A COMPARATIVE STUDY OF RECYCLING IN THE EUROPEAN AND BRAZILIAN TEXTILE INDUSTRY
ULRICH GARVERT

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Thesis presented to Escola de Administração de Empresas de São Paulo of Fundação Getulio Vargas, as a requirement to obtain the title of Master in International Management (MPGI).

Knowledge Field: Gestão e competitividade em empresas globais / Management and competitiveness in global companies

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Lastly i thank my parents for their unconditional support during 4.5 years of university in the Netherlands and Brazil.
ABSTRACT

This master thesis analyzes and compares the Brazilian and European textile recycling industries. The research analyzes how both Europe and Brazil can learn from each other to improve the textile recycling process and increase the rate of textile recycling. It puts the topic of textile recycling into a broader perspective of recycling and sustainable supply chains. In that it shows that both in Brazil and Europe there are significant amounts of textile waste both from production processes and from post-consumption. Through the analysis of ten interviews with stakeholders from the European and Brazilian textile recycling industry it is shown that in Europe the industry is significantly ahead through technology and process leadership in certain countries, which is reached through strong research and cooperation along the textile value chain, an aspect not found in Brazil. More specifically it shows that in Brazil a lack of fiscalization of the national policy on solid waste leads to low incentives to comply with the law and to innovate in order to find new solutions for the use of textile waste. As one of the main barriers both in Europe and Brazil the research identifies the lack of sufficient market perspectives and requests consequently investment into research for application of textile waste and its derivative products.

KEY WORDS: recycling, textile recycling, reverse logistics, textile waste, sustainability, triple bottom line, sustainable development
RESUMO

Esta tese de mestrado realiza uma comparação entre as indústrias de reciclagem têxteis brasileiras com as europeias. A pesquisa analisa como a Europa e o Brasil podem aprender um com o outro para melhorarem os processos de reciclagem têxteis bem como aumentarem as taxas do mesmo. O tema da reciclagem de têxteis aplica-se sob uma perspectiva mais ampla de reciclagem e de cadeias de suprimento sustentáveis; na medida em que o estudo demonstra que, tanto no Brasil quanto na Europa, existem quantidades significativas de resíduos têxteis - advindos estes tanto dos processos de produção quanto do pós-consumo. Por meio da execução de dez entrevistas com as partes interessadas do setor de reciclagem têxteis da Europa e do Brasil, percebe-se que na Europa a indústria está significativamente adiante através da liderança de tecnologia e processos reaplicados em certos países - aspecto este alcançado a partir de uma forte pesquisa e cooperação ao longo da cadeia de valor têxtil, que não é encontrado no Brasil. Mais especificamente, depreende-se que no Brasil, devido à ausência ou pouca fiscalização da Política Nacional de Resíduos Sólidos, os incentivos gerados são baixos nos sentidos de se fazer cumprir a lei e levar à busca por inovação (a fim de encontrar novas soluções para o uso de resíduos têxteis). Uma das principais barreiras identificada pela pesquisa, tanto na Europa como no Brasil, é a falta de perspectivas de mercado suficientes e solicitas; consequentemente, assim ocorrendo da mesma forma em relação aos investimentos em pesquisas para a aplicação de resíduos têxteis e seus produtos derivados.

PALAVRAS CHAVE: reciclagem, reciclagem têxtil, logística reversa, retalhos têxteis, sustentabilidade, triple bottom line, desenvolvimento sustentável
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1. INTRODUCTION

Probably to the contrary of many people’s expectation, the textile industry is the second largest polluter globally, being responsible for 10% of all carbon emissions. Only the oil industry “wins” against textile (Forbes, 2015). Large parts of the supply chain of textile products, be it t-shirts, jackets, uniforms or home appliances, are characterized by energy- and resource intensive production processes. For example, for the production of the average blue jeans, made of cotton, 8,000 liters of water are used (Sueddeutsche Zeitung, 2017). This fact becomes even more uncomfortable, when considering that cotton is most often produced in poor countries such as India, where access to fresh water for large parts of the populations is difficult. If all water that is used for India’s cotton production was used for stilling the thirst of the countries’ population, it would have been sufficient to provide 85% of the population with 100 liter of water a day for an entire year, according to the Guardian (2015). The process of preparing cotton for use in textile products such as yarn requires the elimination of a waxy layer of the cotton, which needs to be removed through a procedure called “scouring”, using large amounts of chemicals (Chen & Burns, 2006). An example of the environmental consequences of cotton production can be found in Uzbekistan. As a consequence of intense cotton production and over-use of water from the Aral lake for the irrigation of the cotton plantations, the lake has dried out between 2000 and 2014 (The Guardian, 2014).

![Figure 1: The Aral Lake 2000 (left) and 2014 (right) (from The Guardian, 2014)](image)

Next to natural fibers such as cotton, there are also synthetic fibers that are made from oil. Producing synthetic fibers is energy-intensive and produces harmful emissions such as CO2
and acid gases, which can trigger respiration problems (Claudio, 2007). When landfilled, the decomposition of this fiber takes up to 200 years (Forbes, 2015).

Not only the processes of growing and producing the raw material such as cotton and polyester have a negative impact on the environment. The further processes of weaving, coloring, bleaching, cutting and sewing to produce the final product, are highly resource intensive, too. Large amounts of chemicals are used for coloring and bleaching the textiles, where resulting wastewater is then often injected into local rivers, polluting the water the local population might depend on (The Guardian, 2013a; Claudio, 2007).

Not only does the textile industry cause negative environmental consequences, but it also causes social problems. Often textile and garment production takes place in countries with low labor standards, where production workers are exploited in factories that are very dangerous to work in. The low labor standards became evident to the global public in 2013, when the Rana Plaza factory in Bangladesh collapsed, leading to more than 400 death workers (The Guardian, 2013b). Many renown international companies such as C&A, Benetton and Walmart were buying clothes produced in that same factory and faced strong criticism in consequence of the factory’s collapse (Clean Clothes Campaign, 2015).

Much of these developments are being enforced by the emergence of the so-called Fast-Fashion industry, which introduces new products on a high rate, suggesting to the customer that what he was wearing last week, has already come out of fashion and that he now needs to buy what is in fashion this week or month. Players such as H&M and Zara are already established players in Europe. McKinsey (2016) states that consumers reacted to the low prices of fast fashion by purchasing more pieces of garments. According to the consultancy between 2000 and 2014 the amount of annually produced clothing pieces has doubled and surpassed 100 billion units in 2014. According to the same source the growth has been especially strong in developing countries as Brazil, due to the growth in its middle class. Nowadays in Brazil there are also established players in the Fast Fashion industry, such as Zara from Europe or the national brand Riachuelo. Between 2014 and 2017, amidst the crisis in Brazil, Riachuelo increased its number of shops from 212 to 291 and also its competitor Lojas Renner has managed to grow (Business of Fashion, 2017). This industry growth not only leads to more and more negative environmental and human consequences as shown above, but it also leads to massive amounts of textile waste created, consisting of post-consumption clothing and vast amounts of textile scraps from the production processes.
However, currently it seems like there is only a nascent industry in Brazil that processes such textile waste.

In Europe the Fast Fashion industry is already at a more mature stage and countries have to deal with large amounts of textile waste, totaling 5.8 million tons every year (EcouTerre, 2013). Europe as a whole, as Brazil, still has a lot of upside potential in dealing with these amounts of textile wastes. However, there are certain countries, such as Germany, where textile recycling has historically played an important role and which have significantly higher textile recycling rates than other European countries as well as than Brazil (Gulich, 2009). Germany worldwide is the country with the highest absolute amount of collected textile waste, with stakeholders like commercial companies, charities and the church involved (Zacune, 2013). In theory, 97% of all textiles are recyclable, however neither Brazil nor Europe even gets close to this value (Jordeva, Tomovska, Trajković, & Zafirova, 2015). Whereas other European countries such as France, Spain and Italy appear to lead in terms of textile recycling technologies, Germany leads in terms of textile waste management (Gulich, 2009; Zacune, 2013). As a consequence of this, this work will have a strong focus on Germany within the European textile recycling landscape, however it will in some aspects also consider other European countries.

1.1. Definitions

In order to facilitate the reading of this master thesis, this section will provide a clarification of terms.

First of all it is necessary to agree on what textile waste actually means. In this research textile waste will include pre-consumption textile waste, which means scraps from production processes of fabrics, garments and other textile products, that cannot be used anymore for the production of new garments, as well as post-consumption textile waste. The latter one includes both products that have come to the end of its useful life as well as those that consumers want to get rid of, as they see no further use in it, but which can potentially get a second life as second-hand clothing.

Whereas recycling means that a material is used again and again in its original product, downcycling means the use of waste for lower quality goods (Greenhome, 2013). In the case of textile waste it can thus be said that recycling would be the reuse of textiles and
fibers for the production of clothing, whereas downcycling would be the use of shredded clothing for e.g. car insulation products in the automobile industry. WRAP (2012) makes the differences between closed loop recycling, which happens when “a material is substituted for the same primary material in a similar application” (p.43) and open loop recycling, which “occurs when a material is recycled into other product systems and the material undergoes a change to its inherent properties” (p.43). Whereas the former one can be seen as recycling as defined by Greenhome (2013), the latter one would rather correspond to downcycling. The European Union (2008) defines recycling as “any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes.” (p.312/10). This can thus include the use of downcycled fibers from textile waste in applications in the car or civil construction industries, but also the re-use of these fibers for the production of new textiles. For the scope of this thesis the term recycling will include all activities that give the textile waste a useful second life, thus following the definition of the European Union.

In the discussion around recycling the term of a “circular economy” also often arises. The Ellen MacArthur Foundation (2017) states that a circular economy “is restorative and regenerative by design. Relying on system-wide innovation, it aims to redefine products and services to design waste out, while minimizing negative impacts.”. At this point it should be made clear that recycling in the definition it is applied in this work is not the same as circular economy. Even though a circular economy would be the most desirable state for the textile industry, it is not yet realistic, as will become clear throughout this thesis.

The terms textile and clothing waste recycling more specifically include different activities. On the one hand it contains the aforementioned recycling activities of fiber recycling. In these processes used textiles or textile scraps are processed and torn apart in order to produce recycled fibers. On the other hand textile and clothing waste recycling also includes the extension of the useful life of clothing e.g. through exporting it to other countries and selling it as second-hand clothing.

Furthermore this thesis will talk a lot about the textile and garment/clothing industry. Here it needs to be clear that the garment/clothing industry is a part of the textile industry. It should also be clarified that generally most of textile waste stems from garments, once they reach the end of their useful lives.
1.2. Research Questions and Objectives

When looking at academia, there is plenty of literature available on textile recycling in Europe, potentially also due to the technology leadership of the continent in this area. There are special institutes dealing with textile recycling research, such as the Sächsisches Textilinstitut e.V. (Textile Institute from Saxony) from Germany or the IVL Environmental Research Institute from Sweden. These institutes for example have published reports over general barriers in textile recycling and recycling technology more specifically. However, in the case of Brazil the interest of academia in textile recycling appears still rather nascent as became clear in the research of literature on the topic in Brazil. As not only from an academic but also from an operational perspective the textile recycling industry in certain European countries seems more sophisticated than in Brazil, Brazil could benefit from the adoption of policies and processes from Germany and technologies from other European countries in order to increase the rate of recycling of textile waste. Especially the fact that the country even imports textile leftovers from other countries for recycling shows that there potentially is a use for the textile waste generated in the country itself (Zonatti, Baruque-Ramos, & Duleba, 2016). Furthermore, as there is also exists a textile recycling industry in Brazil, there could potentially also be learnings for Europe from Brazil. From this the main research question of this master thesis arises:

• How can both Europe and Brazil learn from each other to improve the textile recycling process and increase the rate of textile recycling?

The main objective of this research is to give Brazilian and European companies from the textile industry as well as policy makers insights on how they can improve the recycling processes in their respective countries and potentially capitalize the findings. This shall happen from a macro perspective, meaning that the research should give indications about how legislation and government support can influence textile recycling, but also from the micro perspective, how the respective companies along the textile value chain can learn from each other.

