



HAL
open science

Sustainability in Fabric Chains and Garments for a Circular Economy

Solimar Garcia, Irenilza De Alencar Naas, Pedro Oliveira Costa Neto, João Reis, Valdice Neves Pólvora, Luiz Lima, Angel Martinez, Vanessa Santos Lessa

► **To cite this version:**

Solimar Garcia, Irenilza De Alencar Naas, Pedro Oliveira Costa Neto, João Reis, Valdice Neves Pólvora, et al.. Sustainability in Fabric Chains and Garments for a Circular Economy. IFIP International Conference on Advances in Production Management Systems (APMS), Aug 2020, Novi Sad, Serbia. pp.531-537, 10.1007/978-3-030-57993-7_60 . hal-03630866

HAL Id: hal-03630866

<https://inria.hal.science/hal-03630866>

Submitted on 5 Apr 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

Sustainability in fabric chains and garments for a circular economy

Solimar Garcia¹[0000-0002-5807-8041], Irenilza de Alencar Nääs¹[0000-0003-0663-9377], Pedro Luiz de Oliveira Costa Neto¹[000-0002-6987-2996], João Gilberto Mendes dos Reis¹[0000-0001-6409-2299], Valdice Neves Pólvara¹[0000-0002-5157-0201], Luiz Antonio de Lima¹[0000-0003-4228-238], Angel Antonio Gonzalez Martinez¹[0000-0003-1012-9812], Vanessa Santos Lessa²[0000-0003-4062-5462].

¹ Paulista University, São Paulo, Brazil

² Mackenzie Universitie, São Paulo, Brazil
solimar.garcia@docente.unip.br

Abstract. The society has been driven to create parameters for sustainable development and to transposition into the circular economy. Sustainability strategies were assessed in fabric value chain and clothing. To discuss this subject, we analyzed the results found using the information published in the current literature about sustainability in the textile chain. The results indicate that the fabric and clothing production chain needs to expand sustainable practices, such as selective collection, reuse, recycling, and proper disposal of textile waste, and to improve the population's awareness of the theme, one of the obstacles to sustainability. The adoption of recycling will be a qualitative leap for the circular economy in the studied business chains and will just happen when education becomes a priority. The results show it is urgent to change the paradigm in society in order to enter a circular and sustainable economy.

Keywords: Textile residue, waste textile, reverse logistics.

1 Introduction

Society, in general, seeks new forms of development, which contributes to reducing and limiting the use of natural resources, contemplating three pillars of sustainability, or the triple bottom line (TBL): profit, environment, and society, proposed by Elkington in 1997 [17], with the maintaining of the natural resources, and seek activities that can lead to a circular economy in advances of industry 4.0.

In Brazil, the National Solid Waste Policy (PNRS), introduced by Law No. 12.305/2010, led to responsibility for the proper disposal of waste to companies[11] and implemented reverse logistics for some segments, including agrochemicals, tires, and batteries. The daily production of garbage is estimated at 10 million tons, two billion tons per year [32]. Brazilians produced 215,000 t/day of waste [5]. Data from 2018 show that the damage reaches US\$ 40 billion per year, with recycling reaching only 3% of the 80 million tons of annual wastes [9].

On the other hand, one of the largest generators of waste and environmental pollution is the textile and garment chain. In the world, textile production, cotton or synthetic, moves US \$ 797 billion [4]. The fabrics and apparel textile industry as an essential segment in the Brazilian economy, which is amongst the five most significant in the world, and produced US\$ 48 billion in 2019, representing 8% of the Brazilian GDP [2].

The destination of waste from the textile and clothing industry is part of the complexity and difficulty of bringing sustainability to the supply chain. In Brazil, these numbers are diffuse, and no agency has specific information on reuse and recycling of textiles [36]. This waste is considered with the total number of urban waste in Brazilian standard NBR 10.004 [6].

In addition to the chemicals used in textile production, there is also the aggravating factor of fast fashion, these low prices products, which generate excessive consumption and waste. The reuse of textile waste and discarded clothing can reduce the negative impact on the textile chain; however, reverse logistics is still insipient in the segment. It is also necessary to recycle and reuse fabrics in the production phase or collection of clothes discarded by the consumer, since the disposal is done incorrectly and without care for the environment.

There is no information about the waste generated by the disposal of clothes done by the final consumer, and that can be recycled. The recycling and reuse industry, part of reverse logistics and the circular economy, can generate 1.8 trillion euros by 2030 [29].

There are still few companies that work with the recycling of fabrics, reuse of production residues, and discarded clothes. These activities are carried out by handicraft and charity initiatives, which involve an inexpressive result. Indeed, Brazil imports fabric waste, because the recycling does not have the quality to be used for the companies of that segment.

