Resources, Conservation & Recycling Advances 18 (2023) 200154

Contents lists available at ScienceDirect

Resources, Conservation & Recycling Advances

journal homepage: www.sciencedirect.com/journal/Resources-Conservation-and-Recycling-Advances

Textile waste management in Australia: A review

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ARTICLE INFO

Keywords:
Textile waste
Apparel
Waste management
Policy
Production and consumption
Social enterprise

ABSTRACT

Textile sector accounts for around 10% of worldwide CO_2 emissions. Textile waste is a global problem. It is a significant and quickly expanding issue in Australia, with the lowest recovery rate of all waste kinds. The entire understanding of textile waste management is incomplete. This study aims to analyse textile waste management in Australia from the perspectives of textile consumption and waste generation, the role of social entrepreneurs and charities, recent initiatives by government and other organizations, and textile waste laws and regulations. The findings of this study indicate that (1) Textile consumption and waste data are insufficient to unveil the circular economy potential; (2) Textile waste management processing capacities were lacking; (3) Clear instructions are required to comprehend textile waste laws and regulations; (4) To combat the textile waste issue, consumer awareness of managing textile waste should be raised. Future research should focus on data collection for model development.

1. Introduction

Textile industry is one of the world's leading industries in terms of market size, employment and product value. The global textile sector is worth $3 trillion annually and accounts for 2% of the global gross domestic product (Hole and Hole, 2019). It is estimated that one in sixth of the worldwide population is employed in the global fashion supply chain (Boulton et al., 2020). Globally, 80 billion new garments are consumed annually (Inside Waste, 2020). While the textile sector is a significant contributor to the world economy, it is also a significant polluter (Fråne et al., 2017; Hole and Hole, 2019). The textiles sector (across production, manufacture, and disposal life cycles) is responsible for more than 1.2 billion tonnes of CO_2 emissions annually, or 8% of the global total (Australasian Circular Textile Association, 2021). Each year, 108 million non-renewable resources like oil, fertilisers, chemicals, etc. are used to create apparel; for example, oil is utilized to produce synthetic fibres. It is believed that dyeing and treatment of textiles account for 17 to 20% of all industrial water contamination (Naish, 2020). The global manmade textiles exacerbates the problem, with around 60% of all clothes made from synthetic materials such as polyester, acrylic, and nylon, all of which are generated from plastic (Taylor, 2021). Polyester manufacture for textiles produces 706 billion kg of CO_2 each year (Australasian Circular Textile Association, 2020).

The world produces 100 billion clothing annually, of which 33% are discarded within the first year of purchase (Monash University, 2021). In the United Kingdom, textile waste increased by around 2 million tonnes annually between 2005 and 2010. According to the US Environmental Protection Agency, around 26 billion pounds of textiles end up in landfills annually in the United States (Cezario, 2020). The annual value of the Australian garment industry is AU$22 billion (Australasian Circular Textile Association, 2020). It contributes more than $27.2 billion to the Australian economy and employs 489,000 people, 77% of whom are women (Australian Fashion Council, 2021). The present trend of fast fashion encourages individuals to buy more clothing and discard it in a shorter period, resulting in increased demand for new clothing as well as a high volume of textile waste disposal (Moazzem et al., 2021b). The rates of clothing use and waste in Australia are relatively high. Approximately 501 million kilograms of textiles and clothes were thrown annually in Australia (Moazzem et al., 2021b).

Circular economy (CE) is defined as an industrial system that is restorative or regenerative by intention and design, uses and reuses natural capital as efficiently as possible, and finds value throughout products' life cycles, which involves the implementation of sustainable design strategies, zero-waste design, product-life extension, resource recovery, repair and remanufacturing services (Koszewska, 2018). Therefore, the fashion industry is an important group to consider for a change to the take/make/waste fashion model in Australia. Internationally, enterprises are employing design-thinking methodologies to re-evaluate clothing design, production, and consumption and are constructing creative business models based on the CE principles (Piller,

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https://doi.org/10.1016/j.rcradv.2023.200154

Available online 28 April 2023

2022) which are to eliminate waste and pollution, circulate products and materials (at their highest value), and regenerate nature.

2. Literature review

To understand the Australia's situation comparing to the other countries in the world specially in the Organization for Economic Co-operation and Development (OECD) countries the following literature review was conducted, and a summary is presented in Table 1. To conduct literature review in 2022, the web of science core collection database was utilized using keywords "textile waste" generating 2084 articles. The search was then refined by selecting OECD countries except Australia found 872 articles. These articles were scrutinized by the relevancy of this study through abstract analysis, only 10 articles were found partially related to the topic of this study.

Table 2 contains a summary of the publications with an emphasis on textile waste in Australia. Majority of articles in Table 2 concern recycling, wastewater, regeneration of cellulose fibre, upcycling, and the environmental impact assessment of textile waste in Australia. This present review article addresses textile consumption and waste generation in Australia, the involvement of social entrepreneurs and charities, legislation and regulations for textile waste treatment, hurdles and enablers, and new attempts to combat textile waste.

Piller (2022) explored the challenges that the Australian fashion industry had in implementing the CE and analysed the strategies used by local SMEs to overcome these challenges. Payne and Binotto (2017) investigated the interactions between Australian fashion stores, designers, and community organisations about clothes and textile waste. To a limited extend, Shirvanimoghaddam et al. (2020) discussed about the significance of circular fashion and textiles, along with various approaches for reuse, recycling, and repurposing of textiles waste. The authors also argued the necessities of disruptive scientific breakthroughs, innovations, and strategies for a circular textile economy. Critical issues such as textile consumption, waste generation, role of social enterprises and charities, legislation and regulation, recent initiatives and major barriers and enablers were not investigated in the Australian context by the previous researchers.

This is a systematic attempt of providing an overview of the current state of textile waste in Australia and finding answers for questions such as:

Q1: What are the consumption and waste generation scenarios of textiles in Australia?
Q2: What initiatives have been taken to tackle the textile waste problem?
Q3: How do charities and social enterprises contribute to solving the textile waste issue?
Q4: What are the current regulations and laws around textile waste management in Australia?

3. Methodology

This study paper seeks to comprehend the current situation of textile waste in Australia through literature review (Fig. 1). In order to conduct the literature study, the web of science core collection database was queried in April 2022 using keywords "textile waste", generating 9630 articles; the search was then refined by selecting Australia as the country/origin, yielding 170 articles. Table S1 in the supplementary document shows information gathered from the grey literature mentioning textile waste in Australia. All articles were examined using full-text analysis. Nonetheless, only 25 publications were pertinent to the topic. Their topical relevance determined the inclusion of these items. Circular economy-related articles on Australian textile consumption, waste generation, initiatives, policy, and laws were included.

Table 1
Summary of the selected articles from OECD countries.

Reference	Country of first author's affiliation	Study focus	Major findings
Farahani et al. (2022)	France	Operational management of textile waste	• Collaborative challenges between fast fashion firms and charity organizations. • Charity could contribute to reverse supply chain. • Charities are subject to competition and appear less effective.
DeVoy et al. (2021)	USA	Socioeconomic imbalance of post-consumer textile waste and disposal	• Post-consumer textile waste is dumped in landfills at a higher rate in wealthy communities. • Landfills are more prevalent in lower socioeconomic level neighbourhoods.
Degenstein et al. (2021)	Canada	Clothing waste streams and disposal practices	• Opportunities exist for Edmonton's waste management to increase the longevity of garments. • Produce items with extra value from discarded garments using current infrastructure. • Consumer engagement in environmentally responsible garment disposal procedures.
Niinimaki et al. (2020)	Finland	Global fashion supply chain	• Determining the environmental implications along the textile and apparel value chain from production to consumption. • Highlight the need for major modifications to the fashion business model.
Bick et al. (2018)	USA	Impacts of fast fashion	• Negative externalities of fast fashion supply chain. • The environmental and social impacts of textile production. • The role played by business, policymakers, consumers, and scientists in encouraging sustainable production and responsible consumption.
Lang and Armstrong (2018)	USA	Collaborative consumption	• Individuals engage in collaborative consumption not just because of their inner traits, but also because of self-interest and societal ideals.
Dobilaite et al. (2017)	Lithuania	Textile waste generation and treatment	• The primary destination for textile waste is landfills. • The recycling trend for textile waste is rising.
Weber et al. (2017)	Canada	Consumer textile waste management	• Fashion customers are increasingly interested in and inclined to participate in alternate textile disposal techniques (such as reselling, swapping, and taking back). • Textile consumption and textile waste cannot be directly correlated, as fashion customers have a lower disposal rate than non-fashion consumers.
Moorhouse and Moorhouse (2017)	United Kingdom	Sustainable design and circular economy	• Textile waste has social and environmental benefits and untapped economic potentials.
Žurga et al. (2015)	Slovenia	Sustainable apparel acquisition and disposal behaviours	• Recycling behaviour of apparel differs from recycling plastic, glass or other traditional recyclables included into curbside collection programmes. • Location of the apparel bank have no relation of the recycling frequency.

Table 2
Summary of published articles focusing on textile waste in Australia.