Further specific objectives of this research are the identification of textile recycling technologies in the Brazilian and European textile recycling industry and the identification of potential technology. Next to this, another objective is the identification of specific textile recycling processes and principles in terms of waste management in the regions’ textile recycling industries. An additional specific research objective is the identification of which principles Brazilian stakeholders can adopt in order to increase textile-recycling activities. Also, the identification of
barriers when it comes to textile recycling in both regions is a specific objective of this research.

1.3. Structure of the Master Thesis

The present master thesis is structured as follows: After this first introductory part, theoretical foundations are laid out through a general literature review of sustainability and sustainable supply chains in the second section, in order to put textile recycling into a broader context. In the third part the scope and the methodological approach of this research will be discussed. The fourth part provides an overview of the global, European and Brazilian textile industry. This overview is followed by an analysis about the current state of the textile recycling industry in Brazil and Europe in section five and six, respectively. The seventh part of this thesis presents the analyses of ten in-depth interviews with stakeholders from the textile and textile recycling industry from both regions and secondary data in order to identify the main barriers concerning textile waste recycling. Before concluding the thesis, a short discussion of the general future of textile recycling is given. The thesis concludes with recommendations derived from the entire foregoing analysis and suggestions for future research as well as a discussion of the expected contributions of this research.

2. LITERATURE REVIEW AND THEORETICAL CONTEXT

Even though it seems that sustainability has only gained momentum in the past few years, the topic has existed already for decades. The purpose of this section is to review relevant literature on sustainability, sustainable supply chains and recycling to put the topic of this master thesis into a broader theoretical context.

Gray (2010) states that generally there is a consent that sustainable development and sustainability are positive things, however that there is a debate of what it actually is. In the Brundtland report the United Nations (1987) define sustainable development as “meeting the needs of the present without compromising the ability of future generations to meet their own needs” (p.16).

Giovannoni and Fabietti (2014) argue that the general issue of sustainability has entered into corporate mission statements and codes of conducts only as sustainability
rhetoric, but not as a concept that has indeed been implemented in companies. They therefore suggest that to overcome this pure rhetoric and to get to real sustainable development, a definition is necessary that embraces social, environmental and financial concerns. They further argue that true sustainable development cannot happen through separate activities, but that it needs an integrated approach at different levels that include social, environmental and financial perspectives. Underlining this claim they cite Gray (2010), who states that “any foreseeable sustainable state will be the result of interactions between organizations, individuals, societies and states” (p.57). Gray thus underlines the importance of cooperation and collaboration across stakeholders to improve sustainability.

With regard to the environmental perspective the United Nations already as early as 1972 addressed the issues of sustainability during its conference on Human Environment in Stockholm. The report resulting from the conference establishes 26 principles, mainly evolving around environmental issues. Principle two for example states, “the natural resources of the earth, including the air and water (…) must be safeguarded for the benefit of present and future generations through careful planning or management, as appropriate” (p.4). The sixth principle establishes that “The discharge of toxic substances (…) must be halted in order to ensure that serious or irreversible damage is not inflicted upon ecosystems (…)” (p.4). These issues have not lost any significance since then and got reinforced first by the millennium development goals in 2000 and most recently by the sustainable development goals from 2015 by the United Nations. Among others, sustainable development goal six calls for clean water and sanitation whereas goal 12 demands responsible consumption and production (United Nations, 2015). Furthermore goal nine asks for the construction of resilient infrastructure, the promotion of sustainable industrialization and fostering of innovation. The textile industry needs to be part of the solution in order to achieve these three goals.

According to Dempsey et al. (2011) definitions that stress the inter-generational aspects of sustainability, such as the one from the Brundtland report stated earlier, underline the importance of social aspects in sustainability, as they respect inter-generational equity. Giovannoni and Fabietti (2014) state that “The social discourse has also developed in the context of corporations and has been particularly associated with the notion of social responsibility” (p.26). It directs the sustainability discussion to the responsibility that corporations have towards the society at large.
This turns the focus to another important aspect in sustainability, which is the role of the corporate world. Dyllick and Hockerts (2001) discuss economically, ecologically and socially sustainable companies in their work “Beyond the business case for corporate responsibility”. They state that “economically sustainable companies guarantee at any time cashflow sufficient to ensure liquidity while producing a persistent above average return to their shareholders” (p.133). Furthermore “ecologically sustainable companies use only natural resources that are consumed at a rate below the natural reproduction (…). Finally they do not engage in activity that degrades eco-system services.” (p.133). Therefore ecologically sustainable companies act concordant with the capacity of nature. The authors further explain that “Socially sustainable companies add value to the communities within which they operate by increasing the human capital of individual partners as well as furthering the societal capital of these communities (…).” (p.133).

Carter and Rogers (2008), in their work on sustainable supply chain management, build on these three elements of environmental, societal and economic performance, working together towards sustainability, also termed the triple bottom line.

![Figure 2: The Triple Bottom Line](image)

Departing from this, the authors introduce the concept of sustainable supply chain management (SSCM), which they define as “the strategic, transparent integration and achievement of an organization’s social, environmental, and economic goals in the systemic coordination of key inter-organizational business processes for improving the long-term economic performance of the individual company and its supply chains.” (p.368). It thus...
covers the three aspects of sustainability covered in the triple bottom line approach. SSCM should not be mistaken with a closed loop supply chain. Whereas in a closed loop supply chain as defined under 1.1. materials are recycled after its useful life and then used again and again as input materials for the same products, sustainable supply chains do not necessarily mean that they are closed loop. Whereas a closed loop is the most desirable state for textile recycling, a sustainable supply chain is currently the more realistic approach to textile waste recycling (Sueddeutsche Zeitung, 2017).

Carter and Rogers (2008) furthermore stress that the social and environmental aspects need to be put into place with a clear respect to the economic goals of the company. The authors state that not doing so would be socially irresponsible. Further it is discussed that along the supply chain there exist activities that are socially and environmentally friendly, and which also intersect with economic sustainability. Different potential economic advantages are listed, among them cost savings as a consequence of less packaging waste. Another economic benefit is gains from recycling activities and commercialization of waste, instead of dumping it on the landfill. It is at this intersection point of environmental, social and economic performance where this master thesis is contextually located. Whereas there is a strong focus on the ecologic and economic performances in textile recycling, this master thesis will also focus on the aspects of social sustainability, due to its importance for a holistic discussion of sustainability.

Forbes (2013) discusses the waste recycling and commercialization activities of General Motors, stating that the company in 2011 was able to recycle or sell 2.5 million tons of garbage. This created an additional US$ 1bn for the company. The example shows that through acting socially and environmentally responsible, the company is able to create an economic benefit. However, not only large multinational companies such as GM can create significant additional gains from recycling and commercializing their industrial waste. Also companies working with textiles can sell their textile production waste to textile recycling companies that produce a wide array of different products from it.
3. SCOPE AND METHODOLOGICAL APPROACH

3.1. Scope

The research focuses on Brazilian and European companies from the textile value chain, including textile-recycling equipment manufacturers, textile producers, sorting companies/collectors and recyclers. Furthermore, as representatives of the textile industries, industry associations were also included. As the Brazilian textile industry is strongly concentrated in the southeastern and southern region, representing 78% of the national textile production, the research was mainly conducted in the southern part of the country (Lectra, 2014). Companies from the textile centers from São Paulo as well as from Santa Catarina were interviewed. For Europe the research was spread across countries, however with a focus on Germany due to its high recycling rate and developed waste management. Taking a look also at other European countries proved useful, as Italy, France and Spain are technology leaders in textile recycling or as they have interesting research projects when it comes to innovative recycling solutions (various countries).

3.2. Type of methodology applied

The research is of a qualitative nature. In line with Creswell (2014), this qualitative research is characterized by collection of data in the field, through talking directly to the stakeholders involved in the textile industry. Interviews were conducted in-person and partly on-site in Brazil and via telephone in Europe. An overview of the interviews conducted can be found in table 1. The names of some organizations are codified either because they did not give written consent that their company names are used in this research, or because their approval is conditional on review before submission of the final version of this research. Among the codified companies there is a leading Brazilian fashion producer, which owns several popular clothing brands for different target groups in Brazil. The company is strongly committed to sustainability issues. Furthermore two of the largest German textile collectors, sorters and recyclers have been interviewed. Both of them are active across Europe, and one of them is present on all six continents. It was of special interest to talk to these companies, as they set
up clothing collection containers in Germany and one of them is completely integrated along the recycling value chain, from collection of the clothing to production of the recycled fibers.

Next to personal interviews, literature was reviewed and documents of textile associations and companies in both Brazil and Europe were analyzed, leading to a rich array of sources of data for the research. Therefore this qualitative research is based on interviews and analysis of secondary data.

In this qualitative research two lines of research are followed, namely the textile recycling chain in Europe and the one in Brazil. Within each arm of this research, activities of different stakeholders are analyzed.

<table>
<thead>
<tr>
<th>Organization</th>
<th>Interview Partner</th>
<th>Country</th>
<th>Date</th>
<th>Interview Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associação Brasileira da Indústria Têxtil e de Confecção (ABIT)</td>
<td>Sustainability Managers</td>
<td>Brazil</td>
<td>20.09.17</td>
<td>47:35 min</td>
</tr>
<tr>
<td>Large Brazilian Fashion Company (Codified)</td>
<td>Sustainability Analyst</td>
<td>Brazil</td>
<td>27.09.17</td>
<td>47:06 min</td>
</tr>
<tr>
<td>Brazilian Textile Scraps Exchange Company (Codified)</td>
<td>CEO</td>
<td>Brazil</td>
<td>01.09.17</td>
<td>48:03 min</td>
</tr>
<tr>
<td>German Textile Collection and Sorting Company (Codified)</td>
<td>Business Development Manager</td>
<td>Germany/Europe</td>
<td>29.08.17</td>
<td>26:04 min</td>
</tr>
<tr>
<td>German Textile Recycling Company (Codified)</td>
<td>Innovation Manager</td>
<td>Germany/Europe</td>
<td>14.09.17</td>
<td>31:54 min</td>
</tr>
<tr>
<td>JFFibras (Textile Recycling Company)</td>
<td>CEO</td>
<td>Brazil</td>
<td>31.08.17</td>
<td>42:53 min</td>
</tr>
<tr>
<td>LaRoche (Textile Recycling Machinery Company)</td>
<td>Brazilian Sales Representative</td>
<td>Europe/Brazil</td>
<td>04.09.17</td>
<td>38:18 min</td>
</tr>
<tr>
<td>Retalhar (Uniform Recycling Company)</td>
<td>Co-Founder</td>
<td>Brazil</td>
<td>18.09.17</td>
<td>63:04 min</td>
</tr>
<tr>
<td>Stienemann GmbH (Textile Scrap Collector)</td>
<td>General Manager</td>
<td>Germany/Europe</td>
<td>26.09.17</td>
<td>23:48 min</td>
</tr>
<tr>
<td>Turkish Textile Recycling Machinery Company (Codified)</td>
<td>Foreign Trade Director</td>
<td>Europe</td>
<td>12.09.17</td>
<td>19:14 min</td>
</tr>
</tbody>
</table>

Table 1: Stakeholders interviewed during research phase
3.3. Data collection strategies

The data of this research was collected from three main sources: the analysis of publicly available secondary data from academia, newspapers and companies, data gathered by companies and industry associations and personal qualitative interviews with stakeholders from the textile recycling value chain. Textile recycling technology companies, not only mature producers but also start-ups developing new technologies and processes in Europe and Brazil, textile producing companies, sorting companies/cooperatives, textile-recyclers and industry associations were personally interviewed or consulted via e-mail. All in all 10 interviews were conducted, six of which were conducted in Brazil and four of which were conducted in Germany. The interviews were conducted in the respective language, meaning that German stakeholders were interviewed in German and Brazilian stakeholders were interviewed in Portuguese. Only the representative of the Turkish textile recycling technology company was interviewed in English.

In terms of data recording, an interview protocol was prepared for all interviews, followed by an analysis of the intermediary results, which lead to adaptations in the questionnaire for future interviews.

