

ASSESSMENT OF THE DEVELOPMENT STAGE OF THE REVERSE SUPPLY CHAIN IN THE BRAZILIAN TEXTILE INDUSTRY: A LITERATURE-BASED PERSPECTIVE

1 INTRODUCTION

Population growth drives consumption to levels that threaten available resources (Dursun; Ulker; Gunalay, 2023). Consequently, the textile industry stands out for its economic relevance, producing 100 billion pieces globally, of which 33% are discarded within the first year of use (Monash University, 2021). In Brazil, the textile industry is the second largest employer within the manufacturing sector (1.36 million direct jobs) and one of the four largest global producers (ABIT, 2024). However, in 2018 only 20% of textile waste received proper disposal, compared to 4 million tons discarded annually (Amaral et al., 2018; Abrelpe, 2022).

Adapting to sustainable standards is essential, and the transition to circular models requires technological innovation and supply chain integration (Jena; Sarmah, 2014). The Reverse Supply Chain (RSC) is a strategic mechanism for reintegrating waste into the production cycle, demanding a systemic and competitive approach (Das; Posinasetti, 2015; Elia; Gnoni, 2015). Accordingly, this study aims to assess the degree of development of the textile RSC in Brazil, based on a previously established theoretical framework.

2 THEORETICAL FOUNDATION

Textile waste can be classified as pre-consumer, post-consumer, and post-industrial. The first arises during production and includes fabric scraps and defective products; post-consumer waste is generated after use; and post-industrial waste results from sectors that use textiles as inputs, such as medical and automotive industries (Tomovska, 2017). Because textiles are composed of diverse materials, they decompose slowly, requiring recovery processes to reduce environmental and social impacts (Parajuly, 2017). In addition, the textile supply chain (SC) generates other negative effects, such as climate change, chemical pollution, biodiversity loss, and risks to human health (Fletcher; Grose, 2011).

Thus, the textile industry must align itself with Sustainable Development (SD) and the Circular Economy (CE), which seeks to keep materials in circulation through maintenance, reuse, remanufacturing, and recycling while addressing challenges such as waste, pollution, and the use of finite resources. However, SC research still tends to privilege tangible processes and gives little recognition to the role of relationships in advancing sustainability (Ashby et al., 2012). The textile SC is long and complex, encompassing both forward and reverse flows, and despite market volatility in emerging economies, it is necessary to make the Forward Supply Chain (FSC) more sustainable (Lin et al., 2023). To achieve this model, recovery and proper disposal practices should be integrated throughout the SC.

In this context, the Circular Supply Chain (CSC) model is adopted, formed by the integration of FSC and RSC, to maximize resource utilization in opened or closed loops (Batista et al., 2018). In contrast to linear SC based on “extraction, production, consumption, and disposal,” closed-loop systems support effective waste management, recycling, remanufacturing, and reuse.

3 METHODOLOGY

To achieve the proposed objective, the study considered a literature survey on stakeholders, activities and practices (operational and strategic), supporting strategies, technologies, concepts, principles, and circularity guidelines that influence the RSC. A Systematic Literature Review (SLR) was conducted following Tranfield et al. (2003),

comprising the following stages: Pilot review, Protocol development, Article selection, Data extraction, and Results analysis. The Pilot review tested search terms; Protocol development defined inclusion and exclusion criteria as well as research questions; and Extraction stage selected only studies related to the research objective and provided the dataset for this study.

Based on the SLR, and with the purpose of assessing the development level of the textile RSC in Brazil, a multi-case analysis of Reverse Logistics (RL) initiatives with publicly available information focused on the textile industry was also carried out. This stage was guided by the method proposed by Yin (2010), namely: Planning, Design, Preparation, Data collection, Analysis, and Conclusions. The planning phase defined objectives and methodological relevance; Design phase selected cases and hypotheses; Preparation elaborated the protocol and a pilot case; Data collection phase used multiple sources (observation, documents, and online records), allowing for triangulation; Analysis phase compared patterns and theoretical propositions; and Conclusion phase discussed limitations and contributions.