Therefore, the research question is: how to bring sustainability to the textile chain and put it on the path of the circular economy, being the objective of this article to discuss recycling and reverse logistics as a driving to circular economy.

2 Background

Reverse logistics is one of the most critical factors for economic and social growth and can be supported for innovation and sustainability [14]. The knowledge of consumer behavior it is a be there are as a path in the search for textile sustainability [21]. Consumers, on the other hand, demand the sustainability of the companies and their products [34].

The Brazilian Association of Technical Standards defines the rejects of domestic and commercial activity in urban centers, which including clothes in brazilian standard NBR 10.004 [6]. The textile waste and the used clothing are discarded with other types recycled waste.

In Brazil and all countries, there is the same difficulty in treating waste textiles. France has a national tissue recovery program whose policy has held the waste producer

for fabric, clothing, and footwear producers since 2017 [12, 30]. In Brazil, this prerogative is still under discussion, as an addendum to Law No. 12.305/2010 [11].

The use of second-hand clothing can reduce greenhouse gas emissions by 53%, pollution, and chemical production processes by 45% [16]. Recycling and reuse contribute to reducing the exploitation of natural resources to produce new products [1, 15].

Despite this, the country cannot properly recycle and reuse its waste and needs to import textile waste [4]. In 2013, Brazilian recyclers imported nearly 10,000 tons of textile waste, more than \$ 11 million, and attributed this to people's lack of information and unorganized waste collection [3]. [22] show that these imports between 2013 and 2018 were 74,000 tonnes and a loss of US \$ 42 million.

[24] attributed to Brazil a loss of US\$ 600 million for not recycling and improving the working conditions of the cooperatives of waste pickers, the main responsible for this work in the country, and running without any governmental support.

The increase in waste use rates positively affects the performance of sustainability indicators but depends on awareness, as observed by [25]. A lack of recycling culture and higher costs of removal, transportation, and logistics has been found by [36]. This behavior associated with a lack of tax incentives is an aggravating factor for the implementation of reverse logistics.

3 Methods

To discuss this subject, we analyzed the results found in Garcia [21, 22, 23], also using the information published in the current literature about sustainability in the textile chain.

These previous studies were based on data mining and government data related to the output of the fabric and clothes processing supply chain, as well as the way consumers face recycling old garments.

4 Results and Discussion

Brazilian consumers' awareness of sustainability about cotton clothing was identified by [21] using data mining. The dissemination of a more sustainable lifestyle, with healthier habits, can contribute to the reduction of the carbon footprint, ecological footprint, and sustainability of the planet [21, 31].

When dealing with solutions that affect not only the citizen but big companies, and the whole of society, change of paradigm is challenging to implement [10]. It is likely that at some point, it will be necessary that both companies and consumers, be forced to change their choices and use. The influence of policies applied to sustainability on political and citizen attitudes was assessed by [35], and the authors noted that such changes might not be suitable to organize this sector

Garcia [21] show that the reduction in the use of vehicles, changes in diet, and in the way of buying clothes can impact sustainability. These habits can make people more aware to avoid excessive purchasing of unnecessary clothes and other items produced

by fast fashion. It was also evidenced that the income and the value consumed in clothes interfere in the sustainable behavior of the surveyed Brazilians, although the results is suitable for the textile chain, the result cannot be expanded to other segments of the population, as the sample of respondents was restricted and limited to high income and education levels.

Garcia [22] provide an overview of the reverse logistics and disposal of the fabrics in the production chain of clothes in Brazil, country that only 3% of the waste generated is recycled. According to calculations by Brazilian Association of Public Cleaning and Special Waste Companies (Abrelpe), about 45 million tons of waste that could be recycled, and be not, could yield about US\$ 750 million a year to the country [5].

Fabric companies must import waste from other countries [22], disregarding the potential for generating income and sustainable businesses that result in this investment because the population does not know about recycling of this waste. Brazilians are not trained about the selective collection (66%), and 39% do not separate organic waste from recyclable waste [20].

The recycling and reverse logistics performed by the textile and clothing industry in Brazil, based on the National Solid Waste Policy (PNRS) and Brazilian legislation, has been studied by [23]. It was found that companies are not responsible for the final destination of their products, which occurs only in some industrial sectors such as tires, lubricating oils, and pesticide packaging [11].

The Brazilian Association of Public Cleaning and Special Waste Companies [5] attributed a possible loss to the country of approximately US\$ 30 billion per year for not recycling products that could be recycled, but are otherwise wasted.

