BJ O&PM Brazilian Journal of Operations & Production Management

ISSN 2237-8960 (Online)

ABEPRO ASSOCIAÇÃO BRASILEIRA DE ENGENHARIA DE PRODUÇÃO

GENERAL REVIEW

Practices for garment industry's post-consumer textile waste management in the circular economy context: an analysis on literature

Pedro Seolin dos Santos[1], Lucila Maria de Souza Campos[1]

[1]Federal University of Santa Catarina – UFSC, Technological Center, Graduate Program in Production Engineering, Campus Trindade, Florianópolis, SC, Brazil

How to cite: Santos, P.S. and Campos, L.M.S. (2021), "Practices for garment industry's post-consumer textile waste management in the circular economy context: an analysis on literature", *Brazilian Journal of Operations & Production Management*, Vol. 18, No. 1, e20211084. https://doi.org/10.14488/BJOPM.2021.004

ABSTRACT

Goal: This study aimed to identify and describe garment's post-consumer textile waste management practices and to analyse them according to environmental, economic and social criteria in the circular economy context.

Design / Methodology / Approach: A literature review was conducted to identify, collect and organize practices from garment's post-consumer textile waste management and the environmental, economic and social criteria taken into account for the analysis of such practices in a circular context.

Results: There were eleven collection practices, three sorting practices, five reuse practices, and six recycling practices. Additionally, even circularity is presented as a new solution to environmental problems, those practices identified in literature are pulled mainly downstream, promoting short-term waste management approaches, while the initial production chain's links continue to extract and use several non-renewable resources from the excessive way.

Limitations of the investigation: The limitations of a literature review of this nature is the complete reliance on the defined strings to search the previously published research and the adopted procedures to select and evaluate these studies (data base, search period, exclusion criteria)

Practical implications: For researchers and garment's industry professionals, the identified practices should provide new solutions that could be tested in the current post-consumer textile waste management model. Moreover, this research allowed understanding the way those post-consumer textile waste management's practices are interpreted under a circular context.

Originality/Value: there is almost no detailed study of post-consumer textile waste management's practices. Furthermore, it is very rare to find those textile waste management practices related in a circular context.

Keywords: Textile Waste Management; Garment Industry; Circular Economy.

1. INTRODUCTION

Over the past few decades, the efficiency and management of natural resources have become an area of great interest for researchers, manufacturers, and professionals to close the material cycles and move towards a circular economy (Bukhari et al., 2018). According to Norris (2019), the garment industry seeks for practices that guarantee the maximum use of resources rather than aim only at final proper disposal of clothing items.

Financial support: The authors would like to thank CNPq (The National Council for Scientific and Technological Development) and CAPES (by the Higher Education Improvement Coordination) for the financial support of this research.
Conflict of interest: There is no conflict of interest associated with this research.
Corresponding author: lucila.campos@ufsc.br
Received: 2 Sep 2020.
Approved: 16 Oct 2020.
Editor: Osvaldo L. G. Quelhas and Julio Vieira Neto.

The emergence of these practices occurs due to the current production model. This linear model has caused several negative environmental impacts in the use of raw materials, water and energy throughout all links in the production chain (Allwood et al., 2006; Pal and Gander, 2018).

This model also had caused problems related with economical aspects, since this current model is not advantageous considering the substantial financial losses in the manufacturing process (Norris, 2019). In adittion, consumers of clothing items are increasingly aware of the negative environmental and social impacts generated by the production and disposal of textiles (McNeill and Snowdon, 2019).

Thus, theorists have suggested (Franco, 2017; Pedersen and Hvass, 2019; McNeill and Snowdon, 2019) new business models, which potentially align the management of textile waste in a context of using these resources to their maximum capacity, such practices inserted in circular models of production.

In summary, practices inserted in a circular context means promoting the maximum use of resources and mitigating environmental impacts during the production and consumption processes (Bech et al., 2019). According to Ellen MacArthur Foundation (2017), the focus of textile waste management in the circular economy should be on the maximum use of clothing, reducing consumption, and recycling resources.

This is because, despite the share of textile waste is relatively small in terms of volume compared to other waste streams, its impact on the environment and human health is high and it is increasing due to the current production model (Bukhari et al., 2018). Therefore, since the garment industry operates in a linear way, being suffering by environmental and social impacts, and economic challenges, the Circular Economy can assist as a regenerative and restorative model, which aims to maintain products, components and materials at their highest level of utility and value (Ellen Macarthur Foundation, 2017; Franco, 2017)

Thus, a theoretical analysis of collection, sorting, and reinsertion practices for clothing items in a circular context presents interesting questions as it makes it possible to demonstrate how the current collection, sorting, and reinsertion systems are operated in the fashion production chain (Hvass, 2014; Ellen Macarthur Foundation, 2017; Franco, 2017; Norris, 2019; McNeill and Snowdon, 2019,) the research's questions arise.

In the context of the circular economy, this study aimed to identify and describe garment's post-consumer textile waste management practices and to analyse them according to environmental, economic and social criteria.

2. METHODOLOGICAL PROCEDURES

The procedures were delimited based on the criteria of location, selection and validation of the material, synthesis and analysis of content and presentation of the results, as demonstrated in Figure 1.

Initially, the search and selection of articles to compose the portfolio was carried out. The ISI Web of Science, Scopus, Compendex, and Elsevier databases were used to locate the articles. Those data based were chosen since they have been used in other studies on circular economics (Geissdoerfer et al., 2017; Govindan and Hasanagic, 2018).

To import and organize the selected publications, the EndNote® software was used. The criteria defined for searching the databases were: (1) there is no restriction on the publication period; (2) the search was made only on the title, abstract, and keywords; (3) only article or review studies published in English were considered. The material was collected in January 2020, comprising publications until then.

After completing the search for the 9 keywords in the 4 databases, it was obtained 64 articles aligned to the research. For the synthesis and analysis of findings, content analysis was chosen as the method, adapted from Bardin (2010), which works the coding and extraction of content from the division of the material into (1) registration units and, (2) thematic axes.

In this study, three thematic axes were developed: (a) circular economy (circular aspects take into account), (b) practices (description of the activities, resources and responsibles), (c) criteria (environmental, economic, social). For data processing, it was used Excel® software.

Post-consumer textile waste practices and criteria for analyzes were organized in (a) table with circular criteria identified on the literature; (b) table with circular post-consumer textile waste practices ; (c) discussion of the results from an empirical analysis of practices using economic, environmental and social criteria from method originating at Palm et al. (2014).

