resourcing to disposal, in design practice (Fry, 2009). Tonkinwise asserts that design is not only what is designed into existence, but also what is 'designed away', calling designers 'waste managers, cleaners, problem solvers' (2014, p1). Eighty percent of a product's environmental impact is determined in the design phase (Ballie and Woods, 2018). Designing for circularity and cyclability 'designs out' barriers to recycling and closes the loop on production practices to retain the value of materials (Goldsworthy, 2014; Niinimäki *et al.*, 2020). These approaches form a fundamental shift to a value creation mind-set in perspectives on waste (Fontell & Heikkilä, 2017).

Design thinking perspectives commonly reference iteration and agility (Lawson, 2005; Lawson and Dorst, 2009); and empathy and cocreation (Banerjee, 2014; Krippendorf, 2004; Sanders and Stappers, 2008). The inherent iterative and agile nature of fashion SMEs is considered advantageous in building new business models with a circular foundation (Henninger *et al.*, 2016; Pedersen *et al.*, 2019; Hvass and Pedersen, 2019). Collaborative and co-creative engagement of users is critical in designing for circularity (Raebild and Bang, 2017; Henninger, *et al.*, 2016), while building partnerships with wider industry stakeholders is essential to synchronise infrastructure and share emerging research and innovations in circular technologies (Fontell & Heikkilä, 2017; Niinimäki *et al.*, 2020; Sandvik & Stubbs, 2019). Design thinking and design-led innovation may play a critical role in reimagining the take/make/waste model (Andrews, 2015; Andersen and Earley, 2014; Fleischmann, 2019; Pal, 2017).

2.3 A gap in the literature on applying CE to fashion SMEs in Australia

Internationally, SMEs are reconsidering clothing design, manufacture, and consumption, and are building innovative business models around the principles of CE (Henninger, *et al.*, 2016; Huynh, 2021; Hvass and Pedersen, 2019; Raebild and Bang, 2017; Sandvik and Stubbs, 2019). However limited scholarly literature linking CE theory to practice in the Australian fashion sector exists. Shirvanimoghaddam *et al.* (2020) reference 2009-10 ABS data and review global rather than Australian textile waste types and circular alternatives to manage, recycle and redesign waste. Academic researchers such as Payne (2014) and Payne & Binotto (2017) have reviewed sustainable practices by Australian fashion brands and manufacturers, but not in the context of circularity. Fleischmann (2019) examines the role of design in CE in Queensland, but uses examples from an international context. Australian author Alison Gwilt added a new section on the CE to the second edition of her book *A Practical Guide to Sustainable Fashion* in 2020. Research undertaken in 2021 collected much needed data on textile waste in NSW (NSW Environmental Protection Authority, 2021) and there are plans for further research and action in the sector (Australian Fashion Council, 2021; Department of Agriculture, Water and the Environment, 2021a).

Although the Australian fashion retail sector is dominated by fast fashion consumption of imported product, 88% of the local apparel manufacturing sector is comprised of SMEs (Miller, 2019). Internationally, SMEs and start-ups are demonstrating innovation in TBL fashion business models, adaptability and agility, and tend to have close partnerships in place with their customers - qualities integral to the success of a circular model (Henninger *et al.*, 2016; Hvass and Pedersen, 2019). Innovation in models for sustainability by fashion SMEs can influence larger companies and impact on behaviour in a market sector (Goworek, 2011; Sandvik and Stubbs, 2019). This is therefore an influential group to consider for change to the take/make/waste fashion model operating in Australia. It is also clear that there are some unique challenges of geographical distances, sparse population and fragmentation in the Australian fashion sector (Craik, 2016; Fleischmann, 2019; Payne and Ferrero-Regis, 2019). Brydges (2021) notes the significance of considering local factors for successful pathways to a CE. It is therefore the purpose of this paper to examine the barriers to CE that exist in the Australian fashion sector, and to map the practice of Australian SMEs with circular business models in overcoming these barriers.

3. METHODOLOGY

This study takes a constructivist epistemological perspective, in which design process is engaged within the socio cultural realm of the Australian fashion design and manufacturing sector and its participants. Eighty percent of the environmental impact of a product is determined in the design phase (Ballie and Woods, 2018). Therefore, this interpretivist research study explores the design and associated practices of owners of circular and sustainable Australian fashion SMEs. Tuite (2019, p10) defines small scale independents in Australia as ‘micro- to small-scale businesses employing fewer than 20 people’ and this definition applies to the SME participants in this study. Miller (2019) suggests that 88% of the Australian fashion manufacturing sector comprises SMEs, with low market share concentration for this segment and only a small number of large operators accounting for less than 40% of the industry’s revenue. These SMEs focus on value-added or niche fashion products (Miller, 2019; Payne and Ferrero-Regis, 2019).

This qualitative exploratory study included 3 in-depth interviews and a focus group, meeting ethics guidelines set out in the National Statement on Ethical Conduct in Human Research (NHMRC, 2007). Table 1 forms a summary of participant information. The interviews formed research stage 1 (S1), and purposive sampling targeted founders of Australian SMEs operating with principles of circular, demand-led, and zero-waste systems central to their business model. These SMEs were identified due to their leadership and innovation on circularity and sustainability in the Australian fashion sector through literature, forums, conferences and media. Two SMEs are based in Sydney and one is based in Melbourne. In-depth one-hour interviews were conducted using open, semi-structured questions with a flexibility to ask follow-up questions. The interviews aimed to gain insights into the characteristics of their practice and contexts within which they operate. Participants were given the Interview Guide (Appendix 1) ahead of the interview. Interviews were recorded and transcribed with permission, and sent to interviewees to review and approve before analysis (NHMRC, 2007).