3.4. Data analysis procedures

Following the interviews, I transcribed the recordings of the same. In line with Creswell (2014), still during the data collection I started analyzing results of previous interviews and wrote memos, which were used for the preparation of this final report. To facilitate the qualitative data analysis and coding procedures, use was made of nVivo, a software developed for the analysis of large amounts of qualitative data.

The overall analysis done in section seven was separated in eight different categories. Table 2 summarizes these categories. Four out of the eight categories arouse from the review of literature before conducting the interviews. The remaining four emerged from the interviews and were consequently supplemented by review of relevant literature.
The development of the questionnaire used for interviewing the stakeholders was based on the four categories identified during the literature review. Once new categories were identified in the interviews, the questionnaire was adapted and related questions were asked in subsequent interviews. Whenever it was possible to get back to previously interviewed stakeholders that had not been asked about the corresponding newly emerged topics, they were contacted a second time. The questionnaire can be found in appendix 1.

### 3.5. Data Interpretation

After codification, organization and initial analysis of the data collected, the data was interpreted and contextualized. This means that the data was given meaning through comparing it with other interviews and insights gained from literature and other sources. Next to the basic interpretation, in line with Creswell (2014), this final report contains a section with calls-for-action, as the goal of the intended research is to find how both countries can learn from each other.
3.6. Data Validity

In order to validate the data gathered in the interviews follow-up conversations were done towards the end of the data analysis phase. This has been done on the one hand by calling previously interviewed stakeholders again, whenever it was possible. On the other hand this was done through the participation in the annual conference of German textile recyclers at the 7th of November 2017 in Berlin, where findings could be discussed and confirmed with stakeholders from the industry.

3.7. Time schedule

Table 3 summarizes the time perspective of the development of this thesis. Overall the development took 3.5 months and was concluded in mid-November 2017.

Table 3: Time planning of thesis development
4. THE GLOBAL, BRAZILIAN AND EUROPEAN TEXTILE INDUSTRY

4.1. Textile Industry

In order to understand the increasing problem of textile waste, it is necessary to understand the industry that generates this waste, the global textile and apparel industry.

The global textile industry is one of the most important industries when it comes to employment. It accounts for 14% of the global workforce and accounts for 5.7% of the global manufacturing activities (UNIETHOS, 2013). The industry sales in 2016 amounted to around US$ 2.8tn and are expected to rise to US$ 3tn until 2018. China and India are the largest producers of the industry. The outlook of the industry is rather positive, due to the emergence of a global middle class that will have more available income for clothing (Euler Hermes, 2017).

In Brazil, the textile industry 2017 is expected to generate US$37bn of GDP, fabricating 9.8 billion of pieces of textile products (ABIT, 2017a). This includes around 250 million pieces of professional clothing and 5.2 billion pieces of fashion products (ABIT, 2017; Sinditextil, 2014). All this aggregated production makes Brazil the fifth-largest textile producer in the world (UNIETHOS, 2013). 30,000 companies are active in the sector, being the second-largest employer in Brazil, directly employing 1.5 million people and indirectly giving employment to 8 million people (The Guardian, 2012; Moro, Mendes, & Amancio, n.a.; ABIT 2017). Furthermore the country’s textile industry is the fourth-largest textile exporter in the world (The Guardian, 2012). The Brazilian textile industry has suffered a lot from cheaper imports, especially from China, in the past years, estimated to reach a value of US$4.5 bn in 2017 (ABIT, 2017a). This increased competition creates a necessity for the Brazilian textile industry to innovate across the entire value chain, in order to remain competitive. The Brazilian textile industry is very concentrated in the south of the country, where 78% of the producers reside, especially in São Paulo and Santa Catarina (Lectra, 2014). Furthermore it is the only country in the world, which still contains the entire value chain, from the production of fibers such as cotton to the sale of the products (ABIT, 2017a).
The textile industry in the EU28 countries, generated around US$189 bn\(^1\) in GDP in 2016, of which US$88 bn\(^1\) accounts for clothing production and US$93 bn\(^1\) for other textile products. 178.000 companies in the sector employ 1.7 million people, which shows that small and medium sized companies dominate the industry. The European Union has turned into a large importer of clothing, as in the past years a large part of national fashion production has be shifted to Asia (EURATEX, 2017). The largest textile producers in the Union are Germany, France, Spain, Portugal, Poland, Rumania and Italy (EURACTIV, 2016). EURACTIV (2016) further states that it is expected that until 2025 600.000 additional jobs will be created. The strong job growth is most likely based on the innovativeness of the industry, as most of these 600.000 jobs will demand explicit technical skills.

4.2. Fiber consumption

At the beginning of all textile processes, there is the demand and production of fibers, which are used for creating yarns, which then in turn are used for the production of fabrics, which finally are transformed into various textile products. The two most commonly used types of fibers are synthetic fibers (polyester), which are made from oil and cotton fibers, which are grown naturally. In 2011 these two groups of fibers presented 62% and 25% of the global fiber production, respectively (Association for textile future, 2016). It is expected that the demand for these two kinds of fibers increases from a total of 55mn tons in 2015, to a total of 90mn tons in 2020, translating into a compounded annual growth rate of 8.6% (Sueddeutsche Zeitung, 2017). Next to this strong future growth, it can be seen that the growth between per capita fiber consumption and population growth have been diverging since 2003, a development which was only temporarily stopped by the global financial crisis between 2007 and 2010 and has gained momentum since then, as can be seen in figure 3.

\(^1\) Values translated into USD with EUR/USD average annual exchange rate 2016 of EUR 1=USD$ 1.1066 (Credit Suisse, 2016)
Figure 3: Global apparel fiber consumption vs. population (Textile Beat, 2017)

Whereas the European Union is strong in the production of man-made (i.e. synthetic fibers), Brazil has a strong position in the production of natural fibers (European Man-made Fiber Association, 2012). Brazil currently ranks fifth in the production of cotton, with a production of 1.5mn tons of cotton (Sociedade Nacional de Agricultura, 2015). Whereas Brazil also exports a lot of its fibers, a large amount is also used in the national market, as 60% of national textile production is done with cotton (Zonatti, Baruque-Ramos, & Duleba, 2016).

The price for virgin cotton has increased slightly in the past three years, with strong fluctuations resulting from annual peculiarities of the respective annual harvest as well as other external influences, as can be seen in figure 4a. The upward fluctuations as well as the general price increase might make cheaper alternatives such as fibers from textile recycling a more attractive option for textile producers in future.

Figure 4a: Cotton Price Development (Macrotrends, 2017)
For synthetic fibers, the price development has been a little different. From figure 4b it becomes clear that since November 2016 prices have also been increasing, after a pronounced period of price decrease. However, as synthetic fibers are won from petrochemical products, whose prices in turn correlate with the oil price, it can be expected that with an increase in oil prices in the future the prices for synthetic fibers will also further increase. Therefore also for virgin synthetic fibers, recycled fibers could become an alternative, however it must be stated that this still seems to be further in the future.

![Figure 4b: Synthetic Fiber Price Changes (Sourcing Journal, 2017)](image)

4.3. Environmental consequences of textile and fiber production

The increasing demand in fibers and textiles has brought with it an increase in environmental issues. Along the entire productive chain, from the fiber production on cotton fields and production of synthetic fibers to the bleaching and coloring of textiles, vast amounts of chemicals and energy are used. The percentage of global pesticide use in the cotton producing industry ranges between 10% and 18% of the global pesticides use, depending on the source (Farrant, Olsen, & Wangel, 2010; Sueddeutsche Zeitung, 2017; Umwelt Bundesamt, 2014; Zacune, 2013). Furthermore the crop uses 25% of the amount of all globally used insecticides (Umwelt Bundesamt, 2014). Putting this chemical consumption into perspective by
comparing it to the fact that the cotton production only uses 2.4% of the global arable land, it becomes clear how chemical-intensive the industry is and how this is harming the environment (Zacune, 2013). The strong use of the mentioned chemicals results in contamination of soils and dangerous working environments for field workers (Forbes, 2015). Furthermore the use of chemicals along the entire production process, not only in growing the cotton, leads to a strong contamination of fresh water resources. In China, where 50% of all global garments are produced and the textile industry is one of the main polluters, 70% of all rivers and water reservoirs are by now affected by various types of pollutants, where a significant part comes from the textile industry (Greenpeace, 2011). Next to the pollution of water, to grow one kilogram of cotton on average 10,000 liter of water is used, further intensifying the fresh water problems in the affected regions (The Guardian, 2015).

Also in the production of polyester, by now the mostly used fiber in the world, there is a strong environmental impact. Each year around 70 million barrels of oil are used to satisfy the global demand for synthetic fibers (Forbes, 2015).

Overall it can thus be concluded that as one of the most polluting industries in the world, the textile industry needs environmentally friendly solutions, in order to decrease its negative environmental impact.

4.4. Fast Fashion Industry

An industry that has strongly contributed to the increasing demand of fibers and fabrics is the Fast Fashion industry. The concept behind Fast Fashion is rapidly changing fashion collections, which suggest to the consumer, that what he bought last month might not anymore be in fashion this month, giving him the feeling that he needs to buy the new collection in order to still wear the most fashionable clothes. The periods of introducing new collections can be as short as one month, meaning that per year 12 new collections would be introduced. The focus of the Fast Fashion industry is thus on being fashionable, and not on producing and selling durable goods of high quality. This lower quality and the high fluctuation of new collections lead to significantly shorter product lifecycles. Also the often very low prices make it more attractive for customers to steadily buy new clothes. These low prices also lead to a lower value that customers put on their clothing. When for example a shirt has a whole, instead of repairing it, it is simply thrown away and a new one is bought.
In Europe the industry is already very widely spread, with H&M, Zara, Primark, Mango and Bershka being among the strongest players in the market. The industry is also growing within the Brazilian market, where European companies such as Zara have already gained a foothold and new players are emerging.

Bhardwaj and Fairhurst (2010) state that fashion companies responded to demands of the market, when they started introducing more than the classic two to four collections per year. In order to allure to customer needs and to be faster than competition, the concept of speed to market became crucial for producers. When they had new fashion trends faster in their stores than competitors, they had a competitive advantage against them, which promised higher profit margins, further increasing the attractiveness of the Fast Fashion market.

The associated shorter lifecycles lead to very negative ecologic statistics for the products. A Fast Fashion product that is used five times before being thrown away with an average durability of 35 days produces 400% more carbon emissions per piece when compared to classic, higher quality clothing pieces, that would be used 50 times and would have a useful life of a year (Forbes, 2015). LeBlanc (2017) states that if a clothing piece’s useful life were extended by only three month, it would decrease the water and carbon footprint by five to ten percent.

According to Voss (n.a.) the average German citizen could easily live without buying new clothes for seven to ten years, without wearing broken clothing. In Germany 10-15% of all clothing is either not at all, or only a single time used before it is discarded. Furthermore the large product offering of cheap Fast Fashion clothing by the aforementioned companies seduces the customer to not wear his clothes to the full potential of its useful life.

Another issue is that through the introduction of Fast Fashion and the associated lower quality, it is also harder to reuse the clothing as second-hand clothing. According to Zacune (2013) in the United Kingdom there is a large second-hand clothing market, however the same is suffering from the lower quality of the donated clothing, as the share of Fast Fashion clothing in these donations is rising.

From the foregoing discussion it should become clear, that the Fast Fashion industry has severe negative impacts on the environment and has become a significant generator of post-consumption textile waste. Next to the post-consumption textile waste, there is also waste deriving from cutting processes during production.

However, besides still rather small producers focusing on slow and sustainable fashion, some large players of the Fast Fashion industry such as H&M have recognized the
urgency of changing the consumption model from a linear to a circular economy, as H&M’s CEO Karl-Johan Persson confirmed with Sueddeutsche Zeitung (2017). H&M and some other European textile producers have entered into partnerships that foster the development of fiber recycling solutions in the textile industry.