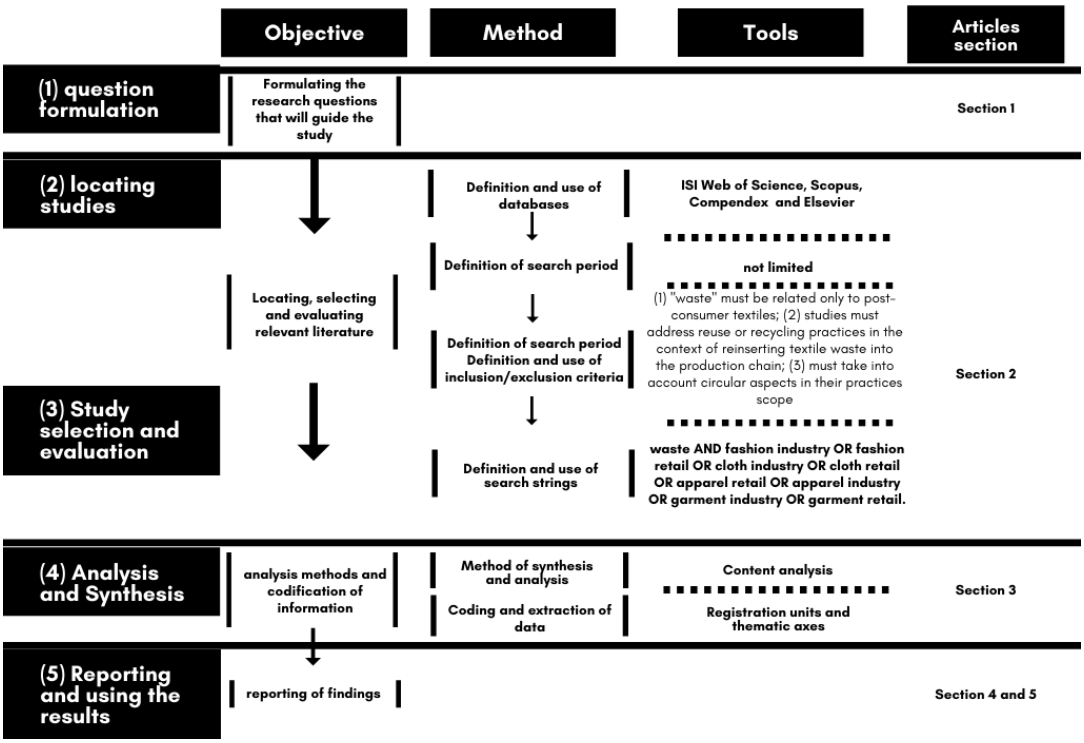

Figure 1 – survey stages diagram
Source: Based on Garza-Reys (2015).

3. LITERATURE REVIEW

3.1 Textile waste management and circular economy

Currently, the way that clothes are designed, produced, and used is not environmental beneficial and it is becoming increasingly clear that turning the way that clothes are produced into a circular one is by no means an easy task. Examples of reverse logistics systems or closed-loop supply chains have been developed to improve the sustainability of discarded items (Larney and Van Aardt, 2010; Hu et al., 2014; Leal-Filho et al., 2019).

These examples and other practices for effective clothing waste management are motivated by the increasing cost of production, the decrease in natural resources, and in the lack of availability of space in landfills (Larney and Van Aardt, 2010). Thus, circular practices among the supply-chain could have the potential to transform the way textiles are produced, consumed, and being disposed (Staicu and Pop, 2018).

Palm et al. (2014) addresses the different forms of post-consumer textiles waste management in Nordic countries, dividing the process in: collection, sorting, reuse, and recycling. In summary, collection indicates gathering of products from all customers and transport to the next waste management step.

The sorting process depends on the final objective (reuse or recycling) and the quantity collected. Finally, reinsertion indicates sending the textile waste to reuse or recycling (Beh et al., 2016). According to Burton (2018), the garment industry faces a variety of collection, sorting, reuse and recycling practices of post-consumer items.

In terms of complexity of these different practices in a circular context, Leal-Filho et al. (2019) point out that by identifying what are the decisive criteria to choose a particular waste

management practice, it makes it possible to clarify how these practices are chosen as well as the performance of such initiative in an economic, environmental or social context.

According to Savageau (2011), though these criteria may be inexhaustible, if standardized make it possible to compare practices applied in different contexts (type of company) and distinct regions. Thus, in order to analyze the practices identified in the literature in a circular context, the criteria on this paper will be divided into economic, environmental and social points.

Table 1 presents the criteria identified in the literature for the analysis of collection, sorting, reuse, and recycling practices.

Table 1 – Criteria for analyzing post-consumer textile waste management practices

Context	Criteria	Description	Reference
Economic	Cost of qualified labor force	Cost of qualified labor for the initiative since it requires specific technical knowledge	Palm et al. (2014), Noman et al. (2013), Hu et al. (2014)
Economic	Flexibility in financial, material and human resource's application	Ability to change the application of resources, due to garment's market complexity	Palm et al. (2014), Franco (2017), Bukhari et al. (2018), Noman et al. (2013)
Economic	Technology involved	Automated processes are visualized and used	Noman et al. (2013), Palm et al. (2014), Hu et al. (2014), Bukhari et al. (2018)
Economic	Transportation costs	Ability to collect the textile waste taking into account: distance to sorting sheme, collection capacity and textile quality	Noman et al. (2013), Palm et al. (2014), Hu et al. (2014), Bukhari et al. (2018)
Economic	Organization's self-sustainability	Considers the allocation of financial resources for the execution of the initiative	Noman et al. (2013), Palm et al. (2014), Hu et al. (2014)
Economic	Capacity to treat textile waste	Consider the number of clothing items that the initiative can collect, sorting, reuse or recycle	Palm et al. (2014), Bukhari et al. (2018)
Economic	Business maturity	Consider solidification actions on defining strategic, managerial and operational activities	Noman et al. (2013), Palm et al. (2014), Hu et al. (2014), Franco (2017), Bukhari et al. (2018)
Environmental	Electric energy consumption	Evaluates the consumption of electricity	Palm et al. (2014), Hu et al. (2014), Franco (2017)
Environmental	Water consumption	Evaluates the consumption of water	Palm et al. (2014), Hu et al. (2014), Franco (2017)
Environmental	Sufficiency of collected resources	Considers the total use of collected material	Larney and Van Aardt (2010), Noman et al. (2013), Hu et al. (2014), Bukhari et al. (2018)
Environmental	Waste Generation	Considers generation of residues sent to landfill	Palm et al. (2014), Bukhari et al. (2018)
Environmental	Final item traceability	Final item traceability	Larney and Van Aardt (2010), Noman et al. (2013), Palm et al. (2014), Bukhari et al. (2018)
Social	Partnership with cooperatives, associations, and consortia	Prioritizes those types of partnership in the regions where they exist	Noman et al. (2013), Bukhari et al. (2018)
Social	Availability of participation by vulnerable groups	Partnerships with vulnerable groups in regions where there are	Noman et al. (2013), Palm et al. (2014), Bukhari et al. (2018)
Social	Employee health and safety regulations	Employee's physical and mental integrity in the performance of their activities in the company	Akbar and Ahsan (2019)

The post-consumer textile waste management practices identified in the literature will be presented below. The following sections (items 3.2 to 3.5) detail the practices in collection, sorting, reuse and recycling practices of post-consumer textile waste management.

3.2 Post-consumer textile waste collection schemes

Currently, the main collection practices identified in the literature, by frequency of citation, were: charity eco points (18), thrift stores (17) eco points - recycling (12), eco points - municipal management (11), Take-Back (10), EPR (6), Flea market (5), Online (3), Specific Campaigns (2) and community collection of the Individual (1) or company (1) type.