In Stage 2 (S2), ten Western Australian-based participants took part in a one-hour focus group. The author is a Western Australian resident, and connected to the WA fashion community through a career in fashion product development and academia. Participants were purposively selected by the author based on the principles of sustainability and ethics at the forefront of their practice. 14 participants were approached and the final 10 was determined due to participant availability. The participants included representatives from academia, fashion SMEs, and a CE consultancy (see Table 1). Three S2 participants were currently applying circular principles to their business and design practice. A focus group method was chosen to capture organic discussion and a flow of ideas among participants not constrained by the researchers perspective (Hennik, 2014). The focus group followed semi-structured questions (Appendix 2) which were provided to participants ahead of the session. Focus group questions concentrated on characteristics of the Australian fashion sector and perceived barriers to sustainability. Interactive presentation software (<https://www.mentimeter.com/>) individually collected live feedback and data from participants in response to the questions while the general discussion occurred. The focus group dialogue was transcribed, and participants’ identities were coded for confidentiality.

Table 1. Stage 1 and 2 Participant Profiles

| Stage 1 | | | | | | | | | | |
|---------|---------------------------|--------------|---------------------|------------------------|------------------|---|-------------------|----------------------|------------------------------|-------------------|
| | ORGANIZATION | TITLE | PARTICIPANT | ESTABLISHED | NO. OF EMPLOYEES | KEY CHARACTERISTICS | | | | |
| S1.1 | Citizen Wolf, Sydney | Co-founder | Zoltan Csaki | 2016 | 7 | Manufactures in own purpose-built Sydney-based factory | | | | |
| S1.2 | The Very Good Bra, Sydney | CEO, Founder | Stephanie Devine | 2018 | Sole proprietor | Outsourcing manufacture offshore in Asia | | | | |
| S1.3 | A.BCH, Melbourne | Founder | Courtney Holm | 2017 | 5 | Manufactures in own purpose-built Melbourne-based factory | | | | |
| Stage 2 | | | | | | | | | | |
| | Fashion Brand | Consultancy | Technology Start-up | Owner, Founder, or CEO | Designer | Fashion Academic | Local Manufacture | Offshore Manufacture | Sustainable/Ethical Practice | Circular Practice |
| S2.1 | | X | | X | | | | | X | X |
| S2.2 | X | | | X | X | X | X | | X | |
| S2.3 | X | | | X | X | | X | | X | |
| S2.4 | X | | | X | X | | X | | X | X |
| S2.5 | X | | | X | X | | X | | X | |
| S2.6 | | | X | X | | | | X | X | X |
| S2.7 | X | | | X | X | | | X | X | |
| S2.8 | X | | | X | X | | | X | X | |
| S2.9 | X | | | X | X | X | X | | X | |
| S2.10 | X | | | X | X | | | X | X | |

The transcripts from S1 and S2 were examined using analytic coding to reduce and organize the data into commonalities in a codebook (Cope, 2010). This process was reflexive and the recursive review and analysis of the data developed eight distinct themes.

4. RESULTS

Eight key themes emerged from analysis of the interview and focus group data. They are summarized in Table 2.

4.1 A system in crisis

The demand for fast fashion challenges abilities of SMEs to compete on quality (Miller, 2019), and greenwashing in fashion marketing dilutes the brand message of authentically circular and sustainable labels. Participants described an accelerated take/make/waste fashion system in Australia fuelled by a consumer culture of consumption, a participant stating: 'the system is broken' (S1.1). 'Greenwashing' (Gwilt, 2020, p. 15) by Australian clothing brands and even textile suppliers was asserted as prevalent (S1.1; S1.2; S1.3; S2.3; S2.7). Greenwashing saturates the market with misinformation (Islam, 2019) and is challenging for participants to differentiate their own product story (S2.7; S2.10):

There's a lot of people saying, "Oh, this is a great product because it's biodegradable", and, yes, it is biodegradable, but it still leaves toxic residue at the end of its life (S1.2).

However, participants considered the 2019 Australian bushfires and COVID-19 as disruptions which had increased consumer awareness of ethics and sustainability issues in the fashion supply chain (S1.2; S2.1; S2.4; S2.10). Interviewee S1.2 stated: 'I think we're going to be more values driven in our choices as consumers after COVID'. Brydges et al. (2021) also suggest Australian brands with messages of local, sustainable and ethical production may appeal to consumers post COVID-19.

4.2 Central purpose of product stewardship (PS)

A moral and ethical rejection of the take/make/waste linear fashion model is central to S1 SMEs. S1 SME business and product design models are purposefully built with a foundation of PS and TBL, and grounded in circularity and zero-waste: 're-imagining the process for making and selling clothes' (S1.1). Participant S1.3 explained the supply chain as 'the birth of the garment, the life, and the afterlife', referring to the resourcing and manufacture; wear and laundering by the customer; and the final disposal of a fashion product.

I've never come from a position of having to convert a conventional product into becoming a circular product ... everything we do is centred around this concept of circular design ... we've created our own system (S1.2).

Henninger, et al. (2016, p409) similarly report on a 'philosophical underpinning of the production process rather than an 'add-on' strategy' in their research into UK-based sustainable fashion micro businesses. This is transformative for design practice, and is the central ethos behind all S1 SME decisions, processes, and system development in their business models.