The country is the largest in the European Union with 67 million inhabitants, France and it aims to recover 50% of the production of annual solid waste. Such anti-action represents a recovery of 300,000 tonnes, or 4.6 kg per person, over the total sold in clothing, bedding and sneakers [18].

Zonatti [37] reports that of the 175 thousand tons of solid textile waste generated in Brazil, about 90% were incorrectly discarded. A clothing cluster in the outskirts of São Paulo houses around 1200 companies that produce 12 tons of textile waste per day, about 2% of the country's total, estimated at 175,000 tons/year. Of these, 36,000 are reused in the production of blankets, twine, new clothes, and yarns [19]. According to [28], this number considers the loss of 10% of the cutting process, of which recyclers reprocess 70,000 tons (40%), and 60% go to landfills and dumps. [13] estimate approximately 10% of the textile production in waste with an inadequate final destination.

The actions carried out for the recycling and reuse of textiles, all over the world, point to charitable activities [27]. [8] show that the clothing banks of charities provide directly to the recycling companies. In the United Kingdom, the collection of textile waste is done by charitable organizations that resell in their stores, and surplus stocks are sold to recycling companies [26].

In Brazil, collectors of recyclable material, live in poverty and are integrated into cooperatives or associations with the support of local governments [7, 27]. The waste collection of fabrics and clothing is just a charity activity in Brazil and has no government support [23].

Currently, 60% more clothes are consumed than 15 years ago. These clothes are kept in the consumer closet for half of their useful life, and a third of them are discarded in after a year. Responsible for 8% to 10% of global greenhouse gas emissions, the fashion industry pollutes more than combined air and sea transport [33].

5 Final remarks

The discussion in search of appropriate governmental policy is an emergency. The scenario is even worse in developing countries due to the lack of structure for recycling and reuse, and the absence of environmental awareness of the general public. When studying the implications of investment in innovation for a textile and clothing chain and its relationship to the circular economy, legislation, and practices, we confirm that are small-scale and handicraft activities that require government support for advances. The National Solid Waste Policy, with action plans for the implementation of reverse logistics in various industrial sectors, has been under discussion at the Brazilian Congress since 2011, without any concrete results.

The support of the responsible authorities must also reach the collectors, with adequate legislation to regulate people's working conditions and quality of life. Such activities are highly harmful and challenging for waste workers.

Acknowledgment: The authors wish to thank the Paulista University, CAPES, and CNPQ.

6 References

- 1 Abramovay, R. (2014). An agreement for the circular economy. *Análise*. V. 83, p. 21. Rio de Janeiro: FGV.
- 2 Abit. Associação Brasileira da Indústria Têxtil e de Confecção. (2020). Brazilian Association of the Textile and Clothing Industry. Profile of the textile and clothing sector. Available in: <http://www.abit.org.br/cont/perfil-do-setor>, accessed on: may 2020.
- 3 Amaral, M. C.; Baruque, R. J.; Ferreira, A. C. (2014). A national solid waste policy and reverse logistics in the national textile and clothing sector. 2nd Textile and Fashion Scientific Congress. *Contexmod*. Available in: <http://www.contexmod.net.br/index.php/segundo/article/view/67>, accessed on: fev. 2020.
- 4 Amaral, M. C. do, Zonatti, W. F., Silva, K. L. da; Karam Junior, D., Amato Neto, J., Baruque-Ramos, J. (2018). Industrial textile recycling and reuse in Brazil: case study and considerations concerning the circular economy. *Gest. Prod.*, São Carlos, v. 25, n. 3, p. 431-443. <http://dx.doi.org/10.1590/0104-530X3305>.
- 5 Associação Brasileira de Empresas de Limpeza Pública e Resíduos Especiais. Abrelpe (2018). Brazilian Association of Public Cleaning and Special Waste