In the case of eco points (charity, recycling or municipal management), collectors are located at the institution itself or with partner companies (example: eco points in supermarkets) for items in good condition (clothes, bed, table, and bath), shoes, and accessories to be sold in thrift stores, donated to charities, or non-usable textile (for recycling) to be sent for recycling or, ultimately, sent for energy recovery.

On the other hand, the collection of thrift stores, on the other hand, occurs when consumers make the clothes available for selection and resale (with a share of the profits), being able to leave the clothing items in the store or removed at their residence (Palm et al., 2014). Although the flea market also collects clothes in good condition, it is pushed by exclusive clothing items and / or vintages (Burton, 2018).

For Take-back, the collectors are found inside the store and the clothes collected are exclusively from the retailer's brand. In this case, they are only accepted if they are suitable for reuse in sales of outlets or remodeling the item. The consumer delivers the product to a seller who analyses the part and indicates the disposal collector, while the consumer receives a discount voucher.

Meanwhile, more complex collection systems, such as the Extended Producer Responsibility (EPR), occur in two routes: (1) public management delegating the function to private companies to operate textile waste management system; or (2) clothing companies organize themselves and formally establish a collection project approved by the public management (Bukhari et al., 2018).

Finally, there is kerbside, which can be in an individual way. In this case, it is communicated to the residents of the region and the textiles are collected (properly packaged) in front of the residences. Regarding partnership, clothing booths are located in residential areas and the collection practice takes place by an outsourced company that seeks unused textiles in residences.

3.3 Post-consumer textile waste sorting schemes

At this stage, the main activity is to identify and select clothing items collected in good condition to ensure that they are not seen as waste, but as high value-added products (Larney and Van Aardt, 2010). The practices used will also vary according to the final objective (reuse or recycling) and the quantity of textile's waste collected. Eventually, sorting activities can occur alongside collection activities (Nayak et al., 2019).

The main practices of sorting identified in the literature were: manual (7), semi-automatic (3), and automatic (1). Manual sorting is being the most used, especially due to the difficulty in tracking the materials used (Palm et al., 2014).

Finally, near-infrared spectroscopy (NIR) technology is already applied to separate plastic and plastic mixed with other materials, however, its application in textiles is still incipient due to the complex mixtures of fibers and additives that make sorting more complex than other materials (Palm et al., 2014).

3.4 Post-consumer textile waste reuse schemes

When compared to recycling practices, reuse practices are more important in terms of ensuring the circularity of resources in the production chain. In the practices of reuse and restoration, the basic functionality of the material is maintained, retaining its highest value for several production cycles (Paras and Pal, 2018).

In reuse, the collected and selected clothes can be converted into a: (1) thrift store or, (2) restoration. The thrift store is currently one of the most cited in the literature among

second-hand retail practices (16 studies addressed the initiative). This is due to the broad characteristics involved in obtaining and disposing of items in this initiative: for example, thrift stores may have clothing items, whether for philanthropic purposes or donation.

Although not the best option from a circular point of view, downcycling practices usually occur when materials undergo reprocessing, producing leftovers and scraps. Even though downclycling practices does not promote greater logenvity, the premise of keeping the use of the textile prolonged is maintained.

3.5 Post-consumer textile waste recycling schemes

There are four major categories of textile recycling pratices: mechanical recycling (17), mixed techniques (9), special techniques (9), chemical recycling (7).

According to Palm et al. (2014), in mechanical recycling, the textile can be: (a) transformed into yarn, (b) transformed into fiber, (c) remanufactured. While in chemical recycling, the item of clothing is mechanically torn and processed in a chemical solution that filters cellulose from a slow flow. The material obtained is capable of producing new textile fibers through the re-polymerization process (Larney and Van Aardt, 2010).

The mixed technologies result from the process of obtaining the raw material, which may be the union of different sub-processes of mechanical recycling with chemical recycling. In special techniques, the textile is cutted into small pieces, then fabric is granulated and turned into chips that are melted and spun into new filament fibres used to make new fabrics (Palm et al., 2014).

4. RESULTS AND DISCUSSION

4.1 Circular practices for post-consumer's textile waste management in the garment industry

Regarding the practices, from 64 studies analyzed, only 7 had an emphasis on the stages of collection, sorting, and reinsertion in the production chain, with 3 applied as a reuse (thrift store and upcycling) and 4 in recycling (emphasis on remanufacturing).

Also, there was little discussion about practices to separate textile waste. The researches that directly addressed this stage (7 studies) understand that currently the sorting process is carried out, in most cases, empirically (Palm et al., 2014), and with a high need for qualified labor to handle the collected items (Bukhari et al., 2018).

Finally, thermal recovery (the process of converting textile waste into energy) can be considered as an alternative that is also economically viable, however, in this study the scope of its activity will only occur in cases where the waste textiles have no possibility of reuse or recycling. Table 2 presents the article considered in this study related to textile waste in the garment industry.

Table 2 – Textiles waste in the garment industry's articles

Title	Reference	Journal
Recycling in the garment industry	Lund (1975)	RandD Management
Linking tactical and operational decision-making to strengthen textile/apparel supply chains	Teng and Jaramillo (2005)	International Journal of Logistics Systems and Management
Development of a flexible composite from leather industry waste and evaluation of their physico-chemical properties	Saikia et al. (2017)	Cleaner Technological Environmental Policy
Characterization of Leather Industry Wastes	Ozgunay et al. (2007)	Polish Journal of Environmental Studies
Ecological management for textile wastes processing	Carpus et al. (2008)	Environmental Engineering and Management Journal