4.3 Role of design thinking behaviours

Behaviours recurring in design-thinking literature are commonly demonstrated by participants - iterative and agile loops of trial and error and feedback (Lawson, 2005; Lawson and Dorst, 2009); and cocreation with manufacturers and consumers (Banerjee, 2014; Sanders and Stappers, 2008; Krippendorff, 2004). Iterative and agile behaviour was described as: 'always trying to move forward and learn' (S1.2), and: 'we just sort of figure it out ... asking naïve questions without presupposing the answer' (S1.1). Participant S1.3 described being 'scrappy', as 'a positive' to iterate quickly in experimentation with materials and processes, and a rapid responsiveness to changing events. This iteration and agility of SMEs is noted in literature as advantageous in building business models around a circular foundation (Henninger et al., 2016; Pedersen, et al., 2019; Hvass and Pedersen, 2019)

Table 2. Themes from the research

| | Theme | Definition |
|---|--|--|
| 1 | A system in crisis | A core belief in the current linear economic business model is that the fashion system operates within is dysfunctional, with a high environmental and ethical impact. Key characteristics of this system in crisis cited by participants include the extremely low prices of fast fashion; overproduction and overconsumption of clothing; exploitation of workers within the global supply chain; and the extreme environmental impact from the excessive use of non-renewable synthetic fibers, textile manufacture, and disposal. |
| 2 | Building a different system with the central purpose of product stewardship | An aspirational moral purpose that is a fundamental rejection of the linear take/make/waste system. Instead, this rejection fuels a new and purposeful business and design model guided by responsibility for the whole of the product lifecycle, with a strong focus on “end of life.” This product stewardship model guides all decision-making related to the brand. |
| 3 | The role of design thinking behaviors | Navigating new circular systems, models, and processes are supported by a design thinking mindset. Ideation, iteration, and resilience boost innovative practice; agility enables responsiveness to a rapidly changing environment; and a strong sense of empathy in collaborative relationships fosters new processes and consumer co-creation. |
| 4 | Barriers to circularity | A group of barriers that inhibit circular design practices and circular business models in the fashion sector. This includes: <ul style="list-style-type: none"> □ The complexities and time-consuming nature of sourcing circular materials due to scarcity, a lack of transparency and information surrounding supply chains, and restrictive qualities of some circular products □ A reluctance from the legacy industry to move away from established practices □ High minimum order quantities and high costs of circular and sustainable materials and components □ Consumer price expectations and a competitive and accelerated fashion environment driven by social media depiction of single-wear items □ “Greenwashing” saturating market with misinformation and undermining the product story of those working in an authentic space |
| 5 | New design processes guided by circular purpose | The development of new (biologically circular) design processes that include the development of sourcing strategies and a resource library of tested materials and components, as well as short and long term strategies for designing our waste from their systems. |
| 6 | New business models guided by circular purpose | A rethinking of business models grounded in circularity through the focus on demand-led production, life-extending strategies and product service systems (PSSs), and a deceleration of fashion business practice. |
| 7 | Building relationships around circular purpose | Connections, partnerships, and collaborative development play critical roles in the pathways to circularity. These collaborative relationships are evident within the global and local supply chain for both suppliers and manufacturers and, more importantly, for the consumer. Consumer behavior in engaging with the circular process is essential to the success of a circular fashion brand. |
| 8 | Fostering circularity in the Australian fashion industry | The role of external stakeholders, government and industry in fostering circularity in the fashion sector. It takes the form of mandating around product stewardship for industry and textile waste for both industry and consumer disposal, the investment in local manufacturing technologies and processing and local procurement, greater investment in education and training on the circular economy as it applies to fashion, and fostering industry collaborations and community-based initiatives to support circularity. |

Empathy and co-creation recur in perspectives on design-thinking; Krippendorff (2004) suggests human-centred design is a participatory social process involving a network of user stakeholders and community. Co-creative interactions with textile growers, mills, and knitting industries enabled S1 participants to get the most ethical, transparent, sustainable and quality textile results: participant S1.2 is currently collaborating in a pilot with CSIRO involving multiple industry stakeholders to re-spin ragged material with virgin cotton fibre to create a partially recycled yarn. Co-creative relationships with the user are evident in customization, crowd-funded and pre-sell models, and workshops are run co-creatively with consumers (S1.1; S1.2; S1.3).

4.4 Barriers to circularity

Participants described 2 key areas of challenge for CE in the Australian fashion sector; complexities and reluctance in sourcing and manufacture, and challenges of meeting consumer price expectations with high material costs (S1.1; S1.2; S1.3; S2.2; S2.3; S2.5; S2.6; S2.7; S2.10). While both S1 and S2 experienced common barriers, S1 SMEs had more established pathways to overcome them.

4.4.1 Complexities/reluctance in sourcing and manufacture

S1 SMEs extensively vet their supply chains for circularity, ethics, transparency, and functionality. Participant S1.3 described the time and expense of this process: 'we don't have the resources to do the whole origin visit every time we want to use a new raw material'. The dependence of the S1 SMEs on highly specialized circular and compostable components such as elastic, thread, labels, or closed-loop tencel fibre make their supply chain vulnerable and expensive, and Australia's geographical isolation and COVID-19 amplifies this challenge (S1.2; S1.3). S1 participants lamented the absence of organic cotton, hemp and linen crops in Australia, and the lack of woven textile mills. S1.1 and S1.3 SMEs work with local Australian knit mills, but in most cases the fibre is grown, processed, and spun offshore. Participants described a lack of local manufacturing and skilled workers for garment production, and technologies for processing and finishing textiles (S1.2; S2.3; S2.6; S2.10).