4.5. Textile waste streams

As mentioned in the foregoing paragraph, the Fast Fashion industry has become a significant producer of textile waste. However not only the fast Fashion industry, but also the textile industry as a whole produces large amounts of pre- and post-consumption textile waste. Pre-consumption textile waste means the textile scraps that are produced as by-products in the production process of all sorts of textile products. For the production of clothing for example, the fabric is put on a so-called cutting table, where it then is cut into its respective form of a shirt, jeans or whatever the final product shall be. In this production step textile scraps are produced, which often are too small to use them for the production of other clothing products and which are then discarded as waste. Textile Beat (2017) expects that at least 15% of the raw material for clothing production turns into these textile scraps due to the cutting activities. Also in the weaving of fabrics the so-called selvedges are produced as a by-product, which textile producers generally consider as garbage. The second waste stream from textile waste is the post-consumption waste, meaning the textile products ranging from fashion, over professional uniforms to blankets and curtains that consumers get rid of.

4.5.1. Ecologic consequences of textile waste

Large parts of the aforementioned textile waste go to landfills, where they cause severe environmental damages. According to Zonatti, Baruque-Ramos and Duleba (2016), about 90% of the industrial textile scraps in Brazil is incorrectly put on the landfills of the country. In the European Union it depends a lot on the individual countries, how much of textile waste goes to landfills. In Germany the rate is as low as 58%, whereas in Finland around 73% is landfilled (EcoOutfitters, 2016; Tojo et al., 2012). Next to contaminating soils and the ground water, natural fibers such as cotton produce methane, a gas 23 times more toxic for the atmosphere than CO2 gases, when being discarded on landfills (WRAP, 2012; Moro, Mendes, & Amancio, n.a.).
5. CURRENT STATE OF TEXTILE RECYCLING IN BRAZIL

This section describes the state of the Brazilian textile recycling industry, the legal backgrounds and the practices associated with textile recycling as it is right now. It is based on the review of secondary data and of descriptive nature. Problems identified through interviews will be analyzed and discussed under section 7.

5.1. Legal foundations for textile recycling

The 2nd of August 2010 the Brazilian government passed law 12,305 – The National Policy on Solid Waste (NPSW). According to its first article, the law establishes “the National Policy on Solid Waste, its principles, objectives and instruments, and sets forth guidelines in relation to integrated management and solid waste management (…), generators’ responsibilities and applicable economic instruments” (Ministry of Environment Brazil, 2010, p. 1). The law applies to “(…) individuals and legal entities, ruled by Private or Public Law, which are either directly or indirectly responsible for the generation of solid waste, and develop actions related to integrated management or solid waste management” (Ministry of Environment Brazil, 2010, p. 1). This means that it applies not only for individual persons, but also to companies and municipalities. Among the ten principles of the policy, there is the polluter-pays principle, meaning that those who cause pollution, have to bear the costs of managing the pollution in order to not cause environmental or human harm (The Guardian, 2012). Furthermore it has as one of its principles the cooperation between the public authorities, companies and other parts of the society, in order to stipulate recycling and integrated waste management.

As its objectives the law, among others, has the reduction, recycling and treatment of solid waste, including an environmentally correct disposal. Furthermore it aims at the “adoption, development and improvement of clean technologies as a way to minimize environmental impacts” (Ministry of Environment Brazil, 2010, p. 3). It intends to incentivize recycling within the country and regards the social peculiarities in Brazil, by including the involvement of catadores (i.e. waste pickers) who collect valuable recycling material. The law is supposed to be put into action through municipal solid waste plans, meaning that each municipality needs to develop its own waste management policy that is tailored to its individual needs.
As a further instrument “selective collection, reverse logistics and other tools related to the implementation of shared responsibility over products’ life cycle” (Ministry of Environment Brazil, 2010, p. 4) are mentioned. Reverse logistics, one of the most crucial aspects of the law is defined as “a social-economic development instrument defined by a set of actions, procedures and means intended for the feasibility of collection and restitution of solid waste to the entrepreneurial sector, or other final environmentally-adequate destinations” (Ministry of Environment Brazil, 2010, p. 2). Reverse logistics can thus include that companies have to take back the products they put on the market. The law defines shared responsibility as “a set of individualized and connected duties from manufacturers, importers, distributors and sellers, consumers and holders of public cleaning and solid waste management services in order to reduce impacts on human health and environmental quality resulting from products' life cycle (…)” (Ministry of Environment Brazil, 2010, p. 2). The goal of shared responsibility is to “make the interests of social agents, economic agents and entrepreneurs compatible with market and environmental management processes” (Ministry of Environment Brazil, 2010, p. 14) through sustainable strategies. This includes the promotion of using solid waste in various productive activities. Shared responsibility thus implies for textile producers that they have to take responsibility in the management and recycling of their waste, and that they need to look for solutions how to productively use their waste, instead of discarding it on the landfill.

To implement shared responsibility sectorial agreements are established as a further instrument. These sectorial agreements are “acts of contractual nature entered into between the Public Authority and manufacturers, importers, distributors or sellers, aiming at implementing shared responsibility for a certain product's life cycle” (Ministry of Environment Brazil, 2010, p. 1). In the case of the textile industry such an agreement would thus include the yarn and fabric producer, confections, fashion retailers etc. However, the law does not establish the extreme version of this, which is extended producer responsibility (EPR). According to the OECD (2017) EPR is a policy under which producers, and not all players along the value chain, bear a large amount of financial or physical responsibility for the waste management of post-consumption goods. The idea behind EPR is to incentivize producers to prevent waste and to design products in an environmentally friendly way and in a way that makes recycling easier.

The policy also determines a hierarchy of waste management, determining a management priority: “non-generation, reduction, reutilization, recycling, solid waste
treatment and final environmentally adequate waste disposal” (Ministry of Environment Brazil, 2010, p. 5). This hierarchy means that non-generation of waste should be the top priority in waste management, followed by the respective lower-ranked options.

The policy states six different categories for which specific reverse logistic plans have to be established. However, textile wastes are not specifically mentioned here, as it is not considered as hazardous waste.

5.2. Waste amounts and recycling rates

According to Corsten, Worrell and van Dael (2012) Brazil produces 1.065 million tons of textile waste every year, which represents 1.8% of all municipal solid waste. The largest part stems from post-consumption clothing waste. However, 19% of this waste (175.000 tons) consists of textile scraps, only coming from leftovers of production processes (Zonatti, Baruque-Ramos & Duleba, 2016; Moro, Mendez & Amanzio, n.a.). According to Zonatti, Baruque-Ramos and Duleba (2016), about 90% of these industrial textile scraps is incorrectly put on the landfills of the country and not recycled, translating into only 10% of industrial textile waste being recycled.

5.3. Waste management

According to the OECD (2001) waste management is “the supervised handling of waste material from generation at the source through the recovery processes to disposal” (OECD, 2001). Furthermore it can be said that waste management can be divided into two parts: internal waste management and external waste management. The internal waste management encompasses all activities at the waste generation site. This includes the separation of all sorts of waste and internal flows of the waste amounts. It can be at a company’s factory where pre-consumption waste is generated, including textile scraps, but also at a consumer’s home, where he generates all sorts of post-consumption waste, including textile waste from used clothing he wants to get rid off.

External waste management refers to what is being done with the waste after it leaves the waste generation site, i.e. how other stakeholders such as recycling companies or municipal waste companies collect, treat and channel the waste.
When it comes to pre-consumption internal textile waste management the picture is quite diverse in Brazil. In São Paulo, there are the Bom-Retiro and Brás neighborhoods, where the problematic of internal waste management becomes evident. The region is one of the most important textile polls in Brazil, comprising more than 6000 textile companies of which more than 50% are active in the cutting processes, where textile waste is generated (Sinditextil, 2015). These companies produce around 26 tons of textile waste per day (Loga, 2011 apud Zonatti et al., 2014). According to Zonatti, Baruque-Ramos and Duleba (2016) and Sinditextil (2013) most companies do not separate the waste, but mix textile waste with organic and other solid waste, which makes it more difficult to recycle. However, when looking at the south Brazil, in the region of Santa Catarina, another textile industry poll, there appear to be certain large producers, like Grupo Malwee, that have stricter waste separation policies in place. Already at the cutting tables they start separating the textile waste from other kinds of solid waste and sort it by color and by qualities (Moro, Mendes, & Amancio, n.a.). This means that there are bins for polyester, cotton and all other types of fabrics in order to separate the textile waste and facilitate recycling.

Looking at the internal textile waste management from a post-consumption perspective it can be said that generally in Brazil there is no separate formal collection system for post-consumption textile waste. Most of post-consumption textile waste is donated to charity organizations such as the Catholic Church, which then distributes it to underprivileged people. Then after potentially giving it a second life, the textiles become finally solid waste and land on landfills (Zonatti, Baruque-Ramos, & Duleba, 2016). Formally, steadily available collection points such as containers on parking lots to discard and donate post-consumption textile waste are not available (See annex 4 for an illustration of these containers in Europe). Professional uniforms, another significant source of textile waste, are also mainly discarded on landfills, as donating them is not possible due to security reasons for the institutions. However, companies and institutions dumping professional uniforms are actually also required to professionally discard and recycle their uniforms in line with the National Policy on Solid Waste (Law 12,305/2010).

From an external waste management perspective for textile waste from factories there are three main ways of discarding: recycling companies, curbside disposal and catadores. In São Paulo for example, it depends on the size of the producer what happens to its textile waste. In line with the Integrated Management Plan for Solid Waste of the city, companies that produce more than 200 liters in volume of waste per day, have to register with the
Municipal waste company AMLURB and need to contract an authorized specialized company, to pick up their textile waste (Prefeitura de Sao Paulo, 2014). These large waste producers need a certificate about the environmentally acceptable disposal of their waste (Machado, 2014). Companies producing less than this specified amount can simply put their waste on the sidewalk from where it then goes one of two ways. Either it is (partly) picked up by catadores who sell the most valuable content to textile recycling companies, or the municipal waste company picks it up. According to Sinditextil (2013b) the problematic about the catadores is that they open the garbage bags, take the valuable pieces out and leave the rest on the sidewalks, polluting the region. Furthermore when it then starts raining the textile leftovers get into the canalization where they pollute the water and can cause technical problems.

5.4. Currently existing processes for textile waste

Once the pre-consumption textile waste has been picked up either by the specialized companies, the municipal waste company or the catadores, it has various different destinies in Brazil. Even though the specialized waste companies have a specific certification that they adequately process the waste, most of them simply bring the textile waste to landfills, without any attempt to recycle it (Sinditextil, 2013b). The same holds for the municipal waste companies, which pick up the textile waste along with all other sorts of waste, bringing it to the landfill as well.

However, there are also specialized waste and recycling companies that channel the pre-consumption textile waste towards industries that work with recycled textiles in Brazil. An example of such a company is Virgeflex. According to Lessa (2016) the company daily collects textile waste from companies before the municipal waste truck passes by. The company then takes it to its own factory, where the mixed textile waste is mashed and the fibers are pulled apart. Illustrations of the recycled fibers can be found in annex 1. Companies like Virgeflex then sell the recycled fibers to various industries such as the car industry, thermic and acoustic insulation industry, non-woven industry for civil construction (e.g. for street construction), popular blankets, the yarn industry, carpet industry, soft toy industry or furniture industry (Lessa 2016; JFFibras, 2017a). Some companies, such as EuroRoma from Blumenau are already vertically integrated along the value chain. The company picks up the
waste directly at the factories, defibers it and produces yarns and strings for handicraft use (EuroRoma, 2017). This is possible as already at the production site the waste is separated by color and sort of fabric, relating back to the advanced internal textile waste management in Brazil’s South, discussed under 5.4. The different destinies for different fiber types are shown in figure 5.

Figure 5: Recycling destinies of various fabric types (Adapted from Sinditextil, 2015)

For the recycling of professional uniforms there are three different final destinations. Most company uniforms are discarded on landfills, after logos have been cut out. Police and Military uniforms, of which annualy 440,000 pieces are discarded, are cut in parts and landfilled as well, or incinerated (Sinditextil, 2014). However, for the environmentally and legally acceptable disposal of uniforms there is an incipient industry in Brazil. Companies like JFFibras, which also produces recycled fibers, accepts professional uniforms as long as they are clean and free from hard parts such as zippers and buttons (JFFibras, 2017b). Another company taking on this problem is the social startup Retalhar, which takes uniforms from companies against a fee, cleans them, removes all hard parts and then channels it to textile recycling companies (Retalhar, 2017). On request the company also produces corporate gifts from used uniforms, working together with cooperatives of sewers.