Title	Reference	Journal
Case study: Apparel industry waste management: a focus on recycling in South Africa	Larney and Van Aardt (2010)	Waste Management and Research
Benzothiazole, benzotriazole, and their derivates in clothing textiles—a potential source of environmental pollutants and human exposure	Avagyan et al. (2015)	Environmental Science and Pollution Research
Sustainable Fashion Education in changing World Scenario	Agarwal (2019)	European Journal of Sustainable Development
Consumer Textile Recycling as a Means of Solid Waste Reduction	Domina and Koch (1997)	Family and Consumer Sciences Research Journal
The Development Of Green Environment Through Lean Implementation In a Garment Industry	Marudhamuthu and Krishnaswamy (2011)	ARPN Journal of Engineering and Applied Sciences
Textile Waste and Sustainability: A Case Study	Savageau (2011)	Research Journal of Textile and Apparel
ReFashioning New Zealand: A Practitioner's Reflection on Fast FashionFast fashion Implications	Fraser (2011)	The International Journal of Environmental, Cultural, Economic and Social Sustainability
Beauty and the Waste: Fashioning Idols and the Ethics of Recycling in Korean Pop Music Videos	Kim (2019)	Fashion Theory: The Journal of Dress, Body and Culture
Sustainable Developments in Knitting	Power (2012)	International Journal of Business and Globalization
Application of Markov chain for LCA: a study on the clothes 'reuse' in Nordic countries	Paras and Pal (2018)	International Journal of Advanced Manufacturing Technology
The role of environmental knowledge in young female consumers' evaluation and selection of apparel in South Africa	Momberg et al. (2012)	International Journal of Consumer Studies
Exit from the high street: an exploratory study of sustainable fashion consumption pioneers	Bly et al. (2015)	International Journal of Consumer Studies
Performance Analysis of the Capability Assessment Tool for Sustainable Manufacturing	Subic et al. (2013)	Sustainability
The effect of consumers' involvement and innovativeness on the utilization of fashion wardrobe	Choo et al. (2014)	International Journal of Consumer Studies
A theoretical investigation of slow fashion: sustainable future of the apparel industry	Jung and Jin (2014)	International Journal of Consumer Studies
Reducing laundering frequency to prolong the life of denim jeans	McQueen et al. (2017)	International Journal of Consumer Studies
Economic and employment potential in textile waste management of Faisalabad	Noman et al. (2013)	Waste Management and Research
Fashion Design Industry Impressions of Current Sustainable Practices	Palomo-Lovinski and Hahn (2014)	Fashion Practice-the Journal of Design Creative Process and the Fashion Industry
Post-retail responsibility of garments – A fashion industry perspective	Hvass (2014)	Journal of Fashion Marketing and Management: An International Journal
Consumers interpreting sustainability: moving beyond food to fashion	Ritch (2015)	International Journal of Retail and Distribution Management
A Review of the socio-economic advantages of textile recycling	Leal Filho et al. (2019)	Journal of Cleaner Production
Consumption of disposed goods for moral identities: a nexus of organization, place, things and consumers	Brace-Govan and Binay (2010)	Journal of Consumer Behaviour

Table 2 – Continued...

Title	Reference	Journal
Effect of Recycled PET Fibers on the Performance Properties of Knitted Fabrics	Telli and Özdil (2015)	Journal of Engineered Fibers and Fabrics
New life luxury: upcycled Scottish heritage textiles	Keith and Silies (2015)	International Journal of Retail and Distribution Management
An examination of the product development process for fashion remanufacturing	Dissanayake and Sinha (2015)	Resources, Conservation and Recycling
The environmental effects caused by solid waste industries clothing in polo fashion of Maringá-PR	Alencar et al. (2015)	Revista Eletrônica em Gestão, Educação e Tecnologia Ambiental
Turkey Fashion Industry's Cut-and-Sew Waste Problem and Its Waste Management Strategies	Enes and Kipöz (2019)	Journal of Textiles and Engineer
Mapping the interactions between the stakeholders of the circular economy ecosystem applied to the textile and apparel sector in Romania	Staicu and Pop (2018)	Management and Marketing: Challenges for the Knowledge Society
Transforming the sequential process of fashion production: where zero-waste pattern cuttin takes the lead in creative design	James et al. (2016)	International Journal of Fashion Design, Technology and Education
Second-life retailing: a reverse supply chain perspective	Beh et al. (2016)	Supply Chain Management: An International Journal
Standard vs. Upcycled Fashion Design and Production	Han et al. (2017)	Fashion Practice: The Journal of Design, Creative Process and the Fashion Industry
The Poetics of Waste: Contemporary Fashion Practice in the Context of Wastefulness	Binotto and Payne (2017)	Fashion Practice: The Journal of Design, Creative Process and the Fashion Industry
Environmental impact of Recover cotton in textile industry	Esteve-Turrillas and De-La-Guardia (2017)	Resources, Conservation and Recycling
Creating a Slow Fashion Collection – A Designer–Maker's Process	Bray (2017)	Scope
An Exploratory Study of the Mechanism of Sustainable Value Creation in the Luxury Fashion Industry	Yang et al. (2017)	Sustainability
Petit Pli: Clothes that Grow	Yasin (2017)	Utopian Studies
Cross-cultural Investigation Of Consumers' Generations Attitudes Towards Purchase Of Environmentally Friendly Products In Apparel Retail	Dabija et al. (2017)	Studies in Business and Economics
The mass consumption of refashioned clothes: Re-dyed kimono in post war Japan	Sugiura (2018)	Business History
Sustainable Rent-Based Closed-Loop Supply Chain for Fashion Products	Hu et al. (2014)	Sustainability
Reducing textile waste in the apparel industry: Examining EPR as an option	Burton (2018)	Clothing Cultures
Case study: Swat Valley Guild peace-building initiative and Artisan enterprise for community empowerment and sustainable development	Deo (2018)	Clothing Cultures

Title	Reference	Journal
Potential Risks and Their Analysis of the Apparel and Textile Industry in Turkey: A Quality-Oriented Sustainability Approach	Erdil and Taçgin (2018)	Fibres and Textiles in Eastern Europe
Consumer attitudes and communication in circular fashion	Vehmas et al. (2018)	Journal of Fashion Marketing and Management: An International Journal
Collaborative consumption: a business model analysis of second-hand fashion	Gopalakrishnan and Matthews (2018)	Journal of Fashion Marketing and Management: An International Journal
Digital innovation for sustainable apparel systems: Experiences based on projects in textile value chain development	Larsson (2018)	Research Journal of Textile and Apparel
"People Gather for Stranger Things, So Why Not This?" Learning Sustainable Sensibilities through Communal Garment-Mending Practices	Durrani (2017)	Sustainability
Developing a national programme for textiles and clothing recovery	Bukhari et al. (2018)	Waste Management and Research
Sustainable Incremental Organizational Change—A Case of the Textile and Apparel Industry	Patora-Wysocka and Sułkowski (2019)	Sustainability
Sustainable fashion index model and its implication	Wang et al. (2019)	Journal of Business Research
Knowledge, skills and organizational capabilities for structural transformation	Khan (2019)	Structural Change and Economic Dynamics
Workplace safety compliance implementation challenges in apparel supplier firms	Akbar and Ahsan (2019)	Journal of Cleaner Production
From waste to fashion – a fashion upcycling contest	Marques et al. (2019)	CIRP
Slow fashion – Balancing the conscious retail model within the fashion marketplace	McNeill and Snowdon (2019)	Australasian Marketing Journal
Traceability management systems and capacity building as new approaches for improving sustainability in the fashion multi-tier supply chain	Mejías et al. (2019)	International Journal of Production Economics
Recent sustainable trends in Vietnam's fashion supply chain	Nayak et al. (2019)	Journal of Cleaner Production
Innovation catalysts for industrial waste challenges: Sri Lankan and Thai cases	Park et al. (2019)	Procedia Manufacturing
Effects of cotton textile waste properties on recycled fibre quality	Ütebay and Çelik (2019)	Journal of Cleaner Production
Improvement of polylactic acid film properties through the addition of cellulose nanocrystals isolated from waste cotton cloth	Yao et al. (2019)	International Journal of Biological Macromolecules

An analysis of the articles located in Tabel 2 was conducted for creating the conceptual definition of post-consumer textile waste management taking into account: (a) the resources necessary for its application; (b) responsible for the practice. Such practices seek to keep textile resources in closed cycles within the production and consumption processes at their highest level.