Participants experienced a reluctance of suppliers to share information on their supply chain, making lifecycle analysis of materials difficult (S1.2; S2.10). Ballie and Woods (2018) also observed this lack of transparency and disconnect of information in their UK study into fashion SMEs. S1 interviewees noted a hesitancy to move away from established practices: 'every time we butted up against the legacy industry, it was literally impossible to get anybody ... to change the way they worked' (S1.1). Minimum order quantities (MOQs) of circular materials are high due to the specialist nature of their production. S1.2 and S1.3 SMEs are unable to use new compostable stretch fibre Asahi ROICA due to the high MOQ. Furthermore, restrictive characteristics of many circular materials impact design. Jia, *et al.* (2020) note the challenge of meeting functionality and aesthetics with circular materials; and participant S1.2 describes tree rubber elastic as 'not the softest thing' for lingerie. S1 participants stated that materials such as stretch lycra, mesh, and polyester padding are very difficult to replicate for closed-loop design (S1.2; S1.3).

4.4.2 Component costs and meeting consumer price expectations

The relationship between material and component costs and the purchase price for the consumer drove design process decisions by participants (S1.1; S1.2; S1.3; S2.3; S2.5; S2.7; S2.10). In a market environment of cheap imported fashion, participants felt burdened by consumer price expectations: 'people's consciousness stops at their pocket' (S2.6). While many consumers have positive attitudes towards sustainability, in fashion purchases, economic benefits commonly take precedence over environmental attitudes (Joergens, 2006; Pal *et al.*, 2016). High costs of specialized components and fabrications meant several participants had to manufacture offshore to keep their price point acceptable to their customer (S1.2; S2.3; S2.7; S2.8). Participant S1.2 described the costs of biologically circular elastic or thread as 'absolutely enormous upfront'. Wholesale business models are prohibitive; participant S1.2 stated their products were unable to sustain a retail markup.

4.5 New design processes guided by circular purpose

Working within the constraints of mono-materiality, biological circularity and zero-waste, designers focused on product longevity are developing new design processes guided by circular purpose. Regarding their raw material supply chain, S1.3 said: 'we make the right decisions at the design phase'. Sandvik and Stubbs (2019) suggest the design phase is crucial and should focus on mono-materiality and easy disassembly for future redesign or recycling. S1 SME commitment to designing for longevity within the constraints of available biologically circular materials guides decisions of participants around enduring design styles, material and colourway selection, construction, free repair and alterations services, and education around laundering practice (S1.1; S1.2; S1.3). A focus on longevity over trend is supported in Raebild and Bang's (2017) study of a Danish rental fashion brand.

The development of a reliable and tested library of quality circular resources with 'mapped' (Gwilt, 2020, p. 26) inputs and outputs is critical to circular design processes of S1 participants. Reliable accreditations such as Cradle to Cradle Gold Certification, Global Organic Textile Standard (GOTS) and Fair Trade certifications provide confidence to participants of the origins of materials (S1.1; S1.2; S1.3). Intensive fibre investigations into carbon emissions, chemical and water use, and end-of-life environmentally-safe decomposability; adds to a narrow resource library of core materials. These are used by S1 SMEs over multiple design styles, collections, and seasons: 'I really just stick to those materials which I feel are very easy to qualify and very easy to trace' (S1.2). Raebild and Bang's (2017, p.596) study of Circular Collection Building also notes the 'range of materials is limited, and changes in the range happens slowly'. As the material resource library builds over time, the time intensiveness and complexities of sourcing in the design process declines.

Participants also develop systems for designing out waste. Zero-waste patternmaking methods and strategies for using textile offcuts in products such as tote bags, garments, homewares and accessories are utilised (S1.1; S1.3). Sorting and recycling bio-based fibres in Australia currently lacks the technology, infrastructure, and scale to provide technical circularity, although S1 SMEs were involved in initiatives to further this development. This includes collecting and sorting textile waste for future recycling technologies (S1.1; S1.3); pilot programs to re-spin ragged textile waste with virgin cotton fibre (S1.1); collaborations with commercial worm farms to assess decomposability (S1.2); experiments using reclaimed materials as mulch for new cotton crops (S1.2); a partnership with a Hong Kong based company to recycle fabric offcuts into knitting yarn (S1.1); and developing new recycling technologies for extracting raw cellulose from organic food and beverage waste (S2.6).

4.6 New business models guided by circular purpose

Participants in this study have developed innovative business models guided by circular purpose, including a focus on demand-led production; life-extending strategies and product service systems (PSS); and a deceleration of fashion business practice.

S1 SMEs utilise crowd-funded models (S1.2), discounted pre-sell methods (S1.1; S1.2) and rapid technology-led customization (S1.1) to eliminate the need to hold surplus stock or inventory. These demand-led systems and direct-to-consumer (DTC) methods include a unique business model that produces rapid customized apparel with a fitting algorithm technology developed by the SME based on data points such as height, weight and age to produce individually-tailored CAD patterns (S1.1). The system was developed to be scaled in the future by: 'combining the best bits of single piece production and some of the efficiencies of mass production' (S1.1). DTC methods, identified as a trend more generally for Australian SMEs (Miller, 2019), also maximizes opportunities for S1 SMEs to engage the consumer more directly in their circular narrative, enhancing product attachment and longevity of use.

S1 SMEs are active in rental, collection or take-back of goods; repair and alterations services; customization services; and education around laundering and care, maximising the engagement and utilization of the customer in their clothing:

whether it's through repair or different styling ideas and ways to wear a garment ... we're trying to keep that customer interested in wearing that piece. And when they're no longer wearing it ... asking them to send it back to us so we can either give it another life with someone else, or depending on its condition it might be repaired, or it might be completely done and ready to be composted or recycled. (S1.3)

PSS systems are an important part of an overall circular design strategy (Raebild and Bang, 2017; Mukendi and Henninger, 2020) and influence change in consumption behaviours by extending user responsibility.