Reference	Study Focus	Major Findings
Tran et al. (2022)	Using recycled textile waste in reinforced concrete	Compressive strength can be achieved by the utilization a small dosage of recycled fibres or recycled fabrics in concrete.
Ma et al. (2020)	Upcycling waste textile	The spun fibres from textile waste showed mechanical strength similar to commercial viscose fibre.
Gan et al. (2021)	Using coloured powder derived from textile waste	Fabric printed with 5 μm powders possessed the best colour and rub fastness.
Ma et al. (2019)	Recycling cotton from denim in a circular textiles approach	Recycling waste denim creating regenerated cellulose fibre which can retain the colour of the starting textile item, or the denim colour can be removed for neutral colour fibre.
Moazzem et al. (2021a)	Estimating environmental impact of apparel supply chain and textile product using life cycle assessment	Guidelines for stakeholders to grow apparel sector in a sustainable way.
De Silva et al. (2014)	Textile recycling to separate cotton polyester blends	By selective dissolution of the cotton component, the polyester component can be separated and recovered in high yield.
Khandaker et al. (2022)	Energy generation from textile biowaste	The available treatment technologies with their merits, demerits, and production performance including key factors.
Shirvanimoghaddam et al. (2020)	Explaining circular economy towards fashion and textile	Various approaches for reuse, recycle and repurposing of the textiles waste as well as disruptive scientific breakthroughs, innovations, and strategies towards a circular textile economy.
Echeverria et al. (2020)	Discarded nonwoven polypropylene (PP) phase for thermoplastic-lignocellulose hybrid material engineered	Disposable technical-grade PP textiles introduce a viable alternative solution for the advancement of multifunctional sustainable building materials manufactured entirely from heterogeneous complex waste mixtures.
Moazzem et al. (2021b)	Estimating environmental impact of discarded apparel landfilling and recycling	The landfill process of natural apparel waste contributes more environmental impact credit compared to synthetic apparel, and this is mainly credited from the power generation from landfill methane gas captured.
Ma et al. (2021)	Regenerated cellulose fibres using wet spun with different cellulose types	The properties of the starting materials and how the waste feed streams are pre-treated have a significant impact on the mechanical properties, crystallite structure, thermal stability, and the morphology of the fibres.
De Silva and Byrne (2017)	Regenerated cellulose fibres from cotton waste explaining mechanical properties	The regenerated cellulose fibres (RCF) from waste cotton lint had increased mechanical properties compared to RCF produced from wood pulp
Echeverria et al. (2019)	Using textile waste for building applications with fibre reinforced composites	Textile fibre reinforced composites have optimal performance for moisture resistance, as well as for load-bearing and non-load bearing applications, in comparison to standard wood-based particleboards.
Zeng et al. (2020)	Using waste textile derived beads for drug delivery	The fibrous morphology showed a better loading capacity than the globular analogue due to its higher surface area and pore volume.
Payne and Binotto (2017)	Typology of fashion waste from Australian perspective	A perception of waste beyond that of inevitable by-product of the industry, towards waste recast as a potent force of loss and renewal.
Dow et al. (2017)	Distillation of textile wastewater in the assessment of long-term performance, membrane cleaning and waste heat integration	Zero effluent discharge would be feasible if saline waste streams were isolated and reverse osmosis processes were coupled with membrane distillation harnessing waste heat.
Navone et al. (2020)	Enzymatic fibre separation and recycling of wool/polyester fabric blends using close the loop	Complete breakdown of the natural fibres in fabric blends, while spectroscopic and mechanical analysis of the recovered synthetic fibres confirmed that the enzymatic treatment had no significant impact on the properties of the polyester compared to virgin samples.
Villalobos García et al. (2018)	Distillation of textile wastewater using hydrophobic and hydrophilic-coated polytetrafluoroethylene (PTFE) membranes	The viability of membrane distillation membranes on real textile wastewaters containing surfactants using hydrophilic-coated hydrophobic PTFE.
Davies and Cottingham (1994)	Treating textile dyes by using constructed wetlands	Breakdown of the visible dye occurred mainly in the first one third of the bed.
Hla et al. (2016)	CO_2 gasification reactivity of chars using Australian municipal solid waste	This study has a broader applicability and could be extended to estimate the gasification behaviour of municipal solid waste streams of different compositions in a range of gasification technologies.
Chhabra et al. (2019)	Mixed municipal solid waste characterizations, interaction effect and kinetic modelling utilizing the thermogravimetric approach	Rubber is found to cause maximum interactions which impose a negative synergistic effect on the pyrolytic decomposition behaviours of biomass and plastic mixtures, resulting in an overlap ratio of 0.9 and 0.95, respectively, for these mixtures.
Niinimäki et al. (2020)	Explaining the environmental impacts of fast fashion	It examines how technology, policy and consumer behaviour can mitigate the negative effects of the fashion industry on natural resources and the environment.
Nowack et al. (2013)	Carbon nanotubes potential release scenarios in composites	Significant release of carbon nanotubes from products and articles is unlikely except in manufacturing and subsequent processing, tires, recycling, and potentially in textiles.
Nekouei et al. (2022)	The role of oxides in electrochemical performance of activated carbons in high voltage symmetric electric double-layer capacitors	The current understanding on the optimization of electrochemical behaviour of activated carbon (ACs) using structural and morphological modifications, while uncovering the impacts of oxides on improving both energy density and cycling stability of AC-based supercapacitors.
Piller (2022)	Qualitative exploratory study on Australian fashion small to medium enterprise	The barriers to circular economy that exist in the Australian fashion sector, and the roadmaps of practice of Australian small to medium enterprises (SMEs) with circular business models in overcoming these barriers.

Other than that, only seven articles were discovered when searching for "textile waste in Australia". In addition to academic studies, it is claimed that grey literature, consisting primarily of industry/organization reports, periodicals, and website articles, has a tremendous amount of knowledge and data necessary to comprehend the textile waste problem in Australia. In this instance, the Google search engine was used with keywords "textile waste in Australia". Each of the first ten pages of a Google search is comprised of ten web pages. For this review, 100 websites were visited, the material was analysed, and data was collected. Eighty sources were pertinent to the topic. The collected data identified five groups: 1) consumption and waste generation patterns, 2) recent initiatives, 3) contribution of social enterprise and charity

organisation, 4) policy and regulation guidelines, 5) major barriers and enablers of textile waste in Australia.

4. Results

4.1. Textile consumptions and waste generation

4.1.1. Textile consumption

Australia is the second-largest textile consumer per capita in the world, behind the United States of America (Guardian, 2021; Moazzem et al., 2021b; Taylor, 2021). Overproduction and underutilization of garments are fundamental underlying issues (Piller, 2022). Each Australian consumes 27 kg of new apparel annually on average (Kollmorgen, 2021; Shirvanimoghaddam et al., 2020; Taylor, 2021). Recent research by the Australian Circular Textile Association (ACTA) on textile use in New South Wales (NSW) suggests that this figure could be considerably higher than 27 kg (Piller, 2022). When clothing and home products such as bed linen, curtains, and furniture are included in the consumption figures, the annual per capita amount is roughly 39–41 kg (Gorman, 2021). Australians purchase 60% more clothing than they did 15 years ago and keep them for only half as long (Clean Up Australia, 2022; Parliament of Australia, 2019) and Australian consumers have spent $28.58 billion annually on fashion (Boulton et al., 2020). On average, Australian only wears between 33 and 40% of their clothing (Clean Up Australia, 2022; Naish, 2020). Additionally, gender is a contributor to textile consumption. The life cycle of a garment is single wear; 62% of women have items that have never been worn or still have the tags on (National Retail Association, 2022). In addition, 83% of women have clothing that has been worn only once or twice (National Retail Association, 2022). Alternatively, the ACTA believes that Australia consumes close to one million tonnes of textiles annually (Gorman, 2021). Currently, the average shopper considers 52 seasons in a year, rather than the traditional Spring/Summer and Fall/Winter, and 3 out of 10 people admit to having discarded approximately 10 items in the prior year (Cezario, 2020). New South Wales is Australia's most populous state. ACTA (Australasian Circular Textile Association, 2021) reported a constant 1–2% annual growth in textile imports in NSW between 2015 and 2018, from 323,934 tonnes (2015) to 337,736 tonnes (2018). As a result of early supply chain disruptions caused by the COVID-19 pandemic, a 4% decline in 2019 has been seen.

Fig. 2 depicts the garment consumption in Australia from 2007 to 2026, with projections for 2022 to 2026. The data is taken from the Australian passport database as retail volume. This retail volume represents clothing consumption. According to this data set, womenswear is the most popular product (about 36% of total consumption volume), followed by menswear (about 23% of total consumption volume). Conversely, jeans are ranked as the lowest category. As a result of COVID 19′s potential impact on the supply chain, 2020 has the lowest total consumption amongst these years. In 2026, it is anticipated that approximately 900 million units of apparel will be used.