It is also worth noting that literature review have shown some practices are not necessarily limited to a single step of textile waste management (e.g. thrift store) and the presence of practices that are similar concerning the scope of activities (e.g. eco points). Therefore, it was unified as follows: (1) charity eco points, recycling, municipal management

and community collection; (2) Thrift store, flea market, and online platform; (3) Take-back and EPR, (4) Restoration and Remanufacturing.

Finally, the conceptual definition did not consider energy recovery, although it points out as a final solution in cases where no other method of reuse or recycling can be applied. Table 3 presents the final definition of the practices identified in the literature for the management of textile waste in the post-consumption of the clothing industry in the context of the circular economy.

Table 3 – The conceptual definition of practices for post-consumer textile waste in the clothing industry, from a circular perspective

Practice	Brief practice's description	Practice's Resources	Practice's responsible	References
Ecopoints	Collection points for clothing, bedding, table and bath items, shoes and accessories	Collection points in public areas, transport chain, sorting center	The public authority, a third-party company, Non-governmental organization (NGO), and micro and small companies (MPEs)	Lund (1975), Palm et al. (2014), Bukhari et al. (2018), Burton (2018), Keith and Silies (2015), Gopalakrishnan and Matthews (2018), Durrani (2017), Fraser (2011), Paras and Pal (2018), McQueen et al. (2017), Ritch (2015), Dissanayake and Sinha (2015), Yang et al. (2017), Beh et al. (2016), Hu et al. (2014), Bly et al. (2015), Leal Filho et al. (2019), Larney and Vann Aardt (2010)
TriftStore/Flea Market	Panning and collecting activities of clothing items with different characteristics (luxury thrift stores or traditional thrift stores) for profit or philanthropic, from their store or online platform	Collection points, storage capacity, transport network	MPE	Gopalakrishnan and Matthews (2018), Dissanayake and Sinha (2015), Palm et al. (2014), Bukhari et al. (2018), Han et al. (2017), Durrani (2017), Fraser (2011), Paras and Pal (2018), Binotto and Paine (2017), Patora-Wysocka and Sułkowski (2019), Beh et al. (2016), Hu et al. (2014), Bly et al. (2015), Leal Filho et al. (2019), Larney and Vann Aardt (2010)
EPR	Collection points in proper establishment or partner networks	Collection points in public areas, partner network and transport network	Global Retailer/manufacturers	Burton (2018), Bukhari et al., (2018), Durrani (2017), Palm et al. (2014), Leal Filho et al. (2019)
Manual Sorting	Manual process to separate clothing items	Qualified labor force	MPE (sorting small volume)	Palm et al. (2014), Bukhari et al. (2018), Dissanayake and Sinha (2015), Sugiura

Practice	Brief practice's description	Practice's Resources	Practice's responsible	References
				(2018), Larney and Van Aardt (2010), Noman et al. (2013)
Semi-automated sorting	Process of semi-automatic sorting clothing items / fabrics	Qualified labor force, technologies for specific sortings stage	MPE (sorting small/medium volume)	Palm et al. (2014)
Automatic Sorting	Automatic process for pre-sorting, sorting, and reinsertion of textiles for reuse/recycling	Advanced information technology skills-based workforce, NIR technologies for pre-sorting, sorting and disposal of textiles	MPE (sorting large volume)	Palm et al. (2014)
Restoration and remanufacturing	Remodeling or transforms used clothing or high-quality textiles into new products with the same or similar function (e.g. transforming pants into a bag)	Technologies to remodel previously collected clothing items	Designer / Recycling companies	Binotto and Payne (2017), Keith and Sillies (2015), Bukhari et al. (2018), James et al. (2016), Dissanayake and Sinha (2015), Leal Filho et al. (2019), Bukhari et al. (2018), Han et al. (2017)
Downcycling	Converting used clothes and textiles (not converted into fibers/yarns) as raw material for by-products production	Technologies for dismantling previously collected clothing items	Designer	Bukhari et al. (2018), Dissanayake and Sinha (2015), Leal Filho et al. (2019)
Mixed technologies - Recycling	Textile mixing process using different technologies. The recovered raw material is used to produce a polymer (in synthetic fibers) and is processed in the same product with similar quality	Technologies for tracking high-quality fibers, technologies for reducing textile waste during the recycling process	Recycling Companies / Global Retailer	Palm et al. (2014), Noman et al. (2013), Lund (1975)
Chemical recycling	Chemical process of transforming textile into fiber. The raw material is re-polymerized in a new textile with equal or superior material in quality	Technologies for tracking high-quality fibers, Technologies for reducing textile waste during the recycling process	Recycling Companies / Global Retailer	Palm et al. (2014), Noman et al. (2013)
Mechanical recycling	Mechanical process of polyester-based textiles cutted into small cuts, crushed, granulated and transformed into new filament fibers	Technologies for: (1) cutting and melting textiles (2) cleaning fibers, (3) reducing textile waste during the recycling process	Recycling Companies / Global Retailer	Palm et al. (2014), Paras and Pal (2018), Beh et al. (2016), Hu et al. (2014), Fraser (2011), Bukhari et al. (2018)
Special Techniques - Recycling	Activity that mixes textiles from different technologies where the recovered raw material is used to produce a polymer (in	Technologies for tracking high-quality fibers, Technologies for reducing textile waste during the recycling process	Recycling Companies / Global Retailer	Noman et al. (2013), Palm et al. 2014; Domina and Koch (1997), Larney and Van Aardt (2010),

Table 2 – Continued...

Practice	Brief practice's description	Practice's Resources	Practice's responsible	References
	synthetic fibers) and it is processed in the same product with similar quality			Bukhari et al. (2018), Lund (1975)

4.2 Analysis of garment's industry post-consumer textile waste management practices

Based on the practices defined in Table 3, an analysis of these practices was carried out using the criteria defined in Section 3.1. From a literature point of view, the intention is to analyze the practices identified in an environmental, economic and social perspective.

From the environmental analysis, collection (e.g. eco points) and reuse (e.g. thrift store) practices have a better performance. The problem with isolating the analysis only to eco points is that the activity is not self-sufficient. Being a middle activity, it makes the ecopoints depending on the final activity (usually reuse or recycling) who will actually define whether the negative environmental impact will be greater or not.

Table 4 presents the environmental analysis of the practices identified in the literature, in the context of the Circular Economy. The classification is subjective and defined from "---" to very disadvantageous to "+++" which indicates very beneficial compared to other practices.

Table 4 – Analysis of practices identified in the literature from environmental criteria

Criteria	CA1	CA2	CA3	CA4	CA5
Ecopoints	+++	+++	++	+	-
TriftStore/Flea Market	+	+	+++	+++	--
EPR	--	--	+++	---	+++
Manual Sorting	+++	-	+++	+	-
Semi-automated sorting	---	--	+++	-	+
Automatic Sorting	---	--	+++	-	+++
Restoration and remanufacturing	+	+	++	-	-
Downcycling	-	-	+++	-	---
Mixed technologies - Recycling	--	--	+	---	---
Chemical recycling	---	---	++	---	++
Mechanical recycling	-	-	---	---	---
Special Techniques - Recycling	-	-	++	---	---

Note: Electric energy consumption (CA1); Water consumption (CA2); Sufficiency of collected resources (CA3); Generation of final waste (CA4); Final item traceability (CA5).