All participants from S1 described their styles as limited and worked slowly on only a few product styles at a time. Decelerated and life-extending business models focus on slower, enduring, curated styles that do not go on sale. None of the interviewees engaged in sale culture, their items never went on sale: 'I don't want to discount at the end. I don't believe in that philosophically; we sell at full price' (S1.2).

4.7 Building relationships around circular purpose

Participants in this study emphasized the importance of building participatory relationships with their supply chain and their customers. A level of supplier reluctance is among the barriers to circularity and S1 participants invest heavily in building positive and collaborative relationships with their manufacturers and suppliers over time, encouraging and driving them to work differently. Raebild and Bang (2017) describe fashion designers and their manufacturers as co-creative partners. Influenced by the brand narrative and circularity goals of S1 SMEs, suppliers innovate to develop and sample new components, introduce new materials and colourways, and show an inclination 'to be a bit more flexible' (S1.2).

Four SMEs in this study run micro-factories with in-house employees (S1.1; S1.3; S2.4; S2.5) and describe the agility their local supply chain and DTC distribution provided during the supply demands of the 2020 pandemic. Working with local supply and manufacturing supports a shorter, cleaner, more agile and more traceable supply chain, as well as providing a positive brand narrative for Australian-made localism. Brydges *et al.* (2021) suggest that supply chain issues related to COVID19 has in fact led some Australian designers to rethink their business and manufacturing model, and Larsson (2018, p.384) promotes building 'value chains that support local manufacturing'. All S1 SMEs were involved with the Australian textile knitting industry, and much of the fibre was locally grown, though sent offshore for processing. Payne and Ferrero-Regis (2019, p. 10) describe this as 'glocalism', combining local Australian fibre and onshore apparel manufacturing with internationally-sourced specialized circular components. The transparent supply chain is kept as short as possible. S1 SMEs with glocal supply chains use European closed-loop Lenzing Tencel fibre in Australian textile knitting factories (S1.1; S1.3), and Italian-processed, locally-grown wool fibres knitted in Australia (S1.1; S1.3).

A human-centred approach (Krippendorf, 2004) and the role of the user is critical to the success of the circularity of S1 SMEs: 'anything could still end up in landfill, we have to rely on our customers to take the right actions' (S1.3). Consumer behaviour regarding repair, care, and disposal of fashion product ultimately determines whether the circular loop is 'closed' (Fletcher and Grose, 2012; Fontell and Heikkila, 2017). Strategies employed by S1 participants to engage, educate, inform, and co-create with their customer include open communication regarding fibre origin and product supply chains (S1.1; S1.2; S1.3); running reward-driven garment take-back schemes and zero-waste and repair DIY workshops (S1.1; S1.3), educating customers about biological composting methods (S1.2; S1.3), and providing detailed care manuals for their products (S1.1; S1.2; S1.3). Co-creative relationships with the customer are also evident in customization, accessing crowdfunding for new product launches, and use of pre-purchase methods (S1.1; S1.2; S1.3). S1.2 utilises a crowd-funded model where customers pre-buy a print design product with a small discount *ahead* of manufacture. The product only goes into production if pre-orders enable MOQ of the printed textile to be met. This participant

had also used crowd-funding platform Kickstarter (<https://www.kickstarter.com/>), for the initial launch of their SME.

4.8 Fostering circularity in the Australian fashion industry

Participants in this study feel burdened by the responsibility of educating their supply chain, consumers, and the wider community, and advocate for external support, infrastructure, and systems to further circular pathways and practices in the Australian fashion and textile industry. Participants suggest that a lack of initiatives to regulate environmental textile standards, and infrastructure to facilitate textile waste collection, form a barrier to value creation mindsets in a CE (S1.2; S1.3; S2.1; S2.2; S2.4; S2.5; S2.6; S2.7; S2.10). Research participants suggest mandating standards for environmental impact in the Australian fashion sector (S1.2; S1.3; S2.6), including fibre environmental impact labelling and financial disincentives for unsustainable fibre imports. When consumers have '\$2 T-shirts in a store, then that choice is there for them to make' (S2.2). Stricter environmental standards will foster responsibility of manufacturers for the impact of their materials; less wasteful consumer purchasing behaviours and investment in technologies to collect, sort, separate, and regenerate fibres (Caulfield, 2009).

Participants suggest government investment and procurement processes should be led by ethical and sustainable local producers focused on PS (S1.2; S1.3; S2.4; S2.10). They stated community education, education programs in schools, and industry training are critical to cultivate 'a buying dynamic and audience of informed customers' that value quality, longevity, and sustainability (S2.6); as well as helping communities and consumers differentiate between genuine sustainability and greenwashing. Participants identified a need for education within industry, with S2 participants in particular seeing a requirement for deeper understanding of what circularity means in terms of design in fashion education curriculum and industry programs (S2.1; S2.2; S2.6; S2.7; S2.10).

Building partnerships with wider industry stakeholders to share emerging research and innovations in circular technologies and synchronising infrastructure is required (Fontell and Heikkila, 2017; Sandvik and Stubbs, 2019).

We're going to need multiple solutions. We're going to need composting solutions, biodegrading solutions, mechanical and chemical recycling solutions. (S1.3)

Interviewees promote collaboration and industry dialogue on the CE; appearing on podcasts, at symposiums and industry forums (S1.1; S1.2; S1.3). S1.3 supports community access to low quantities of circular trims and materials. SME S1.1 aims to release their algorithm based custom-fit technology more widely: 'if we can prove that model is viable, then our hope is that many more companies become like us in producing on-demand'.