Brazilian private initiatives that manage post-consumer textile waste and contribute to structuring the textile RSC were selected. The evaluation, based on secondary data (websites, reports, and publications), described processes, partners, and components. These data were confronted with the SLR in order to assess the alignment between the State of the Art and the State of Practice, thereby indicating the current stage of development and research gaps. It is worth noting that the survey was not exhaustive, and other initiatives may exist that were not included in this research.

3 ANALYSIS AND DISCUSSION OF THE RESULTS

The components identified in the SLR are presented below. These components encompass stakeholders, operational and strategic activities and practices, supporting strategies, technologies, concepts, principles, and circularity guidelines that influence the functioning of the textile RSC. For clarity, the components were grouped into categories, and their corresponding information is presented in Tables 1 and 2.

Table 1 – Categories of stakeholders in the textile RSC identified in the literature

Categories	SC	Stakeholders	References*
Consumers	FSC/ RSC	Consumer; Customer; Society; Communitie; Media	24; 35; 4; 30; 23; 3; 20; 2; 11; 19; 27; 25; 18; 32; 17; 15; 28; 31; 1; 7; 14; 33; 29; 8; 16; 6; 21; 13; 5; 34; 9; 22; 26
Repairers	RSC	Repair services; Seamstress	22; 24; 11; 19; 31; 7; 33; 13
Reusers	RSC	Resale sites; Flea markets; Second-hand clothes stores	24; 20; 12; 32; 31; 16; 34; 21; 23; 22; 11; 25; 28; 7 ;5
		Rental companies; Rental platforms; Clothing library	7; 13; 22; 12; 31; 16
		Charities; Charitable associations/organizations; Commercial clothing reuse companies	31; 16; 27; 5; 24; 11; 12; 19; 1; 7; 34; 20; 21; 13; 35
Voluntary Drop-off Points (VDP)	RSC	Voluntary Drop-off Points	11
Collectors	RSC	Collection companies; Collectors; Waste pickers; Waste picker cooperatives; Collection centers	14; 5; 18; 20; 32; 17; 33; 13; 28
Logistics operator/ Transporter	RSC	Waste exporters	5
Processors	RSC	Cooperativas de separadores; Separadores; Empresas de triagem; Centro de coleta; Catadores	11; 13; 10; 28; 31; 33
NGOs	RSC	NGOs; Social enterprises; Sustainable organizations; Activists	11; 15; 22; 31; 7; 8; 26; 19; 28; 24; 35; 27; 13
Waste managers	RSC	Waste management companies; Waste vendors	19; 27; 26; 9; 7; 32; 20; 28
Remanufacturers	RSC	Upcyclings; Entrepreneurs; Reuse companies; Upcycling companies; Designer	20; 27; 28; 6; 31; 30; 11; 19; 18; 17; 15; 7; 14; 34
		Remanufacturers	19
Recyclers	RSC	Recyclers; Recycling organizations; Recycling companies	3; 20; 11; 19; 27; 18; 32; 17; 28; 29; 5; 15
Other FSC	FSC/ RSC	Brick industry; Cement industry	28; 32

	RSC		
Landfill/Incinerator Operators	RSC	Landfill; Incinerators	4; 23; 5; 19; 25; 10; 32; 17; 28; 31; 1; 33; 29; 8; 16; 6; 13; 21
Government	FSC/RSC	Government/ Authorities; Policy makers	35; 20; 11; 19; 27; 18; 9; 17; 15; 28; 22; 31; 7; 33; 8; 16; 13; 26; 24; 30; 23; 12; 32; 1
Researchers and Technology Developers	FSC/RSC	Academy; International industry and research consortia; Technology developers	35; 30; 20; 19; 12; 27; 1; 13; 26; 28; 17
Creditors	FSC/RSC	Investors; Financial institutions	30; 13