Besides, recycling practices suffer mainly from disadvantages when considering water and energy consumption criteria. Currently, this is because the garment industry does not have technologies capable of recovering the textile with less water and energy during the process.

However, from economic criteria, recycling practices showed more benefits when compared to reuse practices. This is due to the fact that recycling practices are capable of handling larger volumes of textile waste. Table 5 presents the economic analysis of the practices identified in the literature, in the context of the Circular Economy.

As indicated in Table 5, reuse practices still lack technologies that enhance activities and facilitate processes that are mostly carried out manually. Those types of practices (reuse) demand a more qualified workforce and it makes the collection process (input of raw material) and the final product (reuse) more costly both from financial and production time's point of view.

Table 5 –Analysis of practices identified in the literature from economic criteria

Criteria	CE1	CE2	CE3	CE4	CE5	CE6	CE7
Ecopoints	-	+++	---	-	---	+++	++
TriftStore/Flea Market	---	---	---	--	---	--	++
EPR	---	--	+++	--	--	+++	---
Manual Sorting	---	---	---	-	+++	++	+++
Semi-automated sorting	--	--	++	---	+	+++	---
Automatic Sorting	-	--	+++	---	---	+++	---
Restoration and remanufacturing	---	---	---	-	++	+++	+++
Downcycling	---	---	---	-	--	--	--
Mixed technologies - Recycling	+	+++	+++	-	+++	+	--
Chemical recycling	-	++	+++	--	+++	+++	--
Mechanical recycling	+	++	+++	-	+++	+	+++
Special Techniques - Recycling	+	+	+++	--	+++	+	+++

Note: Cost of the highly qualified labor force (CE1); Flexibility in the application of financial, material and human resources (CE2); Technology involved (CE3); Transportation costs (CE4); Organization's self-sustainability (CE5); Capacity to treat textile waste; (CE6); Business maturity (CE7).

Another economical criteria observed is the cost of transportation. It was noticed that none of the practices has an advantage over the others in relation to this criteria. This is due the high complexity of actions involved during this process (Noman et al., 2013; Bukhari et al., 2018).

When analyzed under social criteria, all circular practices have shown that they need improvements in the context of worker health and safety criteria. As they are still in a reactive environment, the practices are more responsive to latent external demand (due to consumer pressure or public management) than necessarily improving their activities in a more controlled environment.

This process ends up making the adjustments also reactive, that is, extreme action must take place so that the necessary precautions are taken. This issue was widely seen in macro processes, such as EPR systems or municipal textile waste management, which encompass a larger number of employees. Studies in this area appear with greater intensity in the period between 2018 and 2019 (4 articles identified), proving to be an emerging concern.

The availability of participation by vulnerable groups also depends on the scope of the business. This is because there are practices that require more technical specialization (recycling practices). Usually, the participation of groups of vulnerable people occurs more in the collection stage, which allows inserting even associations of individual collectors, endowed with the necessary knowledge to perform a better screening.

Table 6 presents the social analysis of the practices identified in the literature, in the context of the Circular Economy.

Table 6 - Analysis of practices identified in the literature based on social criteria

Criteria	CS1	CS2	CS3
Ecopoints	+++	+++	-
TriftStore/Flea Market	+++	+++	---
EPR	+++	+++	---
Manual Sorting	+++	+++	-
Semi-automated sorting	+	+	+
Automatic Sorting	+	+	+
Restoration and remanufacturing	+++	+++	---
Downcycling	+++	+++	---

Mixed technologies - Recycling	++	---	--
Chemical recycling	++	---	--
Mechanical recycling	++	---	---
Special Techniques - Recycling	++	---	---

Note: Partnership with cooperatives, associations, and consortia (CS1); Availability of participation by vulnerable groups (CS2); Employee health and safety regulations (CS3).

In summary, the conceptual definition of the textile waste management practices in post-consumption allowed to conclude that although promoted as a new solution to the environmental problems of the garment industry, circularity is pulled mainly downstream. The practices identified are promoting approaches to the management of clothing short-term waste, while the initial links in the production chain continue to extract and use excessive amounts of non-renewable resources.

Although the circular economy is often seen as an environmental alternative superior to the linear economy model, it is necessary to understand that such practices depend on the contributions of various stakeholders to the business models. In this way, increasingly improving the current business model from managers and resources (especially technologies), allows studies to begin to leave the microstate of activities and include municipalities, regions, states, and so on.

5. CONCLUSION

Although the garment industry post-consumer waste management practices have been discussed as an alternative to changing the current linear model of extraction, production, and disposal of textile waste in the linear economy. Circular business models are still viewed uniquely, without taking into account the different dynamics between the different agents and resources existing in these processes.

Thus, it is concluded that that post-consumer textile waste has grown in importance in the clothing industry as it increases the frequency of purchase, the poor quality of clothing, and the reduction in price levels. In a circular context, this means a production and consumption's closed-cycle of textiles due to the reduced use of resources in production and through reuse (preferably) and recycling after the first cycle.

The literature also showed that practices for collection, sorting, and reinsertion of clothing items in post-consumption that adhered to the circular economy were mapped and organized. This identification aimed to answer the first objective of the research, having found eleven collection practices, three for sorting, five for reuse, and six for recycling.

It was also observed that the practices are not necessarily limited to a single step of textile waste management. This means that practices are viewed as a group of activities for textile waste management and not necessarily separated in collection, sorting, reuse or recycling.

Such practices were analyzed based on six environmental criteria, eight economic criteria, and three social criteria, all being found in the theoretical framework. Among them, the sufficiency of the collected resources, reduction in the generation of post-production waste, and the labor involved in the process stand out among other criteria.

Among recommendations of future studies, a replication of the same study in a practical way making an analysis solo or with clusters would contribute to understanding the real application in the garment market. Finally, measure the impact of the criteria identified quantitatively in a case study to assess whether waste management performance is really affected by criteria considered as priorities by the decision makers, being also an opportunity for future work.

REFERENCES

Akbar, S. and Ahsan, K. (2019), "Workplace safety compliance implementation challenges in apparel supplier firms", *Journal of Cleaner Production*, Vol. 232, No. 1, pp. 462-73.

Alencar, J.L.S., Simoni, J.H., Fiorelli, M.N. et al. (2015), "The environmental effects caused by solid waste industries clothing in Polo Fashion of Maringá-PR", *Revista Eletronica em Gestao Educacao e Tecnologia Ambiental*, Vol. 19, No. 3, pp. 478-504.

Allwood, J.M., Laursen, S.E., Russell, S.N. et al. (2006), *Well Dressed? The Present and Future Sustainability of Clothing and Textiles in the United kingdom*, University of Cambridge, Cambridge.

Agarwal, V. (2018), "Sustainable fashion education in changing world scenario", *European Journal of Sustainable Development*, Vol. 7, No. 1, pp. 365-73.

Bardin, L. (2010). *Análise de Conteúdo*, Actual, Lisboa.