5. DISCUSSION

The interactive relationships of the key themes above have been visualized in Figure 1. Visualisation of information enables quick insight and understanding of connections and relationships (Lankow, Ritchie, and Crooks, 2012). Frameworks and diagrams depicting circular design and production practices in the fashion sector have been used in literature to effectively depict interrelated factors at play (Islam, 2021; Jia, *et.al.*, 2020). Figure 1 advances these examples by introducing further themes that emerged from the research - underpinning design thinking behaviours, the role of new business models guided by circular purpose, and external supporting influences that may support circularity for Australian SMEs.



Figure 1. Circularity model: Australian fashion SMEs

5.1 Barriers to Circularity for Australian fashion SMEs

Icons representing the barriers (theme 4) are illustrated in Figure 2 and form a red ring on the Circularity Model. Jia, *et al.* (2020) noted similar challenges in their literature review focused on CE in the textile and apparel sector; and this study advances an Australian context of a consumer highly engaged in fast fashion culture (Miller, 2019; S2.6), a fragmented textile and manufacturing industry (Payne and Ferrero-Regis, 2019; S1.2; S1.3), and geographical isolation (Fleischmann, 2019; S1.2; S1.3).



Figure 2. Barriers to Circularity

5.2 A central purpose of PS and circularity, supported by design thinking behaviours

Central to S1 SME business models is a fundamental rejection of the linear take/make/waste system (theme 1), and the reimagining of a new system built around a central purpose of PS and circularity (theme 2). This central core of PS is illustrated in Figure 1. Brydges (2021) research into the Swedish fashion industry similarly asserts that a holistic systemic approach is vital for CE in the fashion sector. Fleischmann has suggested that Australia has an 'innovation deficit' in its approach to CE (2019, p.385). However S1 SMEs in this study demonstrate a design thinking mindset (theme 3), and their iterative, agile, and co-creative behaviours form blue foundations in Figure 1, supporting new design processes, business models and relationships guided by circular purpose. Literature too suggests the inherent design thinking behaviours demonstrated by SMEs may be advantageous in building new business models with a circular foundation (Henninger *et al.*, 2016; Pedersen *et al.*, 2019; Hvass and Pedersen, 2019). With flexible and agile business models and a shorter, integrated, and collaborative supply chain (Gwilt, 2020), Australian fashion SMEs may be well positioned to innovate to overcome the barriers to circular design and manufacturing, as they already exhibit many characteristics of a design thinking mindset.

The barriers to circularity are distributed around the central core (Figure 1) to indicate the strategies employed by S1 SMEs that challenge them.

5.3 New design processes guided by circular purpose

The bottom trisection of Figure 1 illustrates new design processes guided by circular purpose (theme 5). S1 SMEs maintain lifecycle thinking (Gwilt, 2020) and end-of-life at the forefront of their process; focussing on mono-materiality and biological circularity; designing for longevity; designing out waste; and developing circular resource libraries. They design for timelessness of style, quality construct and product investment.

As investment in textile recycling technologies and infrastructure for garment collection at scale increases in the technical loop, larger Australian fashion corporations with single-season fashion items may be well positioned for rapid closed-loop textile recycling at faster speed cycles (Goldsworthy, 2017; Sandvik and Stubbs, 2019). Conversely, this study suggests that Australian fashion SMEs are well positioned to successfully design long-life garments in a sustainable CE with longer biological loops, and that the best pathway may be to transition away from petrochemical-based fibres to regenerative and biocompatible ones.

5.4 New business models guided by circular purpose

New innovations in fashion business models are required to support the CE (Mukendi and Henninger, 2020; Pedersen, *et al.*, 2019; S1.1; S1.3). This is illustrated in the left trisection of Figure 1 (theme 6). DTC methods, crowd-funded presell models, PSS systems, and slower and decelerated product development overcome key barriers identified in the research including pressures of speed, costs and consumer price expectations. Huynh's (2021) Norway-based case study of fashion SMEs suggest digital innovation is a key strategic tool for supporting CE transition. Rapid technology-led customization increases speed, while engaging the customer with a personalized product (Huynh, 2021; S1.1).

5.5 Building Relationships around circular purpose

The right trisection of Figure 1 illustrates the co-creative relationships built around circular purpose (theme 7) that support collaborative connections with the customer and within the supply chain, critical to overcoming barriers to the success of circular models. Collaboration with local fibre and textile industries, and apparel manufacturers, support a shorter, faster, agile and more traceable supply chain (Payne & Ferrero-Regis, 2019; Sirilertsuwan *et al.*, 2019). Supplier reluctance to change legacy practices, share information about origins of materials, or show flexibility with MOQ are overcome through education and engagement in the circular narratives of brands; inspiring innovation, iteration and collaboration within the supply chain. Conflicts between local manufacture and requirements for highly specialized (globally situated) circular components and materials may be met through glocalism (Payne & Ferrero-Regis, 2019); but Australian fibre, processing and reshoring of manufacture are used wherever possible (S1.1; S1.3).

The relationship and role of the customer is intimate to the circular fashion SME, and key to overcoming barriers of a competitive and accelerated fast fashion culture. Products that are personalized or customizable or involve the consumer in co-creation assist in product attachment and longevity of use (Huynh, 2021; Pal *et al.*, 2016; S1.1). The role of the consumer in the end of life of the garment is critical, as their behavior in the repair, care and disposal of the product must comply with the aims of the brand (Fletcher & Grose, 2012; Fontell & Heikkila, 2017; S1.3). Miller (2019) has noted a trend in Australian SMEs moving away from wholesaling to DTC sales methods, so SMEs may therefore be well-equipped to foster these relationships.