4.1.2. Textile waste generation

Textile waste is a significant and quickly expanding concern. Textile waste includes not just "post-consumer clothes" but also "post-industrial sources" along with hotel linen, furniture and upholstery, and uniforms (Parliament of Australia, 2019). Australia generates the most significant commercial and industrial textile waste per capita amongst OECD member countries (Boulton et al., 2020). It has the lowest percentage of recovery of all waste types, with 87.5% ending up in landfills (Parliament of Australia, 2019). The most textile waste ends up in landfills, which significantly contributes to global warming (Moazzem et al., 2021a). Annually, Australians discard an average of 23 kg of apparel, resulting in 93% textile waste (Moazzem et al., 2021a; Shirvanimoghaddam et al., 2020; Taylor, 2021). According to a recent study (Buy Australian Magazine, 2022; Piller, 2022), 24 to 25% of Australian individuals have discarded clothing after wearing it only once, and 41% dispose of old clothing rather than mending or recycling it. Age is an essential determinant of garment consumption, for example, 38% of millennials (those born between 1981 and 2000) purchased half of their clothing in the past year (Buy Australian Magazine, 2022). According to the Australia Bureau of Statistics, approximately 88% of textile and leather waste produced in Australia in 2009–2010, amounting to 501, 000 tonnes, was sent to landfills, with an average of 22.7 kg per person, which is twice the global rate, with the remainder being recovered or exported (Ma et al., 2020; Shirvanimoghaddam et al., 2020). According to the most recent statistics on waste, over 800,000 tonnes of leather, rubber, and textiles were thrown in 2018–2019, with a recycling rate of just 7% (Circular Centre, 2022; Taylor, 2021). Approximately 6000 kgs of textiles and clothes are discarded in Australian landfills every 10 min (Monash University, 2021; QUT University, 2021). In addition, the ACTA estimates that up to one million tonnes of leather and textiles are transported to landfills, with every Australian contributing close to 40 kg of waste annually (Process Technology, 2021). In addition, it is estimated that 3 million tonnes of textile waste are dumped annually in Australia (Tran et al., 2022).

In 2018, over 350,000 tonnes of clothing were shipped to landfills, and only 4 kg were recycled for every 23 kg of clothing discarded (Buy Australian Magazine, 2022). A recent investigation by Foreign Correspondent of ABC (Australian Broadcasting Corporation) discovered that clothing spared from the waste in Australia might nevertheless end up in landfills overseas (Times News Group, 2021). In addition, a considerable number of donated clothing ended up in the ocean (Times News Group, 2021). One of the most significant contributors to textile waste is the residential sector. According to the Australian Bureau of Statistics, 90% (about 540,000 tonnes) of waste typically originates from households (Crowe, 2022). Approximately 3% of Australia's home rubbish stream consists of textiles (Moazzem et al., 2021b). A Victorian council study also revealed that when textiles were included in household waste data collection, textiles accounted for 3% of household garbage, on par with plastic and greater than glass (2%), steel, and aluminium (2%) (Monash University, 2021). Moreover, textile waste is also a component of commercial and industrial waste (approximately 4% by weight). Sixty-eight percent (68%) of all textile waste in Victoria comes from post-industrial sources, the lowest recycling rate of any assessed waste stream, which is less than 1% (Australasian Circular Textile Association, 2020; Tran et al., 2022). Each Victorian produces an average of 28 kg of textile waste annually (Circular Economy Business Innovation Centre, 2021). The volume of carpet landfills alone in New South Wales, Australia, was equivalent to all clothing and textile waste and accounted for approximately 2% of all rubbish items (Tran et al., 2022).

According to ACTA, approximately 95% of textiles that end up in landfills are potentially recyclable (Moazzem et al., 2021a; Naish, 2020; Redooo, 2022). Sustainability Victoria estimates that the overall worth of discarded clothing in Australia is around $500 million (Moazzem et al., 2021a). By extending the lifespan of garments by 9 months, carbon, waste, and water footprints might be reduced by 20–30% each garment (Naish, 2020). Fig. 3 illustrates the predominant waste streams in New South Wales. The category with the highest volume is consumer fashion and retail with 130,000 t/y, followed by furniture, soft furnishing & homewares (62,000 t/y), and uniforms and workwear with 10,000 t/y. According to ACTA, uniforms and workwear contribute around 12,000 tonnes each year to landfills (Times, 2021).

Fig. 4 depicts New South Wales's textile flow from consumer to waste stream. In NSW, an average of 328,904 tonnes of textiles were imported annually from four different categories between 2005 and 2019. Clothing/Apparel & Uniforms is the most considerable contribution at 43%, followed by Bedding/Linen & Homewares at 27%, Other Products at 19%, and Carpets at 11%. The overall outflow of textiles was 305,531 tonnes, of which 23,374 tonnes were unaccounted for, and 236,498 tonnes were disposed of in landfills. The garbage was managed by three distinct entities: businesses, households, and charitable organizations. The top contributing categories in these three entities are Construction

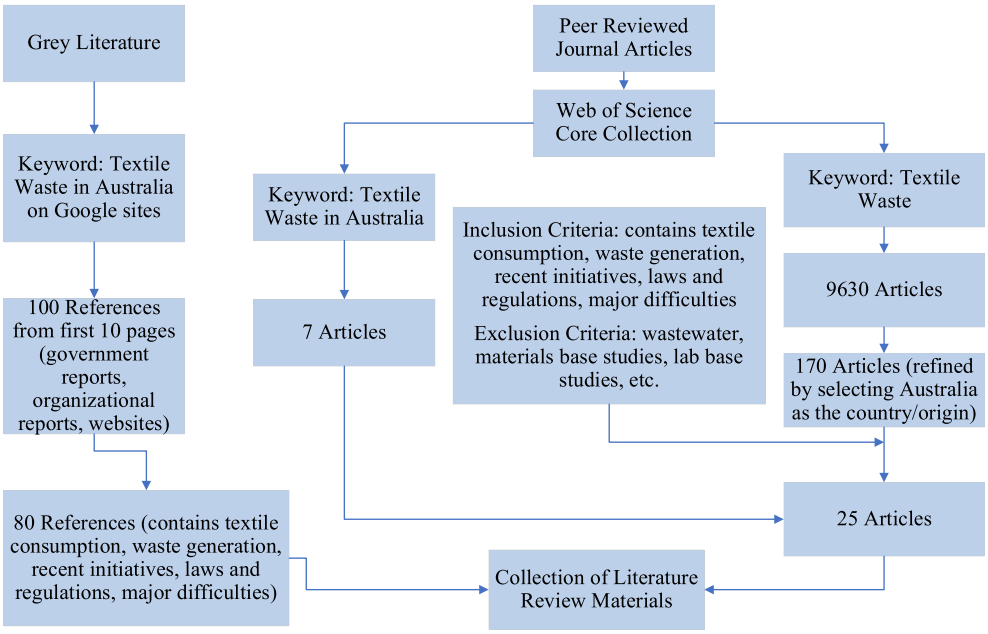

Fig. 1. Data collection for literature review.

and Industrial Waste (92.10%), Kerbside Waste and Recycling (77.74%), and Offshore Reuse (68.99%) for charities, businesses, and households, respectively. Businesses and charitable organisations consider recycling and reuse onshore or offshore, whereas household entities recycle locally. Nonetheless, an average of 13,844 tonnes of clothing was sent to the landfill each year because it was unsuitable for donation, and unexpectedly 2003 tonnes of unlawful dumping were recorded in NSW (Australasian Circular Textile Association, 2021).

4.2. *Contribution of social enterprise and charity organization*

Consumption and production of textile waste pose a challenge for Australia. Australian charities endure the majority of waste and abandoned garments (Payne and Binotto, 2017). A considerable number of consumers donate their garments to charities with the intention of reusing them, while the demand for second-hand products increases (Inside Waste, 2020). There are 3000 charity and social enterprise retailers in Australia, which provide 5000 jobs, 33,000 volunteers, and 10,000 charity collecting bins (Charitable Recycling Australia, 2022; Department of Agriculture Water and the Environment, 2021).

Charitable recycling Australia is a network of many charitable, reuse, and recycling organizations, such as Salvos and Vinnies. During the 2019–20 fiscal year, charitable recycling helped remove over one million tonnes of waste from landfills, creating approximately one billion dollars for the Australian economy and over 5000 full-time jobs (Charitable Recycling Australia, 2022; Taylor, 2021).