- Companies. Overview of solid waste in Brazil 2017. Available in: <http://abrelpe.org.br/panorama/>, accessed on: mar. 2020.
- 6 ABNT. Associação Brasileira de Normas Técnicas. (2004). Brazilian Association of Technical Standards NBR 10004. Validate 30.11.2004.
 - 7 Baruque-Ramos, J., Amaral, M.C., Laktim, M.C., Santos, H.N., Araujo, F.B., Zonatti, W.F. (2017). Social and economic importance of textile reuse and recycling in Brazil. In: IOP Conf. Series: Materials Science and Engineering. Presented at the 17th World Textile Conference AUTEX 2017. <https://doi.org/10.1088/1757-899X/254/19/192003>.
 - 8 Bianchi, C., Birtwistle, G. (2010). Sell, give away, or donate: an exploratory study of fashion clothing disposal behaviour in two countries. *Int. Ver. Retail Distr. Consum. Res.* 20, 353-368. <https://doi.org/10.1080/09593969.2010.491213>.
 - 9 Boehm, C. (2018). Brasil perde R\$ 5,7 bilhões por ano ao não reciclar resíduos plásticos. Brazil loses R \$ 5.7 billion a year by not recycling plastic waste. Agência Brasil. Jun, 7, 2018. Available in: <http://agenciabrasil.ebc.com.br/geral/noticia/2018-06/brasil-perde-r-57-bilhoes-por-ano-ao-nao-reciclar-residuos-plasticos>, accessed on: feb. 2019.
 - 10 Boström, M., Micheletti, M. (2016). Introducing the sustainability challenge of textiles and clothing. *J. Consum. Policy* 39 (4), 367e375. <https://doi.org/10.1007/s10603-016-9336-6>.
 - 11 Brasil. Low n.º 12.305, de 2 de august de 2010. Available in: http://www.planalto.gov.br/ccivil_03/_ato2007-2010/2010/lei/112305.htm, accessed on: may. 2020.
 - 12 Bukhari, M. A., Carrasco-Gallego, R., Ponce-Cueto, E. (2018). Developing a national programme for textiles and clothing recovery. *Waste Manag. Res.* 36 (4), 321e331. <https://doi.org/10.1177/0734242X18759190>.
 - 13 Campos, T. T. S. C., Mendes, F. D., Costa, S. M. (2017). Textile waste, raw material that generates income. International Fashion Business Congress. São Paulo. Brazil. 2017. Available in: http://cinm.org.br/cinm/anais/2017/03_03_06_Res%C3%ADduos%20T%C3%AAs.pdf, accessed on: feb. 2020.
 - 14 Castaño, M. S., Méndez, M. T., Galindo, M. Á. (2016). Innovation, internalization and business-growth expectations among entrepreneurs in the services sector. *Journal of Business Research*, 69 (5), 1690-1695. <http://dx.doi.org/10.1016/j.jbusres.2015.10.039>.
 - 15 Castro, A. B. C.; Amato Neto, J. (2012). Innovation in the fashion industry: the contributions of Marxist theory to the fashion universe. In *Production Engineering Symposium (Simpep)*, Anais. 19, Bauru, 2012. Global supply networks: challenges and trends in the globalized world. Bauru: Unesp, 2012. Available in: <http://sistemasproducao.net/redcoop/images/pdf/congressos/xix-simpep-2012-amato3.pdf>, accessed on: fev. 2020.
 - 16 Ecosign. (2017). Textile recycling as a contribution to circular economy and production waste enhancement. Available in: <http://www.ecosign-project.eu/news/textile-recycling-as-a-contribution-to-circular-economy-and-productionwaste-enhancement/>, accessed on: mar. 2020.