5.6 External Supporting Influences for Circularity

Research suggests that the supply chain disruptions caused by COVID19 and the Australian bushfires have contributed to a shift in consumer sentiment in Australian fashion (Martinez-Pardo, *et al.*, 2020;

S1.1; S1.2). Previous apathy towards excessive waste issues (Birtwistle & Moore, 2007; Caulfield, 2009) is being replaced by an awareness of environmental impacts and the role of resource recovery in sustainable futures. SMEs in this study apply for external support, infrastructure and systems to further circular practices and training in the fashion and textile industries (S2.1; S2.2; S2.6; S2.7; S2.10). Figure 3 is an expanded diagram of the external supporting influences to circularity for Australian SMEs (theme 8), represented by blue icons in the outer ring of Figure 1.

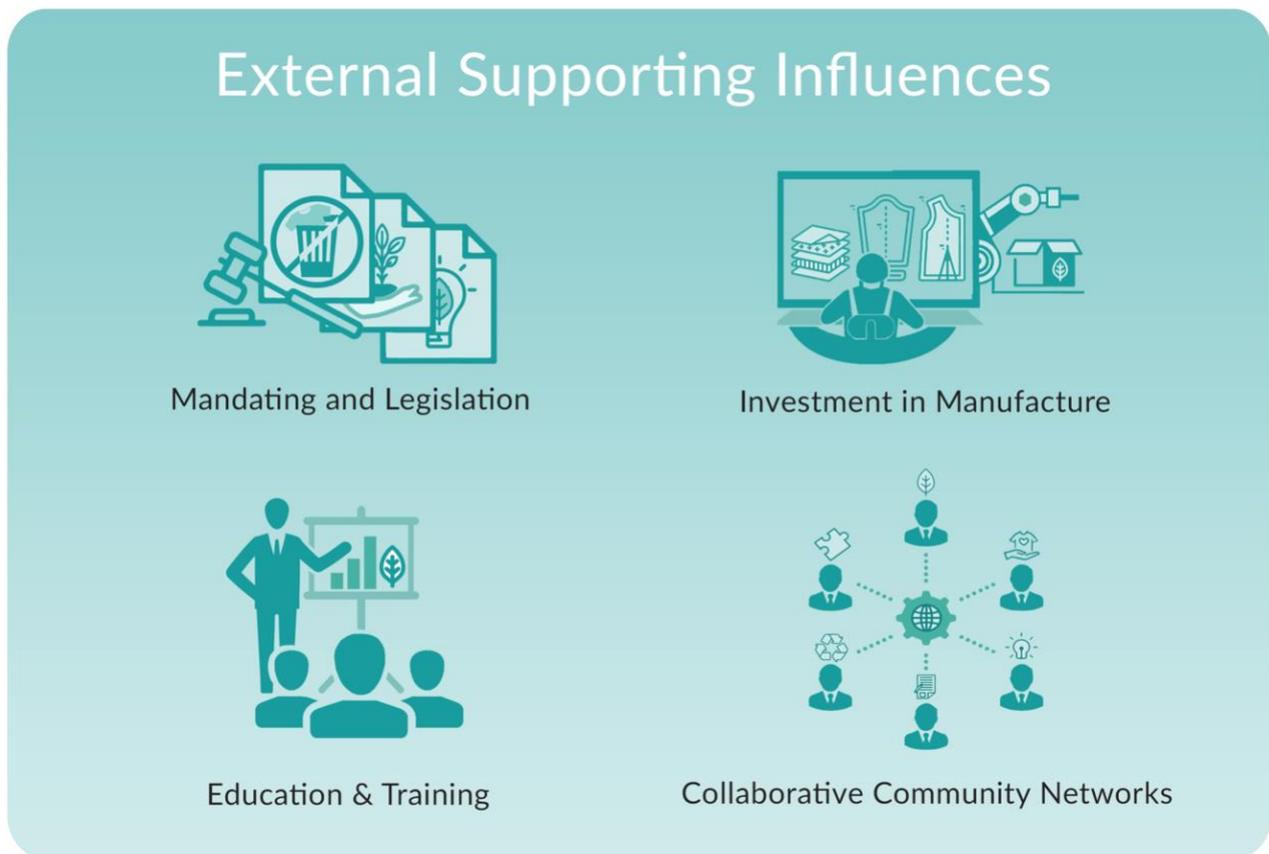


Figure 3. External Supporting Influences for Circularity

5.6.1 Mandating around textile waste and product stewardship

Western Australia's Waste Avoidance and Resource Recovery Strategy 2030 that oversees ten S2 participants claims textile waste as a focus material in 'becoming a sustainable, low-waste, circular economy' (Waste Authority Western Australia, 2019, p. 2), but there are no strategies, actions, or targets for textiles. While the Australian National Product Stewardship Act of 2011 was reviewed in 2021 and textiles and apparel were added to the Ministers 2021-2022 Priority Material List with key targets and timelines (Department of Agriculture, Water and the Environment, 2021a), there are as yet no strategies suggested to achieve these milestones. Landfill bans, taxes on waste, municipal collection systems, and cash incentives for take-back schemes exist for textiles in Belgium, Sweden, and Denmark, and are recommended to enforce product stewardship (Hvass, 2016; Hvass and Pedersen, 2019). Such mandating and financial disincentive require manufacturers to take responsibility for the environmental impact of their materials, and consumers for their disposal. Government policy will encourage development and investment in cost-effective processes, innovations and technologies to collect, sort, separate and regenerate fibres (Caulfield, 2009). Stronger legislation on fibre content labelling will assist more efficient textile waste collection and sorting. Taking confidence from the success of the government campaign on single-use plastic (Department of Agriculture, Water and the Environment, 2021b), this strategy could be applied to the

consumption and disposal of toxic fibres and textiles of the fashion sector. By enforcing stricter environmental and ethical standards for fashion products, consumers purchasing behaviours change.