The National Association of Charitable Recycling Organizations (NACRO) reports that up to 90% of textiles are recovered (Parliament of

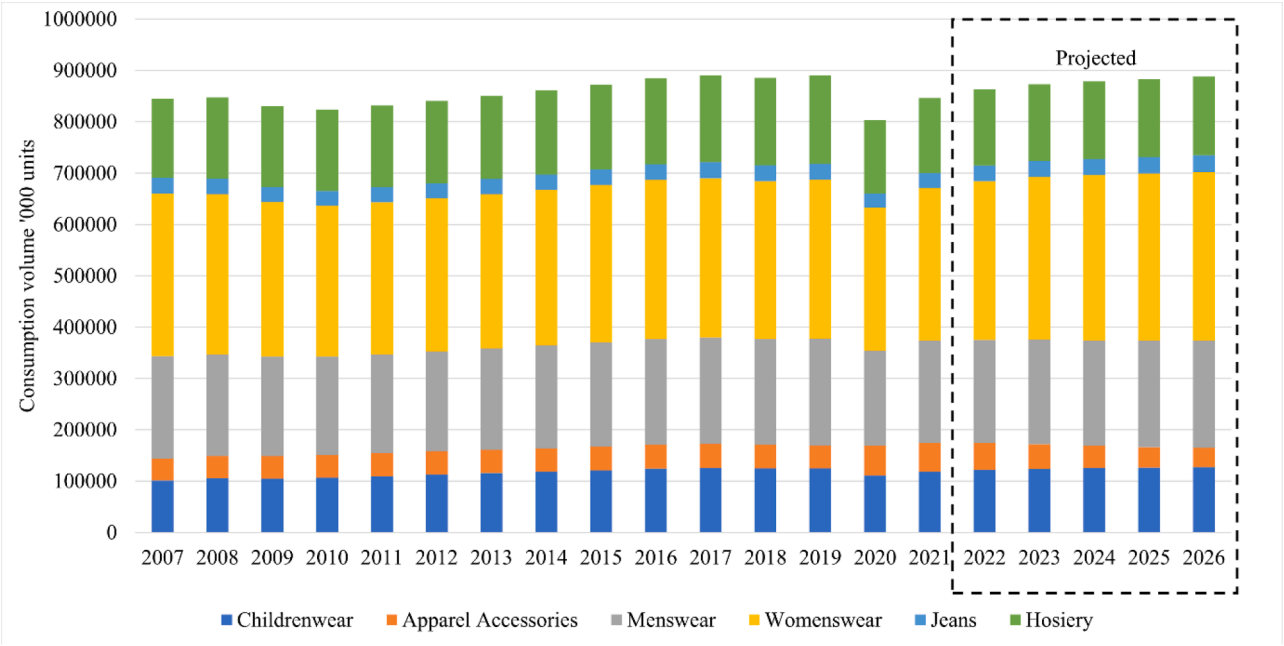

Fig. 2. Apparel consumption in Australia from 2007 to 2026.

Australia, 2019). Although charitable organizations can recover a substantial amount of textiles through donations, they can only sell about 15% of these garments in stores and recoup the rest through exports or recycling (Australasian Circular Textile Association, 2020; Parliament of Australia, 2019). They are battling the issues of low-quality donations with a significant proportion of synthetic fibres, and the traditional cotton ragging is becoming increasingly difficult (Payne and Binotto, 2017). Every day, two million tonnes of unwanted apparel are donated to Australian charities (Piller, 2022).

Australia's charitable groups receive 12.1 kg of clothing per person-year, excluding textiles in furniture and Manchester, as well as donations to commercial clothing reuse businesses (Australasian Circular Textile Association, 2021). Some donated clothes are sent to landfills, but the majority are transported abroad (Payne and Binotto, 2017). In NSW, 98,887 tonnes of clothing are donated annually, of which 16,811 tonnes are resold locally, 32,633 tonnes are exported for ragging or reuse, 35,599 tonnes are recycled domestically, and 13,844 tonnes are landfilled (Australasian Circular Textile Association, 2021). Fig. 5 shows the textile product handling by charities in NSW, where household recycling accounts for 36% of all activities.

Table 3 displays many types of donation-related facts. It illustrates the contribution of charitable organizations to the Australian economy while decreasing environmental concerns.

Fig. 6 depicts several donation collection techniques, with in-store donation collection being the most effective at 93%, followed by donation containers at 81%. In Fig. 7, Tasmania is the state that donates the most per capita, with 67 kg, followed by South Australia with 56 kg, and the Australian Capital Territory with 14 kg.

Globally, landfills are the predominant alternative for garbage disposal (Nowack et al., 2013). Due to a lack of textile regulations and a national waste crisis, Australian charities are forced to pay for the disposal of low-quality, unsellable apparel (Piller, 2022). Charities spend $13 million annually to send unwanted items to landfills, which amounts to almost 60,000 tonnes of garbage (Schultz, 2022). Clothing is frequently discarded in charity dumpsters despite not being reusable or resalable; hence, organizations are educating donors (Inside Waste, 2020). The NACRO collaborates with various levels of government to combat illegal dumping. The NSW Environmental Protection Agency, part of the Department of Planning, Industry, and Environment, is one government agency that, in July 2019, released an action plan to work with charities, local government, and other stakeholders in a coordinated effort to reduce illegal dumping by promoting positive public behaviour change and awareness of acceptable donating (Inside Waste, 2020).

4.3. *Recent initiatives of textile waste management*

A circular economy for textiles is a crucial strategy for achieving a sustainable textile sector in Australia (Department of Industry, 2022; Taylor, 2021). The Australian government hosted the first-ever national clothing and textile waste roundtable at Parliament House on May 26, 2021 (Australian Fashion Council, 2022; Department of Industry, 2022; Piller, 2022). Participants from the retail, fashion, charity, production, environment, research, and waste management sectors reviewed the primary difficulties and potential in reducing the quantity of textile waste sent to landfills and proposed the future holding of a National Clothing Textile Summit (Department of Industry, 2022). The roundtable's success marked the beginning of a collaborative effort between Charitable Recycling Australia, Queensland University of Technology, Sustainable Resource Use, and Waste and Resources Action Program (WRAP) to design an action plan to combat the textile waste generated each year (Australian Fashion Council, 2022; Taylor, 2021). The clothing textiles have been added to the product stewardship priority list, with a financial commitment of up to $1 million to support product stewardship efforts. These efforts will help share the cost of managing the end of life of a product amongst industry, government, and consumers, thereby minimizing the health and environmental impact of a product over its entire lifecycle (Taylor, 2021).

Australian Fashion Council was awarded $1 million by the National Product Stewardship Investment Fund in November 2021 to establish the nation's first product stewardship scheme for textiles. This scheme collaborates with fashion designers, manufacturers, retailers, charities, fibre producers, academics, and waste management companies to reduce the amount of clothing and textile waste going to landfills in Australia (Department of Agriculture Water and the Environment, 2021; Guardian, 2021). This product stewardship provides "a roadmap to 2030 for clothing circularity in Australia in line with National Waste Policy Action Plan targets" and produces three reports on data and material flow, analysis of global initiatives, policies, and technologies, and recommendations on practical steps forwards to guide on progress to the National Waste Policy Action Plan targets by March 2030 (Australian Fashion Council, 2022; Claire Smith, 2021).

National Product Stewardship Investment Fund also funds Australasian Circular Textile Association Ltd's Circular Threads initiative, which will create a business case and design a product stewardship plan to collect, reuse, and recycle uniforms and workwear (Claire Smith, 2021). The Australian Retailers Association, the Australian Council of Recycling, the National Retail Association, and the Waste Management and Resource Recovery Association of Australia are also collaboration partners (Australian Fashion Council, 2022). Currently, the government has awarded $360,000 to the Australasian Circular Textile Association, $350,000 to the Vinyl Council of Australia, and $937,700 to the

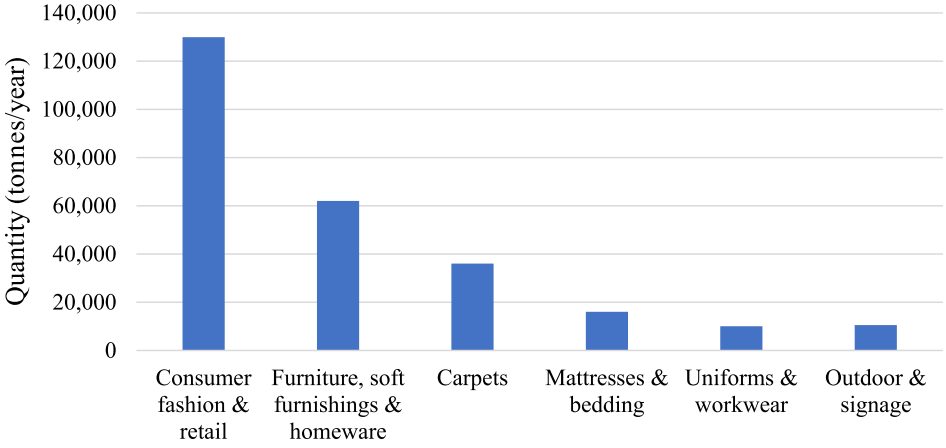

Fig. 3. NSW textile waste stream from various categories (Australasian Circular Textile Association, 2021).