Overall it can thus be said that the largest part of post-consumption textile waste goes to landfills, however there is an increasing interest in processing this type of waste as well. For pre-consumption textile waste there are, to a limited degree, solutions available in Brazil.
5.5. Currently Available National Textile Recycling Technologies

With regard to nationally developed and produced machinery for textile recycling, the offering in Brazil to the best of our knowledge is very limited. Next to some very small, individually produced machines there appears to be only one professional company that produces machinery for the textile recycling process, which is TextilMaq. According to TextilMaq (2007) the company offers products for cutting and fiber pulling machines (See Annex 1 for a more detailed product description).

5.6. Recent Developments & Producer Initiatives

In recent years there have been some developments of projects in order to improve textile recycling and textile waste management in Brazil. The two initiatives that could be identified are mainly of social nature.

On the one hand, the initiative Meias do Bem has been started by Puket, a brand of Grupo Malwee, where consumers can discard their socks in containers that are located in the stores of Puket. These socks are then sent to a recycling company that produces popular blankets from it. Consequently these popular blankets are donated to charity organizations, which in turn deliver it to poor and homeless people. In its four first years after inception the initiative could transform 15 tons of socks into 15,000 popular blankets (Meias Do Bem, 2017a).

A project initiated by Sinditextil in cooperation with the municipality of São Paulo is the Retalho Fashion Project. According to Sinditextil (2015) the goal of the project is to “organize the collection of textile waste in Bom Retiro and Brás, formalizing the work of the catadores” (p.3). Bom Retiro and Brás are two textile production hotspots in the state of São Paulo Part of this is also a sensitization of the companies to separate their waste. Furthermore it has as a goal that a cooperative of catadores shall be responsible to manage and sort the waste, which is then sold to the textile recycling companies in order to increase the rate of textile recycling and decrease the negative environmental and social effects of the unorganized waste disposal. The idea is that catadores pick up the waste of the confections in the Bom Retiro and Brás neighborhoods, bring it to a centralized sorting site where the waste is being separated and from where it will be brought to the recycling companies. Furthermore the project also aims at the problem of professional uniforms’ disposal and specifically wants
to process the uniforms of the military police from São Paulo. Furthermore a contract between the project and the Receita Federal of the state is part of the project, where Retalho Fashion will destroy and recycle fake textile products confiscated by the Receita Federal.

Overall it can thus be concluded that in recent years interest in textile waste recycling has increased and that there are initiatives emerging. Even though these initiatives seem to still be on a rather small-scale, they can be a good starting point for larger-scale activities.

6. CURRENT STATE OF TEXTILE RECYCLING IN EUROPE

This section, similar to the foregoing one, describes the current state of textile recycling in Europe. It reflects what currently characterizes the sector in terms of legal foundations, technologies and processes based on a review of secondary data. A comparison to section five including an analysis and discussion of the differences is conducted in section seven.

6.1. Legal foundations for textile recycling

On 8th of November 2008 the European Union passed directive 2008/98/EC on waste, which gives directives for its member states on how to adapt waste legislations. Therefore it is not a direct law, but a directive that gives orientation on how waste legislations in its 28 member states have to be designed. The policy suggests means to “protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use” (European Union, 2008, p. 312/8). It builds upon directive 2006/12/EC, which establishes requirements for waste management and a compulsion for the EU-Members to establish waste management plans (European Union, 2008).

Directive 2008/98/EC introduces a waste hierarchy, similar to Brazil, which is structured as follows: prevention, preparing for reuse, recycling, other recovery (e.g. energy recovery through thermal use) and disposal. By preparing for reuse, the European Union means “checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing” (p.8). For textiles this could for example mean fixing holes
in clothing. The directive gives the member states a certain degree of flexibility in the application of the hierarchy in that it states that they should select the respective option, which leads to the best environmental outcome. When for example for textiles the recycling process would cause more emissions than discarding it on the landfill in a certain country, the landfill option should be the preferred one.

Article five of the directive directly deals with the management of by-products from production, where textile scraps fall into. It states that any production by-product that has a certain further use inside normal industrial practices may not be considered as waste.

Additionally the directive introduces EPR. It is stated that EU-members can take measures “to ensure that any natural or legal person who professionally develops, manufactures, processes, treats, sells or imports products (...) has extended producer responsibility” (European Union, 2008, p. 312/12). These national policies can include an obligation for producers that they have to accept returned products, the consequent management of the post-consumption waste and the financial accountability for these processes. One of the countries that implemented such an EPR for textiles is France. The EU’s rationale for proposing EPR is to encourage producers to design products in a more environmentally friendly way, that allows for easier recycling after the product’s useful life.

Article 11 of the directive specifically deals with the re-use and recycling of waste, proposing in §1 that measures shall be taken to increase high quality recycling and that to achieve this, separate waste collection shall be established where it makes environmental and economic sense (European Union, 2008). Under §2 of the same article 11 the directive states that until 2020 “the preparing for re-use and the recycling of waste materials such as at least paper, metal, plastic and glass from households (...) shall be increased to a minimum of overall 50% by weight” (European Union, 2008, p. 312/13). Therefore the directive does not limit the recycling goal to the four mentioned material groups, but it leaves it open how countries can achieve this rate. Therefore textiles could potentially also play into this.

The policy further establishes that countries should introduce the polluter-pays principle, as it exists in Brazil. However it also here leaves flexibility for the countries to potentially share the costs among stakeholders.

In 2015 the European commission proposed an amendment of directive 2008/98/EC, proposing even more ambitious recycling goals. By 2030 the Union aims to achieve a recycling rate of 65% for municipal waste and targets a reduction of landfill to at maximum
10% of the municipal waste by 2030 (European Union, 2015). This directive would most likely further increase textile recycling in Europe. However, it has not yet been passed.

6.1.1. German Law for Circular Economy (Kreislaufwirtschaftsgesetz)

The German Law for Circular Economy from June 2012 implements the EU directive 2008/98/EC for Germany. The goal of the law is to increase the amount of recycled waste and to prevent waste, through improving the resource efficiency in the waste industry (Fachverband Textilkreislauf, 2015). It also adopts legal expressions and definitions from the EU directive.

One of the most significant changes compared to the previously prevailing law is that §6 section 1 from the new law adopts the waste hierarchy as defined by the European Union. Previously the German hierarchy equated thermal use to recycling, which allowed companies to burn their textile waste as it was cheaper than separating it for recycling. Today, as long as it is technically and economically possible to recycle the textile waste, preference has to be given to recycling instead of using it thermally through incineration (Ruch, 2012).

The law reinforces the separate collection of waste in Germany, which had already been in existence before 2012. Section two §9 states that waste has to be separated. As the law applies to natural and legal persons this relates to individuals as well as to companies. Mixing waste is only allowed under very limited circumstances that do not apply for textile waste.

Even though the law does adopt EPR for packaging and other waste types, it does not do so for textile waste.

6.2. Waste amounts and recycling rates

In Europe the total amount of discarded textiles lies around 5.8 million tons per year, of which 25% is recycled (EcouTerre, 2013; Zacune, 2013). No data could be found on which share of this waste comes from pre- and post-consumption, however as production has strongly shifted to Asia it can be assumed that the largest part of this waste is post-consumption waste. Within Europe, the textile recycling rates are clearly diverging. The leading country when it comes to textile recycling in Europe is Germany, where more than 42% of textile waste is recycled (EcoOutfitters, 2016). With 1.9 million tons of textile waste Germany is also one of the main
generators of textile waste in Europe. Of this amount the Fachverband Textilrecycling (2015) estimates that around 1.35 million tons is post-consumption clothing, of which around 1.0 million tons are being collected. This leaves around 0.55 million tons of textile waste from other origins. It can be hypothesized that this partly comes from other post-consumption textile waste such as carpets, blankets and other home products. However, this also contains textile scraps from Germany’s textile producing companies. Data on how much of this pre-consumption textile waste is collected or recycled is not available.

6.3. Waste management

As the goal of this thesis is to identify best practices from Europe that could be applied in Brazil, waste management as well as the destinies of textile waste (section 6.4.) will be described from the German perspective, due to the country’s leading role in these activities.

For Germany, waste management is also divided into internal waste management and external waste management, as well as pre-consumption waste management and post-consumption waste-management.

Analyzing internal pre-consumption textile waste, i.e textile scraps from the production, according to the general manager of Stienemann GmbH separation of waste directly takes place in most of the factories, as the German law for circular economy demands (“Kreislaufwirtschaftsgesetz”). Producers are obliged to separate organic, plastic, paper, glass and textile waste. Non-compliance with the law can lead to fines. As there is no separate collection of textile waste by public waste management companies, textile producers have to work with certified waste management companies to discard their textile waste. Among other policies, textile-recycling companies set up containers at the textile waste generation site in order to support the separation process and the logistics (Stienemann, 2017b). Depending on the quality and the purity of the textile waste, textile companies either pay for the discard of their waste, or they get money for it. When textile producers mix the different types of fabrics, the textile recycling companies picking up the waste separate the different qualities in their factories.

When it comes to internal textile waste management from the post-consumption clothing perspective, Germany is a globally leading nation in the collection of this type of textile waste. According to Gulich (2009) in Germany historically there have been efficient
system to collect, separate and recycle used textiles. Nowadays the country can count on more than 120,000 containers that are located across cities in publicly accessible places, where individuals can discard their used clothing (SPIEGEL, 2013). These containers in many cases are operated by commercial textile collecting and sorting companies in collaboration with charity organizations. The containers make up 80% of the German clothing collection activity (Fachverband Textilrecycling, 2015). Historically the charity organizations such as the Red Cross collected clothing for underprivileged people. However, as the amounts of clothing donated grew strongly, soon there was more supply than demand. Nowadays the commercial companies pay a fee to the charity organizations in order to use their name on the collection containers or directly buy the collected clothing from the charity organizations. These fees finance a significant part of the social activities of the charity organizations. According to the Red Cross (2017) the organization annually receives 13.5 million Euros from these activities. Recently also municipalities have recognized the value of used clothing and start to invest into the business of collecting used clothing. This has led to situations where the municipal waste companies are now competing for the quantities and the best qualities with the commercial and charitable collections (Fachverband Textilrecycling, 2015).

Furthermore more and more fashion retailers, among them fast fashion retailer H&M, start offering reverse logistics solutions, where customers can leave post-consumption clothing in boxes in the stores (Fachverband Textilrecycling, 2015; H&M, 2017). Moreover some municipalities in Germany are now starting pilot projects, where they collect textile waste in the paper bins, after the day that these same paper bins have been emptied by the separate municipal waste collection (Fachverband Textilrecycling, 2015). In Germany there is a separate waste collection and respective separate trash bins for plastic, organic and paper waste. As the paper bin is not contaminated with dirt as it might happen for organic and plastic waste, it is used for the textile collection.

It should thus become evident that consumers have a wide array of opportunities to discard their textile waste in Germany and that there is a sophisticated external waste management system in place, to collect and channel the textile waste.
6.4. Current destinies of textile waste and important industry players

For the collected textiles in Germany there are different treatments pathways after use (Figure 6).

In the case of pre-consumption textile waste, after collection and separation by specialized companies it has various different destinies. In line with the European Directive 2008/98/EC and the German law for circular economy, whenever it is possible the waste is directed towards re-use before recycling, energetic use and disposal. Whenever the size of the scraps allows it, they are cut into the right size so that they can be used as cleaning rags. The smaller parts are processed into recycled fibers, which go into various different industries such as acoustic and thermal insulation for houses and cars, other applications in cars, the furniture industry, technical textiles, toy industry, money bill industry or civil construction (Gulich, 2009; Stienemann, 2017b). Furthermore textile waste is also used on horse riding grounds in Germany (Altex Textilrecycling, 2017).

The post-consumption textile waste in Germany has some overlap with the destinies of textile scraps, but also different further uses. 54% of the around 1 million tons of used clothing collected each year in Germany is used as second-hand clothing, which is mainly exported to African countries (Fachverband Textilrecycling, 2015). 21% of the collected amount goes into the production of cleaning rags, similar to the larger pieces of textile scraps.
23% go into fiber recycling and thermal use and only 2% of this of the collected used clothing goes to landfills.