*Reference Code: 1 - Abdallah *et al.* (2024); 2 - Abdelmeguid *et al.* (2024); 3 - Adenle; Haideri; Sandouka (2024); 4 - Ashby (2018); 5 - Boschmeier; Ipsmiller; Bartl (2024); 6 - Choudhury; Tsianou; Alexandridis (2024); 7 - Degenstein *et al.* (2023); 8 - Dhiwar; Bedarkar (2024); 9 - Dursun; Ulker; Gunalay (2023); 10 - Edirisinghe *et al.* (2024); 11 - Ermini; Visintin; Boffelli (2024); 12 - Ghoreishi; Bhandari; Franconi (2022); 13 - Gomes *et al.* (2023); 14 - Han *et al.* (2017); 15 - Härrri; Levänen (2024); 16 - Juanga-Labayen; Labayen; Yuan (2022); 17 - Kayikci *et al.* (2022); 18 - Kazancoglu *et al.* (2022); 19 - Khan; Wang; Padhye (2023); 20 - Kim; Wu (2021); 21 - Moazzem *et al.* (2022); 22 - Neto *et al.* (2024); 23 - Patwary *et al.* (2023); 24 - Pera; Ferrulli (2024); 25 - Ranjan *et al.* (2024); 26 - Rumanti *et al.* (2021); 27 - Singh *et al.* (2019); 28 - Sinha *et al.* (2022); 29 - Solis *et al.* (2024); 30 - Staicu; Pop (2018); 31 - Staicu (2019); 32 - Tang (2023); 33 - Teixeira *et al.* (2023); 34 - Vehmas *et al.* (2018); 35 - Yadav; Majumdar (2024).

Source: Authors (2025).

Table 2 – Categories of other components of the textile RSC identified in the literature

Categories	Others Components	References*
Reverse Logistics	Extended Producer Responsibility; Collection and Sorting; Take-back Systems; Post-consumer Waste Separation; Source Separation; Reverse Logistics Systems	11; 16; 28; 7; 29; 32; 1; 6; 12; 14; 19; 5; 33; 34; 35; 21; 3; 4; 17
Recovery	Redesign; Wallet Manufacturing; Slipper/Shoe Manufacturing; Trashion; Circular Economy; Repair and Alteration; Donation; Sale/Resale; Second-hand Markets; Remanufacturing; Fiber Reprocessing; Recycling; Mechanical Recycling; Thermal Recycling; Biochemical Recycling; Chemical Recycling; Enzymatic Recycling; Pellet Production (Polyester and Nylon); Enzymatic Hydrolysis of Cotton/Polyester; Upcycling; Downcycling; Reuse; Reuse; Use as Carpet Padding; Use as Acoustic Insulation; Polymer Conversion / Polymer Production; Felt Production; Industrial Cleaners; Disposable Diaper Manufacturing; Napkin Production; Recycled Fiber Production; Geotextile Production; Mechanical Separation; Gasification; Composting; Anaerobic Digestion	24; 2; 7; 23; 22; 21; 33; 34; 30; 17; 8; 6; 13; 4; 11; 19; 3; 25; 12; 28; 31; 1; 16; 32; 9; 15; 5; 27; 10; 35; 29; 14; 6
Final Disposal	Export of waste; Incineration; Landfill; Waste management; Environmentally friendly disposal practices	5; 28; 31; 16; 6; 21; 24; 30; 23; 12; 25; 9; 14; 22; 7; 29; 13; 4; 10; 3; 26; 1
General	Consumer/stakeholder education/ awareness; Buying ecologically conscious and environmental preferable clothing; 4Rs; Subscription plan; Renting clothes; Policies; Government incentives	11; 32; 9; 5; 28; 22; 7; 14; 8; 13; 30; 23; 3; 33; 2; 31; 16