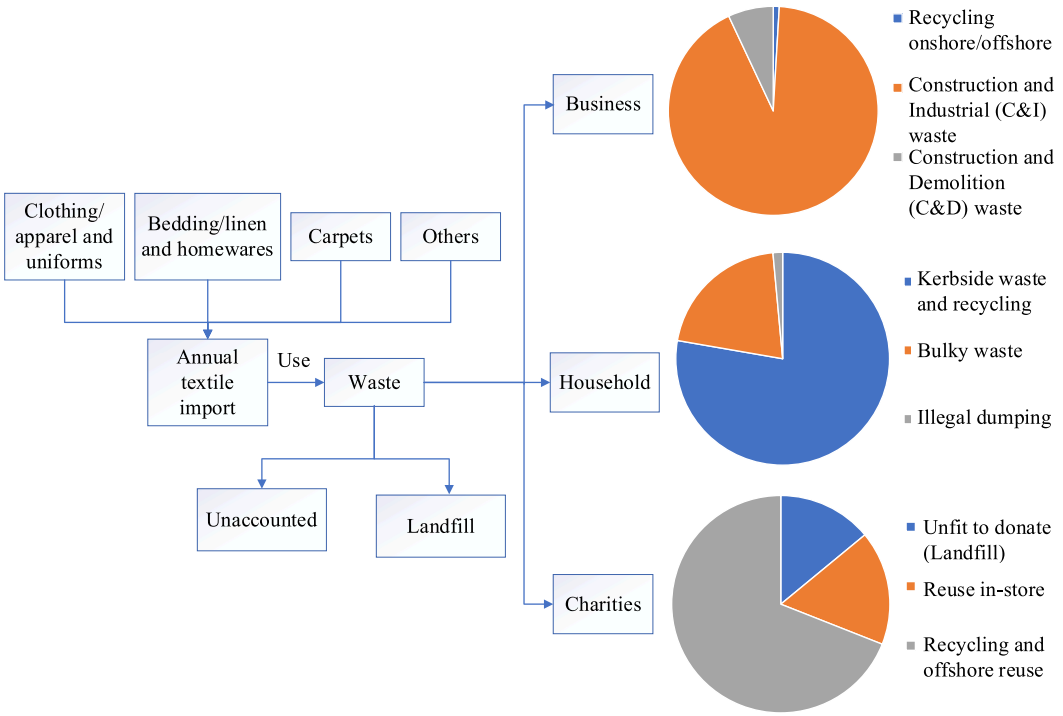

Fig. 4. Textile flow (from consumer to waste stream) in NSW (Australasian Circular Textile Association, 2021).

Australian Bedding Stewardship Council Limited for the development of a business case and a product stewardship (Department of Industry, 2022).

Retailers like H&M and Zara are beginning to provide take-back programs for worn apparel, allowing Sheridan to accept and dispose of used bed linens and towels. These programs reward customer loyalty, which boosts sales, and do their part to divert clothing from landfills (Redooo, 2022; Ross, 2019). Some retailers are implementing efforts, for instance, increasing recycled materials of their commercial goods from 0.62% in 2017 to 5.8% in 2020; the Swedish multinational clothing retailer H&M Group will use 30% recycled materials in its commercial goods by 2025 (Kollmorgen, 2021). MUD Jeans leases jeans and repurposes the denim (Jane, 2016).

Incorporating sustainability into the educational system is a crucial factor to learn sustainability. Currently, sustainability courses are incorporated into tertiary fashion programs, ensuring that graduates utilize sustainable techniques in their workplace (Monash University, 2021). The Commonwealth Government is also taking action on sustainable procurement, which covers the environmental sustainability of proposed goods and services, such as the use of recycled content, the Commonwealth Government's purchase of textiles such as uniforms and carpets for office fit-outs, etc. (Department of Industry, 2022).

Landfilling cotton product could be beneficial for environment. For example, A cotton field just outside of Goondiwindi is the site of an experiment to see whether shredded cotton products can improve the health of cotton soil. The initiative is a collaboration of the Queensland Government, Goondiwindi Cotton, Sheridan, Cotton Australia, Worn Up, and the University of New England. It is intended that the cotton fabrics decompose in the soil, stimulate microbial activity, sequester carbon, and provide a protective layer to promote soil moisture. Instead of being sent to a landfill, these clothing will be decomposed in the soil, preventing the release of 2250 kg of carbon dioxide equivalents (CO_2 e) into the atmosphere. The trial will conclude prior to the cotton harvest in early 2022, with preliminary results anticipated shortly after that (Cotton Research and Development Corporation (CRDC), 2021).

Australian initiatives such as SWOP Clothing Exchange shops,

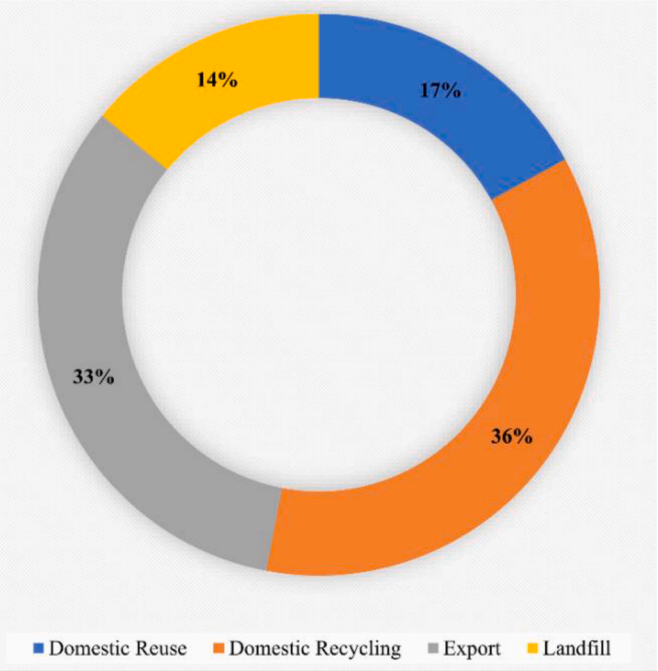

Fig. 5. Textile product handling by charity (Australasian Circular Textile Association, 2021).

Suitcase Rummage, the Garage Sale Trail, and the Brisbane Revive festivals showcase discarded clothing in novel ways. In the proper context, worn-out jeans and t-shirts acquire a vintage air (Payne and Binotto, 2017). Table 4 contains various initiatives to tackle textile waste from various organizations. Additional information about various organizations can be found in Table S2 in the supplementary document.

Table 3
Various facts related to the clothing donations (Charitable Recycling Australia, 2022).

Facts	Amount
Annual clothing donations to charity shops	310,316 Tonnes
Annual total revenue from sale of clothing donations	AUD $527.5 Million
Revenue per tonne of clothing recovered	AUD $1700
Annual total clothing revenue per charity shop	AUD $197,132
Clothing donations to charity shops per person	12 Kilograms
Greenhouse gas emissions saved annually	888,000 Tonnes (66%)
Water consumption saved annually	89,000 ML (57%)
Energy use saved annually	1.9 MWh (59%)

4.4. Laws and regulation around textile waste management in Australia

Australia lagged behind other nations in recognizing and addressing the textile waste issue (Kollmorgen, 2021). Several organizations, including the NACRO and the Salvation Army, proposed the development of a "National Textiles Reuse Policy" in consultation with all stakeholders, which would include long-term goals for the recovery of textiles from landfills (Parliament of Australia, 2019). In addition, the SCR (Southern Cross Recycling) group who is Australia's largest company for the recovery of Australia's unwanted clothing proposed a policy modelled after the Waste Framework Directive of the European Union and France's Extended Producer Responsibility Policy for Textiles (Parliament of Australia, 2019). Similarly, the ACTA recommended national standards for textile imports and a requirement that new synthetic textiles comprise at least 70% recycled material, while NACRO advocated for more uniform state and territory regulations (Parliament of Australia, 2019).

Victorian Government's Department of Environment, Land, Water and Planning developed a circular economic policy and action plan for Victoria that identifies fundamental longer-term improvements related to using resources and managing waste generation by a growing population, including regulations, incentive programs, innovation support, and/or education, and engaged researchers whose proposed research was to collaborate with the Textile, Clothing Footwear Association (Behaviour Works Australia, 2022; Boulton et al., 2020).

In order to offer oversight and support for textiles recovery activities, the Commonwealth Government should adopt a national textile waste strategy (Fig. 8) based on the ideas of a circular economy (Department of Industry, 2022; Parliament Of The Commonwealth Of Australia, 2020).

Australia has few incentives, municipal collection infrastructure, and regulatory regulations for textile waste management and recycling

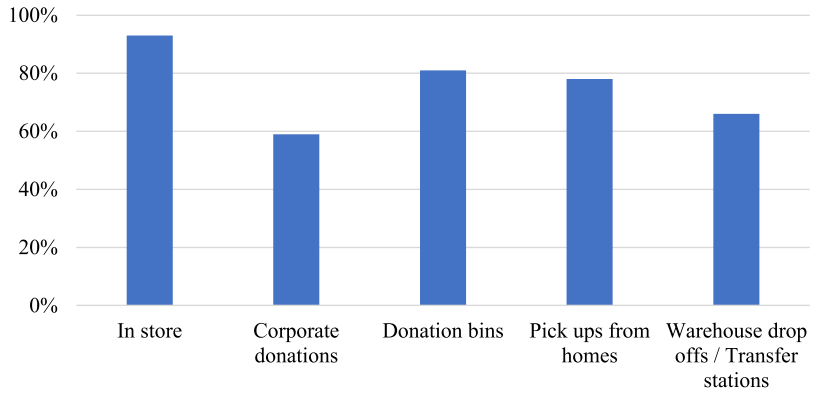

Fig. 6. Effectiveness of different methods of donation collection (Charitable Recycling Australia, 2022).

Fig. 7. Donations per capita by states in Australia [Data source: (Charitable Recycling Australia, 2022)].

(Piller, 2022). Australia lacks cost-effective techniques and technologies for collecting, sorting, separating, and regenerating fibres, and there are no laws to steer their development (Piller, 2022).

4.5. Major barriers and enablers

The constraints and enablers to textile waste management in Australia are outlined in Table 5. Poor infrastructures in different areas, such as collection and recycling, are significant barriers to textile waste management. On the other hand, consumer behaviour has a substantial effect. Inaccessibility to information/knowledge is another crucial obstacle for textile waste management. Aside from this, transparency in the supply chain, effective leadership, and investment in knowledge will motivate stakeholders (consumers, organizations) to adopt the necessary measures for textile waste management.