The world’s leading textile collector, sorter and recycler SOEX Group is one of the most important players in the German market of textile recycling. The company is vertically integrated across the entire textile recycling value chain and active on all six continents (SOEX Group, 2017). Next to the SOEX group there are several small and mid-sized textile recyclers that characterize the German textile recycling industry (Gulich, Textile Waste Management in Germany & Developments in Textile Recycling Technology, 2009). Many of them are rather regionally active, than in the entire country.

6.5. Currently available technologies

Currently in Europe there are different technologies available for the recycling of textile waste. The market leaders in textile recycling technologies come mainly from Italy, Spain, France and Turkey. Gulich (2009) states that mechanic textile-recycling machinery from Europe is manufactured for the world markets. The technology can generally be divided into mechanical and chemical methods. Companies like LaRoche from France have developed state-of-the-art mechanic solutions, that are able to sort out hard components of textile waste such as zippers or buttons that previously could cause fire in the machines (See annex 3). In a first step the machine cuts the clothing into pieces. In the second step a tearing cylinder tears the pieces apart and sorts the hard non-textile components into parts (Gulich, Textile Waste Management in Germany & Developments in Textile Recycling Technology, 2009). In a last step the now regained fibers are sieved and separated from dust. (LaRoche, 2017a). Other European producers than LaRoche are Dell’Orco & Villani from Italy, Pierre T. from Belgium, Margasa S.L. from Spain, Balkan Textile from Turkey. These companies produce machinery for processing of textile-production waste, tearing machinery for processing used clothes and machinery for the processing of reclaimed fibers. Table 4 gives an overview of the input and output materials of textile recycling, and the technologies needed to realize these transformations.
Table 4: Textile recycling inputs, outputs and necessary technologies

(Adapted from Elander & Ljunkvist, 2016)

The second, however still not very common method is chemical recycling, which, among other regions, is also under development in Europe. Even though chemical recycling also uses hazardous chemicals and, it is still significantly less harming than the production of new fibers (Sueddeutsche Zeitung, 2017). It still only works on small-scales and does not yet qualify for recycling of mixed fibers because of differences in the separation processes of the fibers (Elander & Ljunkvist, 2016). Table 5 lists the currently available technologies in chemical textile recycling.

Table 5: Currently available chemical methods in textile recycling

Adapted from (Elander & Ljunkvist, 2016)
Even though most chemical processes are still on small scale for cotton, in Asia there already exist large-scale recycling activities for polyester fibers, which are expected to further increase and improve in quality until 2030.

6.6. Recent developments & Producer initiatives

Recently H&M as well as Kering, the mother company of Puma, have entered into an agreement with the UK-Based textile recycling company WornAgain, which develops a chemical solution for textile recycling. The idea behind the cooperation is to truly close the loop in the textile value chain. Most of the above-discussed destinies lead to the use of recycled fibers in other products but not to re-use of fibers in their original products, as it would be the case in the stricter definition of recycling. Worn Again along with H&M and Kering now works towards this goal of making new textiles from old ones (Chua, 2015).

7. ANALYSIS OF IDENTIFIED DIFFERENCES IN TEXTILE RECYCLING IN BRAZIL AND EUROPE

The following section analyzes the differences in processes, technologies and ideas in textile recycling between Europe and Brazil. The categorization of the analysis is done based on the topics that arouse during the literature review as well as on topics that arouse during analysis of interviews and secondary data, as discussed in section 3.4. Table 6 with an overview of the results of each of the categories can be found at the end of this section.

7.1. Awareness and Education

During analysis of the interviews it became clear that for textile recycling to happen there first of all needs to be awareness among all stakeholders along the textile value chain, that textiles of all sorts are actually valuable raw materials for other products. Part of creating awareness is an education about how to deal with textile waste, once it is generated. This holds for companies and their employees, as well as for individual consumers.
7.1.1. Company & Employee Awareness

The city of São Paulo (2014) makes it clear in its Plan for Integrated Solid Waste Management that awareness campaigns should be part of environmental policies. Awareness campaigns for companies and other waste generating institutions have been requested in 2012 by decree 53.040. However, analyzing the activities that have been done so far, the municipality itself recognizes that the awareness campaigns have not yet been satisfying due to a lack of accompaniment by citizens for the results achieved, a lack of goal evaluation and dissolving of the services offered, which lead to a lack of credibility of the actions.

When talking to Brazilian entrepreneurs from the textile recycling sector five out of six interviewed stakeholders raised the topic that there is a lack of awareness across companies about textile waste. According to the CEO of the Brazilian Textile Scraps Exchange Company the lack of awareness already starts in the design phase of the products. She states that many Brazilian companies and consumers do not understand the problematic of post-consumption textile waste. She is convinced that the solution is actually to produce and consume less clothing but of better quality. Companies should produce products of higher quality and with a higher price.

“The solution is that we need to consume less clothes but of better quality.
However this is what our entrepreneurs do not understand.”
- CEO of the Brazilian Textile Scraps Exchange Company-

Furthermore she gave the example of a large company, which had donated a large amount of textiles, supposedly clothing, to an NGO. However, not even 10% of the donation could be used as second-hand clothing. According to her, there is a lack of awareness of what can and should be done with the waste, already at the textile producers level. She thus claims that raising awareness has to start with Brazilian textile producers, which then can raise the awareness of their customers. The general lack of awareness that textile waste is not an inferior product, but a valuable resource, is what the Brazilian sales representative of LaRoche, a leading French textile recycling technology firm, sees as one of the main problems in textile recycling in Brazil. He further states that there is a lack of knowledge among companies and employees about the usefulness of separation by fabric quality and color. The German Fachverband Textilrecycling (2015) underlines the economic and ecologic
importance of textile waste separation by stating that sorting adds very significant value within the textile recycling chain and leads to an improvement in the textile-recycling rate.

Two sustainability managers of the Brazilian Textile and Apparel Industry Association (ABIT) state not only the lack of awareness but also the lack of interest of many manufacturers in the topic, which they faced when introducing the RetalhoFashion project to fashion manufacturers. Even though no data could be found for all Brazilian manufacturers, Debastiani and Machado (2012) found that in Erechim, a city in Rio Grande do Sul, only 32% of textile manufacturers have a formal control system of their textile waste, showing the lack of awareness and interest among producers.

Inside the companies, the employees that are at the site of the textile waste generation seem to lack awareness in many cases as well. The general manager of JFFibras states that impurity of textile waste is one of the main bottlenecks in textile recycling and is the reason why he does not buy textile waste from certain regions anymore. Employees throwing all sorts of non-textile waste such as aluminum cans or organic waste into the textile waste cause this impurity.

However, next to the criticisms about textile manufacturers in the country, the case of the large Brazilian fashion company can show the positive effects that a sophisticated awareness can have on textile recycling. According to the sustainability analyst of the company, separation of textile waste has been in the DNA of the company from the day of its foundation. Therefore employees get used to the separation policies and the importance of separation from day one in the company. Within the company there are even employees that, among other things, are responsible for checking the purity of the textile waste. In case there is impurity, these employees go talk to the respective employee and make him aware that it is necessary to separate more thoroughly. According to Moro, Mendes and Amancio (n.a.) the company even has awareness campaigns and trainings in place for its employees.

According to the general manager of Stienemann GmbH, a German textile recycling company, in most of Germany’s textile producing companies there exists awareness for the importance of the separation of textile waste. However, it seems like this awareness does not primarily stem from environmental awareness, but rather from economic awareness. For many companies selling their separated textile waste creates significant additional income. Whenever different fabric qualities or colors are mixed this leads to significant decreases in the prices paid for the waste. If companies mix textile waste with organic or other waste, then the waste management companies picking up the waste even make them pay for it. The
general manager of Stienemann GmbH stresses that when for example in pure white cotton quality there is a single string of a colored fabric, it is considered as mixed colors and the price paid for it drops by 80%-95%. Therefore companies are well aware that they have to orderly separate the waste. The sustainability analyst of the large Brazilian Fashion company also stresses these economic factors as an important motivation to separate waste, creating a certain similarity to the German case. However it appears that many other Brazilian manufacturer are either not aware of the economic benefits of separating and commercializing their textile waste, or do not see it as economically viable for them.

7.1.2. Consumer Awareness

As Moro, Mendez and Amancio (n.a.) correctly state, “the success of reverse logistics depends largely on the final consumer” (p.4). Even though it is very important that companies and their employees are aware of the value that rests in textile waste, it is even more important that consumers have knowledge about the recycling potential of textile products, as they are the ones who finally become holder of the largest part of textile waste, i.e. post-consumption textile waste.

Stakeholders across the entire textile value chain in Brazil stated that there is a general lack of knowledge and awareness about textiles waste among consumers. The sustainability analyst of the large Brazilian fashion company stated that in entire 2016 he had not received a single contact by a client asking about the management of textile waste. This example shows that there seems to be a lack of interest in the topic, which most likely is a consequence of the lack of awareness.

“No one asks where the textiles come from, where it goes, if there is slavery. People want to buy what is cheap and looks nice and that’s it. (...) I never receive e-mails of consumers that want to know how we produce, what we do with the textile waste etc. In 2016 I did not receive a single e-mail related to that, not even by NGOs. So how could I say that the people are really worried?”

- Employee of the sustainability department of a large Brazilian fashion company -
Furthermore it was also stated by three out of six stakeholders, that the price sensitivity of customers in the country lets them buy what is cheap, not what has necessarily the best durability and best environmental balance.

In its Plan for Integrated Solid Waste Management the municipality of São Paulo (2014) criticizes itself that it had difficulties in creating the necessary general awareness concerning waste issues among consumers. Next to the difficulty the public sector is having, Grupo Malwee (2015) states that also for companies one of the most difficult tasks in changing the textile industry is raising the awareness of the customer. However, the CEO of the Brazilian Textile Scraps Exchange Company is still right, when she says that the awareness creation has to happen in a systematic way through companies, i.e. the private sector, as the public sector is failing to do so. Companies therefore must take over environmental education, giving consumers advice about where to discard their post-use clothing and what will be made out of it (Moro, Mendes, & Amancio, n.a.). The CEO of the Brazilian Textile Scraps Exchange Company states the example of C&A, which has recently launched its first ecofriendly shirt in Brazil. She states that just putting the product in the store with the corresponding marketing already creates awareness among many consumers, which may be a good starting point. Especially in light of the growing Fast Fashion industry in the country, education of consumers not only about post-consumption waste treatment is important, but also education about the vast environmental consequences that it takes to produce clothing.

An example for the potential of awareness campaigns in Brazil is the aforementioned case of Meias do Bem, organized by Puket, a brand of Grupo Malwee from Santa Catarina. As it is a social project, the company has been able to convince famous people to become ambassadors for the campaign, promoting it for free through their social media pages. This way of marketing has lead to a broad awareness among consumers. The project has turned that successful, that in the first four years the project has donated 15.000 popular blankets (Meias Do Bem, 2017a). By now over its entire short history of existence the initiative has been able to collect 600.000 pairs of socks (Meias Do Bem, 2017b). Even though it seems that customers are very susceptible for the recycling, it also needs to be mentioned that this project is of pure charitable nature and might thus specifically appeal to the Brazilian customers because of the social aspect. However, what it does show is that it is possible to convince customers to take the effort of bringing their used textiles to a collection place, when they see a deeper sense in it.
In Europe, the level of consumer awareness about textile recycling largely depends on the individual countries. The business development manager of the German Textile Collection and Sorting Company states that awareness and recycling behavior of consumers depends a lot on how the respective National Solid waste Plans are designed in different countries. She explains that if it is anyways clear for consumers that you have to separate waste (e.g. plastic, organic, glass etc.), then people also understand that textiles are a separate group of recyclable material. In Germany for example, which has a sophisticated system of separate waste collection in place, 86% of all citizens use the textile collection containers in order to discard their textile waste. This derives from various motivations such as protection of the environment, support for other people and organizations and the willingness that their clothing gets a second life (Fachverband Textilrecycling, 2015). It is fair to say that separating textile waste has become part of the culture in Germany over the past decades (Gulich, 2009). However it must also be stated, that many consumers in Germany think that all their discarded clothing is channeled as a donation towards underprivileged people, which actually is not the case, as shown in section six (Spiegel, 2013). It can be supposed that once consumers figure out that there is an entire business model behind the collection containers and that charity organizations collaborate with these businesses, it can lead to mistrust towards the collection system and have negative consequences on recycling behavior. It is thus important to create transparency about the entire process, underlining that it has a significant social value to discard the textile waste separately, both for charities and the environment, even if the clothing is not directly going to underprivileged people as a donation.