*Reference Code: 1 - Abdallah *et al.* (2024); 2 - Abdelmeguid *et al.* (2024); 3 - Adenle; Haideri; Sandouka (2024); 4 - Ashby (2018); 5 - Boschmeier; Ipsmiller; Bartl (2024); 6 - Choudhury; Tsianou; Alexandridis (2024); 7 - Degenstein *et al.* (2023); 8 - Dhiwar; Bedarkar (2024); 9 - Dursun; Ulker; Gunalay (2023); 10 - Edirisinghe *et al.* (2024); 11 - Ermini; Visintin; Boffelli (2024); 12 - Ghoreishi; Bhandari; Franconi (2022); 13 - Gomes *et al.* (2023); 14 - Han *et al.* (2017); 15 - Härrri; Levänen (2024); 16 - Juanga-Labayen; Labayen; Yuan (2022); 17 - Kayikci *et al.* (2022); 18 - Kazancoglu *et al.* (2022); 19 - Khan; Wang; Padhye (2023); 20 - Kim; Wu (2021); 21 - Moazzem *et al.* (2022); 22 - Neto *et al.* (2024); 23 - Patwary *et al.* (2023); 24 - Pera; Ferrulli (2024); 25 - Ranjan *et al.* (2024); 26 - Rumanti *et al.* (2021); 27 - Singh *et al.* (2019); 28 - Sinha *et al.* (2022); 29 - Solis *et al.* (2024); 30 - Staicu; Pop (2018); 31 - Staicu (2019); 32 - Tang (2023); 33 - Teixeira *et al.* (2023); 34 - Vehmas *et al.* (2018); 35 - Yadav; Majumdar (2024).

Source: Authors (2025).

In the multi-case analysis, five real-world contexts were examined: three large retailers and two companies that use textile waste as an input. This analysis allowed for the assessment of alignment between the literature and the practice of the textile RSC in Brazil, as well as the identification of gaps. The information, presented in Table 3, was obtained from company websites, social media, and reports.

The multi-case analysis confirmed the centrality of the Consumer, who is present in all programs analyzed; retailers frequently offer discounts or incentives to encourage their

participation. Voluntary Drop-off Points (VDP) prove essential for structuring collection networks, engaging the public, and generating socio-environmental indicators.

Table 3 – Selected cases, their descriptions, and the validated stakeholders

Case	Description	Identified Stakeholders
Case 1	Launched in 2017, it collected 114 tons of clothing, directing 217,000 items for reuse, 98,000 for recycling, and 35,000 to the Circular Jeans program (C&A, 2025). It uses VDPs for collection, with its own sorting system: items in good condition are sent to social institutions, while the remaining items are sent to Retalhar.	Consumers; Reusers; VDP; Sorters; Recyclers
Case 2	Created in 2011 for packaging and expanded in 2017 to include clothing, it collected 56.8 tons of waste (Renner, 2024). The VDPs receive the items, which are sorted by an unidentified partner responsible for reuse and recycling.	Consumers; VDP; Recyclers
Case 3	Since 2014, it has collected post-consumer denim, recovering 10,000 items and launching a collection made with pre- and post-consumer fibers (YouCom, 2023). The denim is defibered and refibered into new items. The initiative is limited to denim.	Consumers; VDP; Recyclers
Case 4	Founded in 2018, it operates with its own and partner VDPs, collects items, conducts sorting in partnership (Case 5), and recycles denim and twill in a partner factory. It has produced 820,000 items with recycled fiber and 81,000 upcycled products (Cotton Move, n.d.).	Consumers; VDP; Recyclers
Case 5	A company specialized in textile waste, it conducts sorting with cooperatives, engages in upcycling and recycling, and uses excess material as co-fuel. It has already repurposed 600,000 kg of uniforms (Retalhar, n.d.). The initiative includes marginalized groups, promoting socio-economic inclusion.	Consumers; Repairers; Reusers; VDP; Sorters; Remanufacturers; Recyclers; Other FSC

Source: Authors (2025).

As for Recyclers, they are also central stakeholders, enabling the closing of the loop by reinserting waste into new products, which reduces disposal, resource extraction, and environmental impacts. In this way, companies that adopt such practices strengthen their sustainability and respond to the growing demand for models aligned with the CE.