5. Discussion

This study from the textile consumption section in Australia demonstrates that a high purchase rate and a low rate of product utilization by consumers drive textile waste. Many consumers had no intention of repairing or recycling their products, even though it could be relevant to do so like repair old apparel or redesign old cloth to give a new look. As a result, the underutilization of textile products accerlates waste generation and reduces the prospects for recovery, repair, or recycling. From 2007 to 2021, the most significant apparel consumption was for women and men, as seen in Fig. 2. Reducing new apparel supply and reusing old apparel, in particular womenswear and menswear, will reduce textile waste significantly. Consumer awareness is crucial in this apparel industry since consumers will decide how to consume the products responsibly and sustainably. Waste reduction may be facilitated by educating consumers. Consumers should be aware of the environmental impact of improper textile waste disposal, the resources required for textile production, the influence of textile-producing nations, and the product and material value of textile waste.

In Fig. 4, a significant share of end-of-life textiles is managed by a social group representing recycling and international reuse. Australia exports a huge amount of textile waste each year. Occasionally, some items shipped for reuse overseas may not meet the standards of overseas vendors. Nevertheless, once the clothing departs from Australia, its subsequent journey becomes obscure, and it is mostly uncertain to what extent the clothes are subjected to reuse and recycling. Besides, the locations and procedures involved in the recycling activities remain unknown. As a result, majority of overseas shops send their unsaleable textiles to landfills, according to a report by ABC. Due to inadequate material handling (at the time of donation to charity shops) and a lack of consumer knowledge, end-of-life textiles are destined for landfills in Australia and other developing nations. In Fig. 6, it is evident that collecting at the store (93%) is the most prevalent way of donation collection and that only 15% of the items are resalable. It could be the cause of social groups' ineffective operations. Sorting at the source and enhancing the social organization's capacity to manage the gathered items could be an efficient method for collecting high-quality goods. Enhancing the technical capacity of sorting and establishing a quality standard for donated things ought to improve the quality of the returned product. In this manner, the economic contribution of social groups will increase as their efficiency increases. Increasing public awareness of high-quality donations could be a turning point in the evolution of recycling and reuse. Vinnies re/CYCLE is an example of a partnership and collaboration in which unsaleable clothing is upcycled into a valuable product and sold in their store.

One of the essential aspects of textile waste management is the collection of textile waste. Most companies listed in Table 4 charge consumers for collecting textile waste, whereas some companies only collect in bulk and others only collect for businesses. There are just two councils, Mosman council and Bathurst's council, collecting textile waste and Bathurst's council serves as a successful experimental version. Establishing designated collection containers should be an initiative of the municipal collection system. Even though specific shop take-back programs are free and open to consumers, collecting is not as

Table 4
Initiatives and business cases to tackle textile waste from various organisations in Australia.

Organization	Type of Organization	Service	Activity
BlockTexx	Clean technology company	Technology	Chemical recycling SOFT (separation of fibre technology)
Circular Centre	Solutions based inter-industry company	Technology and consultation	Collection, sorting, upcycling, recycling, reuse, redesign, etc.
Mosman Council	Local council	Circular textile waste service	Collection, sorting, upcycling, recycling, reuse
Textile Recyclers Australia Pty Ltd	Business	Collection, upcycle, recycle	Upcycle, recycle from textile waste to ceramic tiles
Seljak Brand	Business	Upcycle, recycle	Upcycle from textile offcuts to light weight blanket, recycle wool
Upparel	Business	Upcycle, recycle, reuse	Upcycle to blankets, rugs and insulation, roof tiles, office partitions and stuffing for pet beds. Recycle into new materials such as yarns
Boomerang Bags	Grassroots environmental movement	Collection, upcycle	Collection; Upcycle to reusable bags like handbags, grocery bags, satchels and bumbags from worn jeans, old work shirts, linen pants, and cotton singlets
Worn Up	Business: textile rescue program for schools, businesses, or organisations	Upcycle	Upcycle non-wearable uniforms and production offcuts to dog beds, school desks and tiles
Bathurst Regional Council	Local council (Government)	Collection, upcycle, recycle	Collection, upcycle, recycle
Australian Clothing Recyclers	Business: recycling company	Recycle	Recycle
King Cotton	Business: resource recovery company	Collection, reuse, recycle	Collection, reuse, recycle
Clothing Cleanup	Business	Collection, recycle	Collection, recycle
Tread lightly	Business: national recycling initiative	Collection, upcycle	Collection, upcycle to gym mats, floors and playgrounds from unwanted sport and active lifestyle footwear
Fibre Economy	Social enterprise	Workwear waste management service for companies	Collection, reuse, downcycling, transformation and innovation
Recycle Smart	Business: Waste management company	Collection, recycle	Collection, recycle
SCR GROUP	Business: recovery company	Recovery, reuse, downcycle, recycle	Recovery, reuse, recycle, downcycle to rags, convert to biofuel
Vinnies re/CYCLE	Charitable	Recycle	Recycle to blankets, throws, rugs, and cushions from non-saleable donations
Dempstah	Business: Textile design company	Recycle	Recycling textile waste, offcut scrap into spun yarn without the use of any water, dye, bleach, detergent or liquid chemicals.

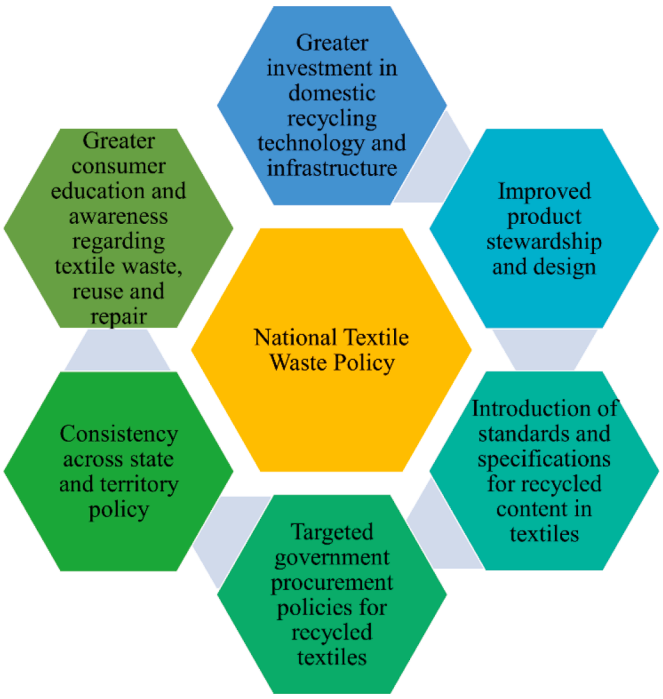

Fig. 8. Focuses of national textile waste policy (Parliament Of The Commonwealth Of Australia, 2020).

Table 5
Barriers and enablers of textile waste management in Australia.

	Description	Area	Reference
Barriers	Lack of infrastructure for collection, sorting and recycling.	Collection and recycling	(Guardian, 2021)
	Complexity of textile, clothing and footwear (TCF) supply chain	Supply chain	(Boulton et al., 2020)
	Access to knowledge, Information	Data collection	(Behaviour Works Australia, 2022; Boulton et al., 2020)
	Lack of consumer awareness	Consumer behaviour	(Boulton et al., 2020; Monash University, 2021)
	Lack of Infrastructure and Innovation in the textile manufacturing	Textile manufacturing	(Boulton et al., 2020)
	Lack of an adequate recycling infrastructure	Only recycling	(Boulton et al., 2020)
	Little to no financial support for the smaller Australian TCF businesses to scale innovative sustainable and circular approaches	Financial assistance	(Boulton et al., 2020)
	Very uneconomical to separate for recycling	Recycling	(Lindley, 2018)
	Inadequate consumer motivation	Consumer behaviour	(Lindley, 2018)
Enablers	Appropriate leadership on sustainability	Organisational practice	(Boulton et al., 2020)
	Investment in knowledge base, along with a commitment to research sustainability initiatives and circularity to support internal leadership and understanding of circular economy	Organisational practice	(Boulton et al., 2020)
	Greater transparency in supply chains	Supply chain	(Liu, 2017)

extensive as it could be. Retailers should increase their efforts to educate consumers about product end-of-life services and increase their participation in the collection of textile waste. The government should take steps to require merchants and manufacturers to commence considerations for textile end-of-life service.

Waste management is predicated mainly on the availability and accessibility of information (Piller, 2022). In this investigation, it was determined that just a limited amount of information regarding textile waste was accessible for NSW, followed by a small percentage for Victoria. However, some states and territories lack any relevant information. For a comprehensive understanding of textile waste in Australia, information from all states and territories is required. In order to view textile waste as a resource, it is necessary to construct a model that describes the input and output flow of textile goods and materials in Australia. Table 1 reveals that, even though some studies on the environmental impact assessment of textile waste have been undertaken, no research has been conducted to construct a model that explains the flows of end-of-life textiles.