In the UK a study revealed that in 75% of the cases when people throw their textiles into the general household waste it is because they think that there is no further use for the item for anyone (WRAP, 2012). The study also states that a majority of people would like to receive more information by producers about their clothing. Furthermore people would actually be willing to separately discard their used clothing for recycling, when there is awareness that these products still have value, underlining the importance of education.

It can therefore be concluded that in Europe awareness can both stem from legislation, as in the case of Germany, and from producer initiatives, as customers in the UK demand it. A policy that reconciles this legal aspect with the initiative of the private sector is EPR. The European directive 2008/98/EC states in article eight section two about EPR, that EPR measures can include the “obligation to provide publicly available information as to the extent to which the product is re-usable and recyclable.” (p.312/12). According to EY (2012), France
gives a good example of how this directive created awareness in real life, through producer initiative: As a consequence of the legal establishment of EPR in the country, companies from the respective industries in France have teamed up to create producer responsibility organizations (PROs). These PROs serve to create economies of scale in collection and recycling. The producers outsource the management of recycling to these PROs and proportionately finance them. Next to these operational tasks, many PROs use websites, where they educate customers about circular economy and the right separation of the waste. The legal initiative of EPR has thus lead to the private initiative of the companies, creating awareness through their PROs.

Both in Brazil and in Europe there also exist examples of how textile producers can create awareness for the potential of recycling products, through offering products that contain recycled material at low prices. In Brazil this is the case of Grupo Malwee, which links its institutional campaigns to discounts for their sustainable products (Grupo Malwee, 2015). H&M in Europe similarly offers their “Conscious” Collection, which contains recycled fibers, at competitive prices. This practice enables to overcome the first barrier of customers getting in touch with recycled products and getting awareness for the issue. As it was mentioned before, price sensitivity in Brazil, and certainly also in Europe, leads to customers always buying what is cheapest. Through offering the recycled products at low prices thus a first touch point with customers is created in both countries.

Overall it can thus be said that in Brazil, awareness creation should become a task of the private sector, as the public sector is having difficulties in this. In Europe the public sector in parts of the continent created awareness through strict regulations and was able to incentivize private sector initiatives through EPR. Forbes (2015) summarizes the point when saying that similar to when people recognized “fast food” as a problem, as a lot of chemicals were used to produce it, this can also happen for textiles.

7.2. Waste Management

This section will be divided into pre-consumption waste management and post-consumption waste management. Each of these sections will be divided into internal textile waste management and external textile waste management, as it was defined in 5.4.
7.2.1. Pre-Consumption Textile Waste – Internal Waste Management

When it comes to pre-consumption textile waste as the input material for textile recycling, it cannot be stressed enough that maximum possible purity is the most important aspect. An efficient internal waste separation management in the textile producing companies should actually generate this purity. Firstly all type of contamination has to be avoided. This means keeping out non-textiles, but also protecting textile scraps from contamination through liquids. As the sustainability analyst of a large Brazilian fashion company points out, when textile waste gets wet, it has to go to the landfill, as it ecologically and economically makes no sense to dry it. Secondly, in the best case the textile waste would be even separated by fabric type and color. This allows textile-recycling companies to produce final products of higher value and gives the waste producers a larger return for their textile waste.

Five out of the six stakeholders interviewed in Brazil have mentioned impurity of textile waste as one of the barriers for increasing textile recycling in Brazil. As purity is often not given in Brazil, the textile waste recycling companies are even importing textile waste from other countries (Zonatti, Baruque-Ramos, & Duleba, 2016; Sinditextil, 2015). In 2012 the country imported nearly 10,000 tons of textile waste including scraps of “silk, wool and cotton, man-made fibers” (Zonatti, Baruque-Ramos & Duleba, 2016, p.6) with a value of US$ 11.4mn. However, a point that is often missed in the available literature about the import of textile waste to Brazil is that more purity is not the only reason for the import of textile waste from other countries. According to the general manager of JFFibras textile waste from abroad is also imported because certain fabric types and colors are not available in Brazil. When it comes to impurity and internal textile waste management in Brazilian confections, the general manager of JFFibras states that many companies simply do not have the separation of textile waste in their company culture.

“They (the confections) have a culture of treating the product as garbage, so they throw everything you can imagine inside the material, sometimes even organic waste comes inside the material (...). There is material that I stopped buying as it is very dirty/impure.”

- General Manager of JFFibras -

Zonatti, Baruque-Ramos and Duleba (2016) state that another reason is the lack of qualified and skilled labor inside the company, that cause the impurities, relating back to awareness and
knowledge as discussed in the previous section. The two sustainability managers of ABIT state, that it would actually already be an easy first step to simply put two different garbage bags next to the cutting table, one for textile waste and the other for non-textile waste. Further they state that there is a lack of interest or even resistance of confections to do this.

„In 2012 when we started the (RetalhoFashion) project, we saw that the companies did not have any interest at all in participating in a project like this. There was a need that they would have to engage themselves in the sense of not mixing organic and other waste with textile waste. This would already be a great step ahead only separating the textile waste from other waste“

- Sustainability Manager of ABIT-

The co-founder of Retalhar confirms this by saying that it costs a lot of effort to convince companies even of this small step. He also states that next to a lack of interest in the topic, for many small confections it is also an economic question. Their waste volumes are too small that it would not be worth to make a special employee responsible for the management of the residuals. With the increasing competition from China and resulting decreasing margins, every cent that can be saved in the production is valuable.

With regard to the size of the producers, the sustainability analyst of the large Brazilian fashion company confirms that for the company, as a very large producer it is also operationally easier to separate the waste due to the large amounts. Whereas in small confections on one cutting table various different types of fabrics are mixed, in large confections such as the large Brazilian fashion company one cutting table generally only generates waste from one type of fabric. The large amount of textile waste then also financially justifies it for the large Brazilian fashion company that they employ three persons only for the management of the textile residuals.

In Germany the sorting of the pre-consumption textile waste works fairly well, according to the general manager of Stienemann GmbH. As stated earlier, the recycling companies put their containers already at the generation site of the waste, so employees of confections get closer to the recycling process by seeing the external recycling company entering and managing these containers. It appears that the internal waste management in the company is mainly working well due to two different reasons: First, the existence of strict laws and penalization in case of non-compliance makes companies establishing management
systems. Second, for most of the companies it makes economic sense to separate the waste and sell it. However, to draw a parallel to Brazil it might also be a consequence of the industry structure in Germany. As a lot of smaller textile producing companies have left the country towards Asia in the past decade, nearly only large professional players are left on the market for whom recycling makes more financial sense. However, as opposed to Brazil, even smaller companies separate the waste, due to fear of conflicts with the law as there is no exception for small waste producers in Germany.

7.2.2. Pre-Consumption Textile Waste – External Waste Management

With regard to the external waste management of pre-consumption textile waste, there are still significant problems in certain parts of Brazil, one of which is the lack of a formalized and organized collection of textile waste in some parts of the country. This problem is especially present in the Brás and Bom Retiro neighborhoods in São Paulo, as the co-founder of Retalhar states. A peculiarity of São Paulo is that there exists a significant informal collection through catadores, which brings four main problems with it: the pollution of sidewalks, illegal activities to distort waste origins, the low financial attractiveness for catadores to collect textile waste instead of other materials and a closed system of informal catadores that is very difficult to formalize. As the CEO of the Brazilian Textile Scraps Exchange Company states, the catadores in the region working with textile waste do one of two things. On the one hand they collect the valuable textile patches that they can still sell to companies like JFFibras or Renovar, with the negative consequence that they leave the garbage bags open and pollute the sidewalks, but at least they create a positive impact for recycling. On the other hand, catadores seem to earn extra money through collaborating with confections in distorting the origin of their waste. This means that catadores are paid by companies in the area to take the garbage of the respective companies and leave it several blocks further away, so the municipality will not know who the actual generator of the waste is and cannot penalize the large producers generating over 200 liters per day. For the company it is cheaper than contracting a specialized waste company, as the NPSW would require it. The general manager of a large textile recycling company confirmed this practice.
“What happens is that for example someone generates 10 bags of waste a day. Then they call the catador to get it, pay him some money, and the catador takes it further away to hide who is the real generator."

- General Manager of a textile recycling company -

A further problem the CEO of the Brazilian Textile Scraps Exchange Company mentioned is the low value of textile scraps. Many catadores prefer to collect other more valuable material such as aluminum, where the same volume leads to a higher price, than collecting textile waste. The two sustainability managers of ABIT confirm this and state that on the one hand the low market price for textile waste and on the other hand the other opportunities to make more money with textile waste through other illegal actions, makes it difficult to formalize the work of the catadores.

According to these sustainability managers this has been a significant problem in the original outset of the Retalho Fashion project, mentioned earlier. Over the course of time the project management recognized that it was hard to get into the work of the catadores. According to the general manager of JFFibras the system of catadores is a completely closed one and as there are certain people that can live very well from it, so it is nearly impossible to get into it and formalize it. As a consequence the Retalho Fashion project, aiming at formalizing the waste collection in the region, changed its initial idea and now considers collaboration with cooperatives instead. According to Sinditextil (2015) the project is now in the implementation phase, however it is still not in practice, as the two sustainability managers of ABIT point out. After overcoming the barrier of getting some confections from the neighborhoods into the project, the project management realized that it was necessary to get the municipality on board, in order to get a physical space of where the waste could be separated by the cooperatives. Changing the focus of the project from catadores to cooperatives was helping in getting the municipality to participate, as it could be justified by the social value the project creates. Even though the project still has no physical space for sorting guaranteed, there is a prospect of a certain place, so potentially the project will become reality soon. Even though the entrance of the municipality into the project seems to have slowed down the project due to slower processes, it will significantly help in turning the project soon into reality.

The situation appears to be different in other parts of the country. According to the sustainability analyst of the Large Brazilian Fashion Company in Santa Catarina the external
waste management is more organized and catadores are rarely present in the system. According to the analyst, it is mostly recycling companies who directly pick the waste up at the companies and pay for the waste, if it is pure. This seems to be the consequence of two factors in the textile industry in Santa Catarina. Firstly, most producers in the textile cluster of the region are very large producers, so it makes it more convenient and economic to recycle. Secondly, as the sustainability analyst believes it might be a consequence of the strict fiscalization of the Electronic System for the Control of Movement of Residuals and Scraps (MTR) in Santa Catarina. According to the Industry Federation of Santa Catarina (FIESC) it is a system that each time when waste is transported to the final destination, it has to be accompanied by a Manifest of Residual Transport (MTR), which is issued and filled out by certified recycling companies. The waste producer has to electronically declare where it is sending the residuals and the receiving company has to confirm this, in order to close the loop. In Santa Catarina the textile waste management thus seems to work better as a consequence of the industry structure and legal aspects.

7.2.3. Post-Consumption Textile Waste – Internal & External Waste Management

The discussion of post consumption internal waste management will be done along with external management, as the topics are closely linked. The activities of the external stakeholders influence how private persons and companies can handle their post consumption clothing and uniforms, respectively.

When looking at post consumption textile waste and the internal waste management for consumers in Brazil, it can be said that the general lack of separate waste collection in Brazil makes it difficult for Brazilian consumers to separate their textile waste from other waste, once it has no further use. Corsten, Worrell and Dael (2012) make the general point for waste management in Brazil, that there need to be more opportunities to separately dispose different materials. In this they also recommend a particular collection system of textile waste, to increase the re-use and recycling of the same. The two sustainability managers of ABIT confirm this, as even though there is a general possibility of donating/discarding worn textiles with churches and charities, there is a lack of an organized, steadily available and coordinated collection of the material, as it exists through the textile collection containers in Germany and other European countries. The only activity giving consumers the opportunity to adequately
discard their textile waste at home in Brazil, is when charity organizations set up cardboard boxes in apartment buildings, to collect clothing donations.