Bech, N.M., Birkved, M., Charnley, F. et al. (2019), "Evaluating the environmental performance of a product/service-system business model for merino wool next-to-skin garments: the case of armadillo merino", *Sustainability*, Vol. 11, No. 20, pp. 2-21.

Beh, L.S., Ghobadian, A., He, Q. et al. (2016), "Second-life retailing: a reverse supply chain perspective", *Supply Chain Management*, Vol. 21, No. 2, pp. 259-72.

Binotto, C. and Payne, A. (2017), "The poetics of waste: contemporary fashion practice in the context of wastefulness", *Fashion Practice*, Vol. 9, No. 1, pp. 5-29.

Bly, S., Gwozdz, W. and Reisch, L.A. (2015), "Exit from the high street: an exploratory study of sustainable fashion consumption pioneers", *International Journal of Consumer Studies*, Vol. 39, No. 2, pp. 125-35.

Brace-Govan, J. and Binay, I. (2010), "Consumption of disposed goods for moral identities: a nexus of organization, place, things and consumers", *Journal of Consumer Behaviour*, Vol. 9, No. 1, pp. 69-82.

Bray, A. (2017), "Creating a slow fashion collection – a designer–maker's process", *Scope*, Vol. 15, No. 1, pp. 29-35.

Bukhari, M.A., Carrasco-Gallego, R. and Ponce-Cueto, E. (2018), "Developing a national programme for textiles and clothing recovery", *Waste Management & Research*, Vol. 36, No. 4, pp. 321-31.

Burton, K. (2018), Reducing textile waste in the apparel industry: examining epr as an option, "*Clothing cultures*", Vol. 5, No.1, pp. 33-45.

Carpus, E., Visileanu, E. and Scarlat, R. (2008), "Ecological management for textile wastes processing", *Environmental Engineering and Management Journal*, Vol. 7, No. 1, pp. 51-5.

Choo, H.J., Sim, S.Y., Lee, H.K. et al. (2014), "The effect of consumers' involvement and innovativeness on the utilization of fashion wardrobe", *International Journal of Consumer Studies*, Vol. 38, No. 2, pp. 175-82.

Dabija, D.C., Cheben, J. and Lancaric, D. (2017), "Cross-cultural investigation of consumers' generations attitudes towards purchase of environmentally friendly products in apparel retail", *Studies in Business and Economics*, Vol. 12, No. 3, pp. 27-42.

Deo, Z. (2018), "Case study: swat valley guild peace-building initiative and artisan enterprise for community empowerment and sustainable development", *Clothing Cultures*, Vol. 5, No. 1, pp. 167-75.

Dissanayake, G., Sinha, P. (2015). An examination of the product development process for fashion remanufacturing, "*Resources, Conservation and Recycling*", Vol. 104(A), pp. 94-102.

Domina, T. and Koch, K. (1997), "The textile waste lifecycle", *Clothing and Textiles Research Journal*, Vol. 15, No. 2, pp. 96-102.

Durrani, M. (2017), "People gather for stranger things, so why not this? Learning sustainable sensibilities through communal garment-mending practices", *Sustainability*, Vol. 10, No. 7, pp. 2018.

Ellen MacArthur Foundation (2017), "A New textiles economy: Redesigning Fashion's future. Geneva", *MacArthur Foundation*, Vol. 1, No. 1, pp. 150.

Enes, E. and Kipöz, S. (2019), Turkey fashion industry's cut-and-sew waste problem and its waste management strategies", *Tekstil ve Muhendis*, Vol. 26, No. 113, pp. 97-103.

Erdil, A. and Taçgin, E. (2018), "Potential risks and their analysis of the apparel & textile industry in turkey: a quality-oriented sustainability approach", *Fibres & Textiles in Eastern Europe*, Vol. 26, No. 6, pp. 30-42.

Esteve-Turrillas, F.A. and De-La-Guardia, M. (2017), "Environmental impact of recover cotton in textile industry", *Resources, Conservation and Recycling*, Vol. 116, No. 1, pp. 107-15.

Franco, M.A. (2017), "Circular economy at the micro level: a dynamic view of incumbents' struggles and challenges in the textile industry", *Journal of Cleaner Production*, Vol. 168, No. 1, pp. 833-45.

Fraser, K. (2011), "Refashioning new zealand: a practitioner's reflection on fast fashion implications", *International Journal of Environmental, Cultural, Economic and Social Sustainability*, Vol. 7, No. 1, pp. 275-84.

Garza-Reys, J.A. (2015), "Lean and green – a systematic review of the state of the art literature", *Journal of Cleaner Production*, Vol. 102, pp. 18-29.

Geissdoerfer, M., Savaget, P., Bocken, N. et al. (2017), "The circular economy – a new sustainability paradigm?", *Journal of Cleaner Production*, Vol. 143, No. 1, pp. 757-68.

Gopalakrishnan, S. and Matthews, D. (2018), "Collaborative consumption: a business model analysis of second-hand fashion", *Journal of Fashion Marketing and Management*, Vol. 33, No. 2, pp. 354-68.

Govindan, K. and Hasanagic, M. (2018), "A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective", *International Journal of Production Research*, Vol. 56, No. 1-2, pp. 278-311.

Han, S.L.C., Chan, P.Y.L., Benkatraman, P. et al. (2017), "Standard vs. Upcycled fashion design and production", *Fashion Practice*, Vol. 9, No. 1, pp. 69-94.

Hu, Z.H., Li, Q., Chen, X.J. et al. (2014), "Sustainable rent-based closed-loop supply chain for fashion products", *Sustainability*, Vol. 6, No. 10, pp. 7063-88.

Hvass, K.K. (2014), "Post-retail responsibility of garments – a fashion industry perspective", *Journal of Fashion Marketing and Management*, Vol. 18, No. 4, pp. 413-30.

James, A.M., Roberts, B.M. and Kuznia, A. (2016), "Transforming the sequential process of fashion production: where zero-waste pattern cutting takes the lead in creative design", *International Journal of Fashion Design, Technology and Education*, Vol. 9, No. 2, pp. 142-52.

Jung, S. and Jin, B. (2014), "A theoretical investigation of slow fashion: sustainable future of the apparel industry", *International Journal of Consumer Studies*, Vol. 38, No. 5, pp. 510-9.

Keith, S. and Silies, M. (2015), "New life luxury: upcycled scottish heritage textiles", *International Journal of Retail & Distribution Management*, Vol. 43, No. 10, pp. 1051-64.

Khan, M.H. (2019), "Knowledge, skills and organizational capabilities for structural transformation", *Structural Change and Economic Dynamics*, Vol. 48, No. 1, pp. 42-52.

Kim, S.Y. (2019), "Beauty and the waste: fashioning idols and the ethics of recycling in korean pop music videos", *Fashion Theory*

Larney, M. and Van Aardt, A.M. (2010), "Case study: apparel industry waste management: a focus on recycling in south africa", *Waste Management & Research*, Vol. 28, No. 1, pp. 36-43.

Larsson, J.K.J. (2018), "Digital innovation for sustainable apparel systems: experiences based on projects in textile value chain development", *Research Journal of Textile and Apparel*, Vol. 22, No. 4, pp. 370-89.