The multi-case analysis also identified stakeholders already engaged in the Brazilian textile RSC. However, several categories present in the SLR were absent, including Collectors, Logistics Operators/Transporters, NGOs, Waste Managers, Landfill/Incinerator Operators, Government, Wholesalers, Researchers and Technology Developers, Creditors, etc. This gap may result either from the lack of mention in the evaluated programs or from the limited scope of initiatives. Nevertheless, the findings suggest that the Brazilian textile RSC, in its current configuration, is more restricted than the model derived from the literature. The absence of Collectors, for example, may indicate a lack of selective textile collection programs.

Although textile waste recycling exists (as in the cases 1, 2, 3, and 4), Recyclers are not always formally recognized as part of the RSC. In one of the cases, a company self-identified as a Waste Manager is treated by partners as a Recycler, revealing terminological imprecision. Moreover, the absence of specific regulations governing post-consumer textile reverse logistics helps explain these inconsistencies, as the responsibility for disposal continues to rest primarily with the Consumer. Another critical point is the lack of a stakeholder foreseen in other RL chains and already regulated in Brazil as in WEEE (Brazil, 2020), aluminum cans (Brazil, 2022), and pesticide packaging (Brazil, 2002), the Producer Responsibility Organization (PRO), responsible for the total management of the RSC according to Extended Producer Responsibility (EPR) principles (D'Ávila et al., 2025).

These gaps indicate a lack of political engagement and insufficient investments aimed at expanding the recovery of different types of textiles, as some initiatives are limited to denim. In this context, adopting hybrid collection models and mobilizing producers (through mandatory legislation or economic incentives) could enhance the efficiency of the textile RSC.

Based on Table 2, it can be observed that RL category exhibits a good coverage of the components identified in the literature. However, the components related to recovery and the “Other” category encompass only a portion of the existing alternatives. Furthermore, the cases

analyzed do not specify final disposal methods, merely stating that the waste are managed in an environmentally appropriate manner.

Table 4 – Validation of other components through the multi-case analysis

Categories	Others Components	Case 1	Case 2	Case 3	Case 4	Case 5
Reverse Logistics	Collection and Sorting; Take-back Systems; Post-consumer Waste Segregation; RL; Source Segregation	✓	✓	✓	✓	✓
Recovery	Donation; Mechanical Recycling; Fiber Reprocessing; Production of New Garments; Upcycling; Reuse; Remanufacturing; Energy Co-processing	✓	✓	✓	✓	✓
Final Disposal	-	✓	✓			
Other	Textile Fiber Recycling; Recycled Fabric Production			✓	✓	✓

Source: Authors (2025).

In cases where no mention is made, it is assumed that all collected waste is reused, an ideal scenario for circularity. The reported components cover industrial and post-consumer waste, with a focus on recycling to create new products and products reintegrated into the consumption cycle. Although the cases show good alignment with the literature, they employ a limited number of recovery alternatives, possibly due to resource or technological constraints. The literature identifies 54 components, but only 15 were observed in the cases, revealing that the State of Practice in Brazil remains underdeveloped compared to the State of the Art.

4 FINAL CONSIDERATIONS

The results indicate the participation of multiple stakeholders is essential for structuring the textile RSC, as each actor can play a strategic role in RL, recovery, and disposal of end-of-life materials, contributing to the mitigation of environmental impacts. However, factors such as lack of financial incentives, regulatory gaps, and low consumer awareness limit the expansion of the RSC. Integration between stakeholders and textile industry is indispensable. The literature highlights that most of the additional components are related to recycling, eco-design, use of recyclable materials, and CE, that are critical to reduce consum of raw materials.

The multi-case analysis validated 8 out of 16 stakeholders and 15 out of 54 RSC components identified. Although the Brazilian textile RSC includes key stakeholders, its scope proved limited compared to what was reported in the literature. The identification of only 27.8% of the other components reveals technological and knowledge gaps, confirming the Brazilian State of Practice remains far from the State of the Art (Literature).

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