Australia's textile waste laws and regulations are relatively low (Piller, 2022). The absence of legislation, regulation, and guidelines places the management of textile waste in a precarious situation. Therefore, clear regulations and guidelines are crucial to building a sustainable textile waste management system.

6. Conclusion

This article seeks to comprehend the whole scenario of textile waste in Australia. It was prepared by analysing grey literature (government reports, reports from affiliated organizations) and published peer-reviewed journal articles. From the literature review, it is seen that previously most studies relating to textile waste in Australia were focusing on recycling, wastewater treatment, regenerating cellulose fibres, and lab-orientated work. This article brings out the critical issues like textile consumption and waste generation, contribution of social enterprises and charities, laws and regulations, recent initiatives and major barriers and enables which were not systematically summarized earlier in the academic literature. This article revealed womenswear and menswear are the most textile popular products in Australia. It characterised the textile waste scenarios. The study determined that, except for New South Wales, national data on textile consumption and waste output were insufficient for a comprehensive examination. To better understand the textile waste issue and develop policies, researchers should gather data at both the state and national levels. Due to the importance of information and data collecting for planning and system optimization, the acquired data can be used to construct models utilizing techniques, such as material flow analysis, to quantify the textiles that are used, reused, and disposed of. Social organizations contribute significantly to management of textile waste. However, companies continue to struggle in terms of processing capacities and customer knowledge regarding waste management. Despite the recent development of a national textile waste policy, the framework of circular economy principles requires more precise and exhaustive directives. This article comes up with valuable and specific information to the academics and policymakers to comprehend the current scenarios to escalate the future strategies, which are crucial to building a sustainable textile waste management ecosystem. To achieve sustainable development, financial support is crucial for small and medium-sized businesses to explore the opportunity of utilising textile waste. Slowly, businesses are transforming textile waste into goods with added value.

Disclosure statement

No potential conflict of interest was reported by the authors.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgement

The study has been supported by the Australian Government Research Training Program (RTP) scholarship.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.rcradv.2023.200154.

References

Australasian Circular Textile Association, 2020. A circular economy for the textile & apparel sector. https://az659834.vo.msecnd.net/eventsairaueprod/production-impactenviro-public/b11ec661054c468d9e902af6c3041d35. (Accessed 18 May 2022).

Australasian Circular Textile Association, 2021. Thread count NSW textile data report. https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/recycling/thread-count-report.pdf. (Accessed 18 May 2022).

Australian Fashion Council, 2021. High fashion to high vis | the economic contribution of australia's fashion & textile sector. https://ausfashioncouncil.com/high-fashion-to-high-vis-the-economic-contribution-of-australias-fashion-textile-sector/. (Accessed 23 May 2022).

Australian Fashion Council, 2022. Creating clothing circularity and reducing textile waste. https://ausfashioncouncil.com/product-stewardship/. (Accessed 18 May 2022).

Behaviour Works Australia, 2022. Pathways to Transition to a Circular Textile Economy in Australia. https://www.behaviourworksaustralia.org/blog/pathways-to-transition-to-a-circular-textile-economy-in-australia. (Accessed 18 May 2022).

Bick, R., Halsey, E., Ekenga, C.C., 2018. The global environmental injustice of fast fashion. Environ. Health 17, 92.

Boulton, J., McCallion, A., Curtis, J., 2020. Transitioning to a circular textile economy in Australia. https://assets.sustainability.vic.gov.au/cebic-microsite/Report-Waste-Transitioning-to-a-Circular-Economy-in-Australia-Summary-of-findings.pdf?mtime=20210902175909&focal=none. (Accessed 18 May 2022).

Buy Australian Magazine, 2022. Ethical shopping – how australian fast fashion is polluting the world. https://buyausmag.com.au/ethical-shopping-how-australian-fast-fashion-is-polluting-the-world/. (Accessed 18 May 2022).

Cezario, M., 2020. Textile waste: how bad is the situation and how can we solve it? https://thesocialoutfit.org/blogs/the-social-journal/textile-waste-how-bad-is-the-situation-and-how-can-we-solve-it. (Accessed 18 May 2022).

Charitable Recycling Australia, 2022. How the charitable recycling sector can help all levels of government meet Australia's 2030 National Waste Policy targets. https://www.charitablerecycling.org.au/education/charitable-impact/. (Accessed 18 May 2022).

Chhabra, V., Bhattacharya, S., Shastri, Y., 2019. Pyrolysis of mixed municipal solid waste: characterisation, interaction effect and kinetic modelling using the thermogravimetric approach. Waste Manage. 90, 152–167.

Circular Centre, 2022. Circular Centre. https://circularcentre.com.au/. (Accessed 23 May 2022).

Circular Economy Business Innovation Centre, 2021. CEBIC year 2 focus area – Textiles. https://www.cebic.vic.gov.au/about-us/focus-areas/cebic-year-2-focus-area-textiles. (Accessed 18 May 2022).

Claire Smith, O.B., 2021. Australia's textile waste problem and how the key players are responding. https://www.claytonutz.com/knowledge/2021/december/australias-textile-waste-problem-and-how-the-key-players-are-responding. (Accessed 17 May 2022).

Clean Up Australia, 2022. Fast Fashion. https://www.cleanup.org.au/fastfashion. (Accessed 18 May 2022).

Cotton Research and Development Corporation (CRDC), 2021. Groundbreaking trial to return cotton textile waste to cotton fields. https://www.crdc.com.au/groundbreaking-trial-return-cotton-textile-waste-cotton-fields. (Accessed 18 May 2022).

Crowe, J., 2022. Textile Recycling ♻ – NSW's Successful Trial. https://waster.com.au/textile-recycling/. (Accessed 18 May 2022).

Davies, T.H., Cottingham, P.D., 1994. The use of constructed wetlands for treating industrial effluent (textile dyes). Water Sci. Technol. 29 (4), 227–232.

De Silva, R., Byrne, N., 2017. Utilization of cotton waste for regenerated cellulose fibres: influence of degree of polymerization on mechanical properties. Carbohydr. Polym. 174, 89–94.

De Silva, R., Wang, X., Byrne, N., 2014. Recycling textiles: the use of ionic liquids in the separation of cotton polyester blends. RSC Adv. 4 (55), 29094–29098.

Degenstein, L.M., McQueen, R.H., Krogman, N.T., 2021. What goes where'? Characterizing Edmonton's municipal clothing waste stream and consumer clothing disposal. J. Clean. Prod. 296, 126516 https://doi.org/10.1016/j.jclepro.2021.126516.

Department of Agriculture Water and the Environment, 2021. Clothing textiles waste. https://www.awe.gov.au/environment/protection/waste/product-stewardship/textile-waste-roundtable#:~:text=Australia%20is%20the%20second%20highest,the%20textile%20waste%20we%20generate. (Accessed 17 May 2022).

Department of Industry, S., Energy and Resources, 2022. Australian government response: inquiry into Australia's waste management and recycling industries. https://www.industry.gov.au/data-and-publications/australian-government-response-inquiry-into-australias-waste-management-and-recycling-industries. (Accessed 18 May 2022).

DeVoy, J.E., Congiusta, E., Lundberg, D.J., Findeisen, S., Bhattacharya, S., 2021. Post-Consumer textile waste and disposal: differences by socioeconomic, demographic, and retail factors. Waste Manage. 136, 303–309.

Dobilaite, V., Juciene, M., Saceviciene, V., 2017. Study of textile waste generation and treatment in Lithuania. Fibres Textiles Eastern Europe 25 (6), 8–13.

Dow, N., Villalobos García, J., Niadoo, L., Milne, N., Zhang, J., Gray, S., Duke, M., 2017. Demonstration of membrane distillation on textile waste water: assessment of long term performance, membrane cleaning and waste heat integration. Environ. Sci. Water Res. Technol. 3 (3), 433–449.

Echeverria, C.A., Handoko, W., Pahlevani, F., Sahajwalla, V., 2019. Cascading use of textile waste for the advancement of fibre reinforced composites for building applications. J. Clean. Prod. 208, 1524–1536.

Echeverria, C.A., Pahlevani, F., Sahajwalla, V., 2020. Valorisation of discarded nonwoven polypropylene as potential matrix-phase for thermoplastic-lignocellulose hybrid material engineered for building applications. J. Clean. Prod. 258, 120730.

Farahani, R.Z., Asgari, N., Van Wassenhove, L.N., 2022. Fast fashion, charities, and the circular economy: challenges for operations management. Prod. Operat. Manage. 31 (3), 1089–1114.

Fråne, A., Askham, C., Gíslason, S., Kiørboe, N., Ljungkvist, H., McKinnon, D., Rubach, S., 2017. The Nordic textile reuse and recycling commitment–a certification system for used textiles and textile waste. Nordisk Ministerråd. https://www.diva-portal.org/smash/get/diva2:1125682/FULLTEXT03.pdf.

Gan, L., Xiao, Z., Zhang, J., Van Amber, R., Hurren, C., Xu, W., Wang, Y., Wang, X., 2021. Coloured powder from coloured textile waste for fabric printing application. Cellulose 28 (2), 1179–1189.

Gorman, M., 2021. Almost 80 per cent of unwanted textiles end up in landfill, a report finds. https://www.abc.net.au/news/2021-06-11/textile-waste-consumption-under-estimated/100184578. (Accessed 17 May 2022).