Leal-Filho, W., Ellams, D., Han, S. et al. (2019), "A review of the socio-economic advantages of textile recycling", *Journal of Cleaner Production*, Vol. 218, No. 1, pp. 10-20.

Lund, G. (1975), "Recycling in the garment industry", *R & D Management*, Vol. 5, No. 2, pp. 167-70.

Marques, A.D., Moreira, B., Cunha, J. et al. (2019), "From waste to fashion – a fashion upcycling contest", *Procedia CIRP*, Vol. 84, No. 1, pp. 1063-8.

Marudhamuthu, R. and Krishnaswamy, M. (2011), "The development of green environment through lean implementation in a garment industry", *Journal of Engineering and Applied Sciences (Asian Research Publishing Network)*, Vol. 6, No. 9, pp. 104-11.

McNeill, L.S. and Snowdon, J. (2019), "Slow fashion – balancing the conscious retail model within the fashion marketplace", *Australasian Marketing Journal*, Vol. 27, No. 4, pp. 215-23.

McQueen, R.H., Batcheller, J.C., Lori, J.M. et al. (2017), "Reducing laundering frequency to prolong the life of denim jeans", *International Journal of Consumer Studies*, Vol. 41, No. 1, pp. 36-45.

Méjias, A.M., Bellas, R., Pardo, J.E. et al. (2019), "Traceability management systems and capacity building as new approaches for improving sustainability in the fashion multi-tier supply chain", *International Journal of Production Economics*, Vol. 217, No. 1, pp. 143-58.

Momberg, D., Jacobs, B. and Sonnenberg, N. (2012), "The role of environmental knowledge in young female consumers' evaluation and selection of apparel in south africa", *International Journal of Consumer Studies*, Vol. 36, No. 4, pp. 408-15.

Nayak, R., Akbari, M. and Maleki, S. (2019), "Recent sustainable trends in vietnam's fashion supply chain", *Journal of Cleaner Production*, Vol. 225, No. 1, pp. 291-303.

Noman, M., Batool, S.A. and Chaudhary, M.N. (2013), "Economic and employment potential in textile waste management of faisalabad", *Waste Management & Research*, Vol. 31, No. 5, pp. 485-93.

Norris, L. (2019), "Waste, dirt and desire: Fashioning narratives of material regeneration", *The Sociological Review*, Vol. 14, No. 1, pp. 453-66.

Ozgunay, H., Colak, S.M., Mutlu, M.M. et al. (2007), "Characterization of leather industry wastes", *Polish Journal of Environmental Studies*, Vol. 16, No. 6, pp. 867-73.

Pal, R. and Gander, J. (2018), "Modelling environmental value: an examination of sustainable business models within countries", *International Journal of Advanced Manufacturing Technology*, Vol. 94, No. 1, pp. 191-201.

Palomo-Lovinski, N. and Hahn, K. (2014), "Fashion design industry impressions of current sustainable practices", Fashion Practice-the Journal of Design Creative Process & the Fashion Industry, Vol. 6, No. 1, pp. 87-106.

Palm, D., Elander, M., Watson, D. et al. (2014), "Towards a nordic textile strategy: collection, sorting, reuse and recycling of textiles", Norden, Copenhagen, pp. 145.

Paras, M.K. and Pal, R. (2018), "Application of Markov chain for LCA: a study on the clothes 'reuse' in Nordic countries", *International Journal of Advanced Manufacturing Technology*, Vol. 94, No. 1-4, pp. 191-201.

Park, C., Tantiyaswasdikul, K. & Evans, S. (2019), "Innovation catalysts for industrial waste challenges: sri lankan and thai cases", *Procedia Manufacturing*, Vol. 33, No. 1, pp. 570-7.

Pedersen, E.R., Hvass, K.K. (2019), "Toward circular economy of fashion: experiences from a brand's product take-back initiative", *Journal of Fashion Marketing and Management*, Vol. 27, No. 1, pp. 55-67.

Power, E.J. (2012), "Sustainable developments in knitting", *International Journal of Business and Globalisation*, Vol. 9, No. 1, pp. 1-11.

Ritch, E.L. (2015), "Consumers interpreting sustainability: moving beyond food to fashion", *International Journal of Retail & Distribution Management*, Vol. 43, No. 12, pp. 1162-79.

Saikia, P., Goswami, D., Dutta, D. et al. (2017), "Development of a flexible composite from leather industry waste and evaluation of their physico-chemical properties", *Clean Technologies and Environmental Policy*, Vol. 19, No. 8, pp. 2171-8.

Savageau, A. E. (2011). "Textile waste and sustainability: a case study", *Research Journal of Textile and Apparel*, Vol. 15, No. 1, pp. 58-65.

Staicu, D. and Pop, O. (2018), "Mapping the interactions between the stakeholders of the circular economy ecosystem applied to the textile and apparel sector in Romania", *Management and Marketing*, Vol. 13, No. 4, pp. 1190-209.

Subic, A., Shabani, B., Hedayati, M. et al. (2013), "Performance analysis of the capability assessment tool for sustainable manufacturing", *Sustainability*, Vol. 5, No. 8, pp. 3543-61.

Sugiura, M. (2019), "The mass consumption of refashioned clothes: Re-dyed kimono in post war Japan", *Business History*, Vol. 61, No. 1, pp. 106-21.

Telli, A. and Özdil, N. (2015), "Effect of recycled PET fibers on the performance properties of knitted fabrics", *Journal of Engineered Fibers and Fabrics*, Vol. 10, No. 2, pp. 47-60.

Teng, S.G. and Jaramillo, H. (2005), "Linking tactical and operational decision-making to strengthen textile/apparel supply chains", *International Journal of Logistics Systems and Management*, Vol. 1, No. 2-3, pp. 244-66.

Ütebay, B. and Çelik, A. (2019), "Effects of cotton textile waste properties on recycled fibre quality", *Journal of Cleaner Production*, Vol. 222, No. 1, pp. 29-35.

Vehmas, K., Raudaskoski, A., Heikkilä, P. et al. (2018), "Consumer attitudes and communication in circular fashion", *Journal of Fashion Marketing and Management*, Vol. 22, No. 3, pp. 286-300.

Yang, Y., Han, H. and Lee, P.K.C. (2017), "An exploratory study of the mechanism of sustainable value creation in the luxury fashion industry", *Sustainability*, Vol. 9, No. 4, pp. 1-16.

Yasin, R.M. (2017), "Petit Pli: clothes that grow", *Utopian Studies*, Vol. 28, No. 3, pp. 576-84.

Wang, H., Liu, H., Kim, J.S. et al. (2019), "Sustainable fashion index model and its implication", *Journal of Business Research*, Vol. 99, No. 1, pp. 430-7.

Wang, Z., Yao, Z., Zhou, J. et al. (2019), "Improvement of polylactic acid film properties through the addition of cellulose nanocrystals isolated from waste cotton cloth", *International Journal of Biological Macromolecules*, Vol. 129, pp. 878-86.

Author contributions: Pedro Seolin dos Santos: data collection, writing, developing the method, analysis. Lucila Maria de Souza Campos: writing, analysis and revision.