- 17 Elkington, J. (1997). Enter the Triple Bottom Line. Chapter 1. Cannibals with Forks: The Triple Bottom Line of 21st Century Business. Capstone, Oxford, 1997.
- 18 European Commission (2017). Circular economy in practice - reducing textile waste. Available in: <https://ec.europa.eu/easme/en/news/circular-economypractice-reducing-textile-waste>, accessed on: jan. 2020.
- 19 Freire, E., Lopes, G. B. Implications of the National Solid Waste Policy for waste management practices in the clothing industry. *Redige: revista de design, inovação e gestão estratégica*, v.4, n.01, abr. 2013.
- 20 Gama, M. (2018). Research shows that Brazilians know little about collection and recycling. *Pesquisa mostra que brasileiro sabe pouco sobre coleta e reciclagem*. Folha de S. Paulo. 25.jun.2018. Available in: <https://www1.folha.uol.com.br/mercado/2018/06/pesquisa-mostra-que-brasileiro-sabe-pouco-sobre-coleta-e-reciclagem.shtml>, accessed on: feb. 2020.
- 21 Garcia, S., Cordeiro, A., Nääs, I. de A., Costa Neto, P. L. de O. (2019A). The sustainability awareness of Brazilian consumers of cotton clothing. *Journal of Cleaner Production*. V. 215, 1 April 2019, p. 1490-1502. <https://doi.org/10.1016/j.jclepro.2019.01.069>.
- 22 Garcia, S., Nääs, I. de A., Costa Neto, P. L. de O., Reis, J. G. M. dos. (2019B). Reverse Logistics and Waste in the Textile and Clothing Production Chain in Brazil. In AMERI et al. (eds.). *IFIP International Federation for Information Processing 2019. APMS 2019, IFIP AICT 566*, pp. 173–179, 2019. Switzerland: Springer, 2019. https://doi.org/10.1007/978-3-030-30000-5_23.
- 23 Garcia, S., Nääs, I. de A., Costa Neto, P. L. de O., Reis, J. G. M. dos. (2019C). Disorganization of the reverse logistics and recycling of textile waste delay advances in the Brazilian circular economy. Abstract in *Proceedings 8th International Workshop on Advances in Cleaner Production*. Available in: http://www.advancesincleanerproduction.net/8th/files/proceedings_8th.pdf, accessed on: may 2020.
- 24 Geraque, E. (2019). Brazil loses R \$ 3 billion a year for not recycling waste. *Brasil perde R\$ 3 bilhões ao ano por não reciclar resíduos*. *Estadao.com*. 23 out. 2019. Available in: <https://sustentabilidade.estadao.com.br/noticias/geral,brasil-perde-r-3-bilhoes-ao-ano-por-nao-reciclar-residuos,70002559053>, accessed on: mar. 2020.
- 25 Heidari, R., Yazdanparast, R., Jabbarzadeh, A. (2019). Sustainable design of a municipal solid waste management system considering waste separators: A real-world application. *Sustainable Cities and Society* 47 (2019) 101457. <https://doi.org/10.1016/j.scs.2019.101457>.
- 26 Kim, C.S., Kim, K.R. (2016). A case study comparing textile recycling systems of Korea and the UK to promote sustainability. *J Textile Apparel, Technol. Manage.* 10, 1e11.
- 27 Leal Filho, W., Saari, U., Fedoruk, M., Iital, A., Moora, H., Kleoga, M., Voronova, V. (2019). An overview of the problems posed by plastic products and the role of extended producer responsibility in Europe. *Journal of Cleaner Production* 214. P. 550e558. <https://doi.org/10.1016/j.jclepro.2018.12.256>.
- 28 Lorenzetti, L. (s/d). *The Importance of Reusing Textile Waste in São Paulo. A Importância do Reaproveitamento de Resíduos Têxteis em São Paulo*. Available

- in: <https://www.tratamentodeagua.com.br/artigo/reaproveitamento-residuos-texteis-sp/>. Accessed on: mar. 2020.
- 29 McKinsey. (2015). Europe's circular economy opportunity. Available in: <https://www.mckinsey.com/business-functions/sustainability-and-resource-productivity/our-insights/europes-circular-economy-opportunity>, accessed on: mar. 2019.
- 30 OECD. Organization for Economic Co-operation and Development (2011). Resource Productivity in the G8 and the OECD. A Report in the Framework of the Kobe 3R Action Plan. Paris. Retrieved from: <https://www.oecd.org/env/waste/47944428.pdf>.
- 31 Ecological Footprint. (s/d). Questionnaire to calculate the index in Brazil. Available in: <http://www.pegadaecologica.org.br/2015/pegada.php>, accessed on: feb. 2020.
- 32 United Nations. (2018). Available in: <https://nacoesunidas.org/humanidade-produz-mais-de-2-bilhoes-de-toneladas-de-lixo-por-ano-diz-onu-em-dia-mundial/>, accessed on: may 2020.
- 33 United Nations. (2019). Available in: <https://nacoesunidas.org/agencias/onumeioambiente/>, accessed on: may. 2020.
- 34 Valenzuela-Venegas, G., Salgado, J. C., Díaz-Alvarado, F. A. (2016). Sustainability indicators for the assessment of eco-industrial parks: classification and criteria for selection. *Journal of Cleaner Production*, 133, 99 e 116. <https://doi.org/10.1016/j.jclepro.2016.05.113>.
- 35 Xu, C-K., Cheng, H., Liao, Z., Hu, H. (2019). An account of the textile waste policy in China (1991 - 2017). *Journal of Cleaner Production*. V. 234, 10 October 2019, p. 1459-1470. <https://doi.org/10.1016/j.jclepro.2019.06.283>.
- 36 Zonatti, W. F.; Amaral, M. C.; Gasi, F.; Baruque-Ramos, J.; Duleba, W. (2015). Recycling of waste from the textile and clothing sector in Brazil: overview and related actions. *Sustentabilidade em Debate*, 6(3), 50-69, 2015. <http://dx.doi.org/10.18472/SustDeb.v6n3.2015.15892>.
- 37 Zonatti, W. F. (2016). Generation of solid waste from the Brazilian textile and clothing industry: materials and processes for reuse and recycling. Doctoral Thesis in Sustainability - School of Arts, Sciences and Humanities at the University of São Paulo. São Paulo, Brazil.