Guardian, T., 2021. We are five to 10 years behind': long road ahead for solving Australia's textile waste crisis. https://www.theguardian.com/fashion/2021/nov/21/we-are-five-to-10-years-behind-long-road-ahead-for-solving-australias-textile-waste-crisis. (Accessed 17 May 2022).

Hla, S.S., Lopes, R., Roberts, D., 2016. The CO2 gasification reactivity of chars produced from Australian municipal solid waste. Fuel 185, 847–854.

Hole, G., Hole, A.S., 2019. Recycling as the way to greener production: a mini review. J. Clean. Prod. 212, 910–915.

Inside Waste, 2020. Tackling textile waste. https://www.insidewaste.com.au/index.php/2020/05/19/tackling-textile-waste/. (Accessed 17 May 2022).

Jane, 2016. The numbers on textile waste. https://textilebeat.com/the-numbers-on-textile-waste/. (Accessed 18 May 2022).

Khandaker, S., Bashar, M.M., Islam, A., Hossain, M.T., Teo, S.H., Awual, M.R., 2022. Sustainable energy generation from textile biowaste and its challenges: a comprehensive review. Renew. Sustain. Energy Rev. 157, 112051.

Kollmorgen, A., 2021. Is Australia waking up to its textile waste problem? https://www.choice.com.au/shopping/everyday-shopping/ethical-buying-and-giving/articles/textile-waste-and-how-to-reduce-it. (Accessed 17 May 2022).

Koszewska, M., 2018. Circular economy — challenges for the textile and clothing industry. Autex Res. J. 18 (4), 337–347.

Lang, C.M., Armstrong, C.M.J., 2018. Collaborative consumption: the influence of fashion leadership, need for uniqueness, and materialism on female consumers' adoption of clothing renting and swapping. Sustain. Prod. Consumpt. 13, 37–47.

Lindley, B., 2018. Bringing industry to the table – why corporate uniforms will be essential to solving textile recycling. https://edgeenvironment.com/bringing-industry-table-corporate-uniforms-will-essential-solving-textile-recycling/. (Accessed 18 May 2022).

Liu, M., 2017. Growable fabrics and zero-waste clothes: fashion needs to do more to tackle its big problem. https://www.abc.net.au/news/2017-08-16/fashion-waste-more-research-needed-to-tackle-industry-problem/8807972.

Ma, Y., Nasri-Nasrabadi, B., You, X., Wang, X., Rainey, T.J., Byrne, N., 2021. Regenerated cellulose fibers wetspun from different waste cellulose types. J. Natural Fibers 18 (12), 2338–2350.

Ma, Y., Rosson, L., Wang, X., Byrne, N., 2020. Upcycling of waste textiles into regenerated cellulose fibres: impact of pretreatments. J. Textile Instit. 111 (5), 630–638.

Ma, Y., Zeng, B., Wang, X., Byrne, N., 2019. Circular textiles: closed loop fiber to fiber wet spun process for recycling cotton from denim. ACS Sustain. Chem. Eng. 7 (14), 11937–11943.

Moazzem, S., Crossin, E., Daver, F., Wang, L., 2021a. Environmental impact of apparel supply chain and textile products. Environ. Develop. Sustain. 24, 9757-9775.

Moazzem, S., Wang, L., Daver, F., Crossin, E., 2021b. Environmental impact of discarded apparel landfilling and recycling. Resour. Conserv. Recy. 166, 105338.

Monash University, 2021. Coming full circle on fast fashion for a sustainable future. https://lens.monash.edu/@environment/2021/03/31/1382982/coming-full-circle-on-fast-fashion-for-a-sustainable-future. (Accessed 17 May 2022).
Moorhouse, D., Moorhouse, D., 2017. Sustainable design: circular economy in fashion and textiles. Design J. 20, S1948–S1959.
Naish, K., 2020. Turning Textile Waste into Fabric Gift Wraps. https://afittingconnection.com.au/2020/09/04/turning-textile-waste-into-fabric-gift-wraps/. (Accessed 18 May 2022).
National Retail Association, 2022. A collaboration to reduce waste in fashion. https://www.nra.net.au/app/uploads/2019/06/3-Moving-the-Needle-Presentation-Deck.pdf. (Accessed 18 May 2022).
Navone, L., Moffitt, K., Hansen, K.-A., Blinco, J., Payne, A., Speight, R., 2020. Closing the textile loop: enzymatic fibre separation and recycling of wool/polyester fabric blends. Waste Manage. 102, 149–160.
Nekouei, R.K., Mofarah, S.S., Maroufi, S., Wang, W., Mansuri, I., Sahajwalla, V., 2022. Unraveling the role of oxides in electrochemical performance of activated carbons for high voltage symmetric electric double-layer capacitors. Adv. Energy Sustain. Res. 3 (1) https://doi.org/10.1002/aesr.202100130.
Niinimaki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., Gwilt, A., 2020. The environmental price of fast fashion. Nat. Rev. Earth Enviro. 1 (4), 189–200.
Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., Gwilt, A., 2020. The environmental price of fast fashion. Nat. Rev. Earth Environ. 1 (4), 189–200.
Nowack, B., David, R.M., Fissan, H., Morris, H., Shatkin, J.A., Stintz, M., Zepp, R., Brouwer, D., 2013. Potential release scenarios for carbon nanotubes used in composites. Environ. Int. 59, 1–11.
Parliament of Australia, 2019. Textiles. https://www.aph.gov.au/Parliamentary_Business/Committees/House/Industry_Innovation_Science_and_Resources/WasteandRecycling/Report/section?id=committees%2Freportrep%2F024400%2F73685. (Accessed 17 May 2022).
Parliament Of The Commonwealth Of Australia, 2020. From rubbish to resources: building a circular economy. https://apo.org.au/sites/default/files/resource-files/2020-12/apo-nid309956.pdf.
Payne, A., Binotto, C., 2017. Towards a typology of waste in fashion practice: an Australian perspective. In: 2nd Conference on Product Lifetimes and the Environment (PLATE). Delft Univ Technol, Fac Ind Design Engn, Delft, NETHERLANDS, pp. 340–346. https://doi.org/10.3233/978-1-61499-820-4-340.
Piller, L.W., 2022. Designing for circularity: sustainable pathways for Australian fashion small to medium enterprises. J. Fashion Market. Manage. Int. J. https://doi.org/10.1108/JFMM-1109-2021-0220.
Process Technology, 2021. First Australian textile recycling facility under development. https://www.processonline.com.au/content/business/news/first-australian-textile-recycling-facility-under-development-1014711649. (Accessed 18 May 2022).
QUT University, 2021. Textile waste: addressing a 92 million tonne global problem. https://www.qut.edu.au/study/creative-industries/news?id=177289. (Accessed 17 May 2022).
Redooo, 2022. Textiles. https://redooo.com.au/waste-management/general-waste-and-recycling/textiles. (Accessed 18 May 2022).
Ross, G., 2019. Why we need to talk about textile waste. https://www.blocktexx.com/post/why-we-need-to-talk-about-textile-waste. (Accessed 18 May 2022).
Schultz, A., 2022. The problem with fast fashion and how it's killing the planet. https://www.smartcompany.com.au/industries/retail/fast-fashion-killing-the-planet/. (Accessed 18 May 2022).
Shirvanimoghaddam, K., Motamed, B., Ramakrishna, S., Naebe, M., 2020. Death by waste: fashion and textile circular economy case. Sci. Total Environ. 718, 137317.
Taylor, L., 2021. Tackling Australia's textile waste. https://www.planetark.org/newsroom/news/tackling-australias-textile-waste. (Accessed 17 May 2022).
Times, J., 2021. Govt to hold roundtable on textile waste. https://www.jimboombatimes.com.au/story/7119567/govt-to-hold-roundtable-on-textile-waste/. (Accessed 18 May 2022).
Times News Group, 2021. Textile waste growing threat to ocean's health. https://timesnewsgroup.com.au/bellarinetimes/featured/textile-waste-growing-threat-to-oceans-health/. (Accessed 18 May 2022).
Tran, N.P., Gunasekara, C., Law, D.W., Houshyar, S., Setunge, S., Cwirzen, A., 2022. Comprehensive review on sustainable fiber reinforced concrete incorporating recycled textile waste. J. Sustain. Cement-Based Mater. 11 (1), 28–42.
Villalobos García, J., Dow, N., Milne, N., Zhang, J., Naidoo, L., Gray, S., Duke, M., 2018. Membrane distillation trial on textile wastewater containing surfactants using hydrophobic and hydrophilic-coated polytetrafluoroethylene (PTFE) membranes. Membranes 8 (2), 31.
Weber, S., Lynes, J., Young, S.B., 2017. Fashion interest as a driver for consumer textile waste management: reuse, recycle or disposal. Int. J. Consum. Stud. 41 (2), 207–215.
Zeng, B., Wang, X., Byrne, N., 2020. Cellulose beads derived from waste textiles for drug delivery. Polymers (Basel) 12 (7), 1621.
Žurga, Z., Hladnik, A., Forte Tavčer, P., 2015. Environmentally sustainable apparel acquisition and disposal behaviours among Slovenian consumers. Autex Res. J. 15 (4), 243–259.