5.6.2 Investment and procurement in local processing and manufacturing technologies

Government and industry procurement and investment in local manufacture and technologies could support those industries focused on product stewardship and authentic sustainable practices (Department of Agriculture, Water and the Environment, 2021c; Fleischmann, 2019; Sirilertsuwan *et al.*, 2019). Miller (2019) identifies that the cost of acquiring technologies in plant and equipment is prohibitive for SMEs in the Australian fashion sector. Investment in technologies and infrastructure that support fibre recycling, automated robotic manufacture, textile processing and printing, customization and fitting, and virtual prototyping and selling tools will encourage new business models and have added benefits beyond the environment to employment and the economy. Indeed, projections by KPMG for CSIRO indicate the circular economy has an additional benefit to Australian GDP of \$23 billion by 2025, and an additional 17,000 jobs by 2048 (KPMG Economics, 2020).

5.6.3 Greater investment in education and training

“Greenwashing” in fashion marketing (Gwilt, 2020, p15) misrepresents sustainability and dilutes the brand message of authentically circular and sustainable labels. Participants in this study are burdened with the responsibility of education of their supply chain, their consumers and the wider community. Education programs in schools, industry training, and education of the community are critical to support values in quality, longevity and circularity, and help differentiate between genuine sustainability and greenwashing (Andrews, 2015; Kazancoglu *et al.*, 2020; S1; S2). Emerging designers and fashion students must be educated in the principles of the circular economy and product stewardship and be encouraged to develop tools and strategies in design-led circular approaches. Andrews states:

Designers must now respond to very different social, economic and environmental needs and adopt a holistic approach to problem solving; they must change their design thinking and practice and lead the development of the Circular Economy by creating products and services that match all inherent criteria of this model. A thorough knowledge of this model must therefore be embedded in design courses (2015, p.313)

This research and the emergent circularity model (Figure 1) aim to assist in this by visually storytelling the complex interrelated relationships and strategies of circularity in an Australian fashion context to the diverse stakeholders involved.

5.6.4 Fostering industry collaboration and industry-based initiatives

New kinds of collaborations are needed to further the circular economy in fashion and textiles in Australia. Designers, educators, researchers, policy makers, fibre and textile industries, manufacturers and the wider community need to come together to work towards a common goal. Reverse logistics required in the collection, sorting and recycling of textiles is complex, and cannot be achieved in isolation (Fontell & Heikkila, 2017; Hvass & Pedersen, 2019; Pal *et al.*, 2016). The innovative practices and business models of circular SMEs may influence the wider sector and larger fashion companies (Goworek, 2011; Huynh, 2021; Sandvik and Stubbs, 2019) and may be a valuable resource. Sharing information and collaborative processes around supply chains, sourcing, and technologies that further circularity is essential.

6. CONCLUSIONS AND LIMITATIONS

While the Australian fashion sector is highly engaged in a linear take/make/waste fashion model, Australian government and industry are aware of the pressing environmental consequences, and the benefits of a shift towards a CE and PS in the industry (Australian Fashion Council, 2021; Department of Agriculture, Water and the Environment, 2021a).

In CE innovation, Australian SMEs may have an advantage over larger fashion companies with more unwieldy structures. Internationally, SMEs and start-ups are demonstrating agility and innovation in TBL fashion business models, and have close partnerships in place with their customers (Henninger *et al.*, 2016; Hvass and Pedersen, 2019); qualities integral to the success of a circular model. Employing design thinking strategies, Australian SMEs with a foundation of product stewardship and circular purpose are creating new systems of viable closed-loop business models and design processes. By studying the dimensions of experience of these SMEs practicing circular and closed-loop design, the wider sector and larger enterprise can benefit and learn from their methods (Goworek, 2011; Sandvik and Stubbs, 2019).

Limited scholarly literature linking CE theory to practice in the Australian fashion sector exists. It is also clear that there are some unique challenges of geographical distances, sparse population and fragmentation in the Australian fashion sector (Craik, 2016; Fleischmann, 2019; Payne and Ferrero-Regis, 2019). Brydges (2021) notes the significance of considering local factors for successful pathways to a CE. It is therefore beneficial to examine the barriers to CE that exist in the Australian fashion sector, and to study and map the practice of 3 Australian SMEs overcoming these barriers to run fashion businesses built around core principles of product stewardship and circularity.

This research into a small data set of SMEs provides an Australian context to the existing literature focused on circular fashion practices and business models largely situated in Europe (Fontell and Heikkila, 2017; Henninger, *et al.*, 2016; Huynh, 2021; Hvass and Pedersen, 2019; Raebild and Bang, 2017; Sandvik and Stubbs, 2019). The themes from this research and the emergent circularity model may contribute to examples of CE practice in the fashion sector (Ballie and Woods, 2018; Fleischmann, 2019; Islam, 2021; Raebild and Bang, 2017), and may aid the growing discussion on pathways for change in Australian fashion. This research clearly outlined the need for external support in investment, legislation and training, as circular fashion SMEs carry the burden of education of their wider supply chain and their consumer.

This research was limited to interviews and a focus group with a small number of fashion SMEs, practitioners, and academics engaged in closed-loop circular and sustainable apparel design. Consumers were not interviewed for this research project and greater understanding is needed in this field to adequately engage them in a circular fashion and textile economy. Furthermore, corporations with larger economies of scale and single-season fashion items may be better positioned for rapid textile recycling under faster technical speed cycles (Goldsworthy, 2017) and more research on this from an Australian context is required. Finally, more data and research are required on the recovery, sorting, and recycling of textile waste as a resource for the Australian fashion sector.

7. BIOGRAPHY AND ACKNOWLEDGEMENTS

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