The sock collection initiative by Grupo Malwee through its brand Puket can be a first step into the direction of collecting post-consumer textile waste in a structured way and giving consumers an opportunity to discard their waste. In their sustainability goals for 2020 Grupo Malwee established the goal of creating such reverse logistics systems also for the other brands of the company (Grupo Malwee, 2017).

A similar activity to the charity collections in Brazilian apartment buildings exists in Germany next to the already mentioned container collections. Commercial recycling companies organize curbside collections where they locate plastic buckets in front of private houses. This activity makes up for less than 20% of recycled clothing in the country. People can then put their worn textiles in these buckets. However, these collections are more costly than container collections, as more people are needed to distribute the buckets and collect them. Furthermore in recent years there have been a lot of illegal activities around curbside collections, as it has turned into a very profitable business, even considering the high labor costs (Fachverband Textilrecycling, 2015). Many of these curbside-collecting companies also pretend that the clothing is donated to people in Africa, whereas in reality it is sold to them (Spiegel, 2013). Here the state would need to exercise more control and rigidness, as these illegal activities can decrease trust in the textile recycling industry and have a negative impact on the recycling behaviors of consumers.

An ever more popular way in Germany is discarding textile waste at clothing retailers, as it is done in Brazil at Puket. In Germany by now 3% of post-consumption textile waste is collected through this channel, with a strongly rising tendency (Fachverband Textilrecycling, 2015).

Concluding it can thus be said that the two countries share certain similarities such as curbside collection, however in the case of Brazil a steady, widely available opportunity for consumers to discard their textile was, as it exists through containers in Germany, is still missing.
7.3. Legal aspects in textile recycling

As the business development manager of the German Textile Collection and Sorting Company stated, the success of textile recycling has a lot to do with the respective waste regulations in a country. Therefore it is important to analyze in what sense legal aspects in recycling differ between Europe and Brazil.

Since 2010 Brazil possesses the NPSW, as was elaborated in 5.1. When it comes to the NPSW four out of the six Brazilian stakeholders from the textile value chain interviewed agree, that the policy is not working whatsoever and the other two mention that it is only partly working. The main problem of the plan appears to be that it is not being sufficiently fiscalized.

“(…) Nothing has changed with the National Policy on Solid Waste; it did not make any difference (…). The policy is not being fiscalized”
- Interview with general manager of JFFibras -

The lack of consequent fiscalization in turn leads to producers not complying with the law, or working around it as it was shown for the case of São Paulo, where catadores distort the origin of the waste. The sustainability analyst of the large Brazilian fashion company mentions that also in Santa Catarina, where actually through the MTR fiscalization works better than in other parts of the country, several firms also do not comply with the law. According to the waste hierarchy introduced through the NPSW companies should not burn their textile waste, but recycle it. However he states, that many textile companies in the region still illegally burn textile waste they cannot sell.

A textile producer from the state of São Paulo even confirms, that he is not complying with the law, as there won’t be any consequences. As he does not have to fear any penalties, he still discards his waste on the sidewalk. However, it is not only an issue about textile producers, but also about companies using professional uniforms. By law they are required to correctly discard used uniforms. However, as the co-founder of Retalhar (2017), a startup offering recycling solutions for used uniforms, points out, also these companies do not care about the law. According to him the companies look at what their competitors are doing with the used uniforms, and as these also do not comply with the law, neither will they. He only sees a difference for multinational and ISO 14001 certified companies, as these companies
care more about compliance with environmental laws. Nevertheless, he further states that he can already see a sort of systemic effect that his company is causing concerning the recycling of used uniforms. Retalhar attempts to create awareness among companies about the existence of the obligation to professionally discard the uniforms, as well as about the security aspects it has to professionally recycle the uniforms. As he says Retalhar got contacted by a company and started negotiating with them about the discard of the uniforms of this company. In the end the deal was not closed, but a little bit later Retalhar received many calls from uniform confections that wanted to know how their business works as they had a client asking for the discarding of his old uniforms. All these confections told a similar story, so Retalhar understood that the company they had negotiated with created a bid request for uniform manufacturers specifying that the reverse logistics of the uniforms would need to be part of it. Awareness creation can thus go beyond the environmental aspects discussed in 7.1. and include legal awareness as well.

A consequence of non-fiscalization of the law is that innovation in textile recycling solutions in Brazil is rather slow. Would companies have to discard their waste appropriately, most likely a lot more initiative and innovation could be seen. First of all producers would try to even more reduce their textile waste. Second, they would have to become creative about how to productively use it. The Brazilian sales representative of LaRoche textile recycling technologies confirms this hypothesis, giving the example of some municipalities in the state of Paraná. According to him there are certain municipalities that strictly fiscalize the law, which had a positive impact on discarding behavior and gave a push to recycling activity in the region. Zonatti, Baruque-Ramos and Duleba (2016) state such a case for the municipality of Londrina, Paraná. According to them in 2011 the municipality started strictly auditing and penalizing textile waste producers. Before that, producers had behaved similarly as they still do today in São Paulo. According to the general manager of Stienemann GmbH, in Germany the authorities are not continuously and strictly controlling the compliance with the law. However, when they get hints from the local waste companies or other persons that companies are not separating their waste, the authorities strictly penalize it. Especially the example of Paraná state shows that a consequent fiscalization of the law can lead to positive consequences for textile recycling. Generally in Brazil there are stakeholders that complain about lacking market perspective for their textile waste. Pushing companies to collaborate and find solutions through fiscalization of the law may lead to fruitful results, as several European examples of cross-stakeholder activities show. Inditex for example works together with fiber
producer Lenzing in the design phase of its products, in order to increase recyclability of pre-consumption textile waste (Weilach, 2017).

In its article 33 the NPSW identifies six groups of products, for which producers, importers, distributors and sellers have to set up reverse logistics systems “upon receiving products from consumers not using public urban cleaning and solid waste management services” (Ministry of Environment Brazil, 2010, p. 14). The co-founder of Retalhar criticizes that textiles are not among these product groups. He states that the identified products are only selected based on their level of danger that they present when they go to the landfill, but not based on their production history. Looking at the resource intensive and polluting production of textiles, there is certainly an argument to include textiles as well in this list. The two sustainability managers of ABIT also criticize the lack of a reverse logistics requirement for textile producers. They state that even the current requirement that large textile producers need a certification that they contracted a special waste management company does not make sense in its current form, as these companies in most of the cases also just bring the waste to the landfill, just as the municipal waste truck would do.

Even though the European directive 2008/98/EC does not have any specific goals or legislation for textile recycling, it still has a section that indirectly incentivizes textile recycling: article 11 sets clear goals for recycling rates that countries have to achieve by 2020. The business development manager of the German Textile Collection and Sorting Company mentions that for the European countries textile recycling is a rather easy way to get closer to this goal, as textile waste streams are easy to catch, once an adequate infrastructure is set up. The directive also allows for EPR for textiles, as it was implemented in France. There it had positive effects on the amount of clothing collected, as the business development manager of the German Textile Collection and Sorting Company mentions.

Still the Boer Group Recycling GmbH (2016) proposes political actions that increase the global availability of separately collected used clothing and those that increase the demand for recycled fibers. In line with this reasoning Zacune (2013) proposes stronger government interaction, promoting “binding national legislation for high collection rates and investment in recycling infrastructure” (p.5). It shows that even though some European state governments are involved in the recycling process and promotion of it, there is still a lack of a coherent legislation. Clear rates of textile recycling could potentially lead to better results both in Europe and in Brazil. Furthermore the proposal by the Boer Group Recycling GmbH also touches on another issue, which is legislation that would increase demand for recycled
fibers. This could for example be a requirement of a minimum content of recycled fibers in new clothing. Technically it is actually already feasible to process a share of recycled fibers into new garments. The barriers why this is not happening more will be elaborated in section 7.5.

A further problem about the law in Brazil is that in some cities like in São Paulo small waste producers (<200l waste per day) are excluded from the obligations of certified disposal. These producers have even less motivation to start separating and prepare their textile waste for recycling, as they are actually complying with the law. In Bom Retiro and Brás 40% of the producers are considered such small producers. However, jointly they create large amounts of textile waste, which they can just discard on the sidewalk. In the German law for circular economy there are also exceptions for small producers, however these exceptions only hold if “for the respective waste an adequate disposal can be guaranteed” (Bundesregierung, 2012, p. 33), an addition missing in the decree no. 45.668 from the municipality of São Paulo.

All in all it can thus be said that law enforcement, binding recycling targets and textile recycling target laws in specific as well as universal legislation without exceptions can be layers to increase the textile recycling rates and innovation. Nevertheless, only laws cannot solve the problem. The CEO of the Brazilian Textile Scraps Exchange Company makes this clear when she mentions that there need to be more market perspectives for the discarded textiles and recycled fibers. This requires innovative business models around used and recycled textiles that are scalable and go beyond only small-scale handicraft use. Furthermore it needs technology that is able to appropriately process textile waste into new fibers. These issues of technology and market perspective will be discussed in the following two paragraphs.

7.4. Recycling Technology & Research

Once textile-recycling companies, that do not throw the waste on landfills, have collected the textile waste, it needs to be prepared for recycling, i.e. sorted and consequently processed in order to produce recycled fibers from it. The respective technologies needed are sorting technologies to separate different input materials and fiber-recycling technologies, as explained under 6.2.
When it comes to sorting technology, there still globally is a bottleneck in the availability of such technologies. Especially in Europe, where most textile waste is post-consumption waste sorting technologies would be needed. This is a consequence of the collection through containers, where consumers discard textiles of different qualities and different fabric types without separation. However, large-scale sorting technologies are not yet available. According to the business development manager of the German Textile Collection and Sorting Company the company does not expect solutions for this in the near future. She gives the simple example that even if a machine could differentiate between the qualities, there would still be the aspect of design. As in Europe a large share of post-consumption textiles is sold to Africa, generally clothing is not allowed to have holes. However, some jeans or shirts have holes as a fashionable element. A sorting machine would not be able to recognize such a whole as a design-element. Furthermore there is also not yet any technology available that allows sorting of textile scraps, as the general manager of Stienemann GmbH points out. Therefore both pre-consumption textile waste sorting and post-consumption textile waste sorting is still manual work, both in Europe and Brazil.

However, when it comes to processing technologies, i.e. fiber recycling machinery, as presented in 6.2. there are significant differences between Europe and Brazil. For Brazil, four problem areas in terms of technology are identified: underdeveloped nationally-produced technology, lack of research for textile recycling technologies, import barriers for European textile recycling technologies and innovation hindrances.

When it comes to nationally produced technology, according to the general manager of JFFibras the available machinery is not at all competitive with European technology. According to him, Brazilian technology has only around 20% of the production capacity compared to European machinery, which significantly limits the scalability of the fiber recycling process.

The underdeveloped Brazilian technology is the consequence of a second problem the co-founder of Retalhar (2017) points out, the lack of research and knowledge.

*I don’t think that technology directly is a barrier, but rather the lack of development of own knowledge and of having people researching about how to separate and recycle fibers etc. In my eyes we have a lack of technology only in terms of a lack of incentive to research (...) If we would produce knowledge we would maybe also produce machines.”*

– Co-founder of Retalhar –
According to him there is no support for research programs for textile recycling technology in the country. When analyzing the technology leadership of the European companies there appear to be two factors that have influenced this leadership position. On the one hand it has historically emerged in textile-producing clusters such as Prato in Italy, where business opportunities around used clothing had emerged. Companies like Dell’Orco & Villani and LaRoche have continuously developed their products further and invested in innovation, which today positions them among the market leaders in mechanical textile recycling machinery worldwide. Furthermore in Europe today next to the established companies there are startups such as Wornagain from the UK developing chemical textile recycling solutions.

On the other hand the European Union and its individual member states fund research programs that create advances in textile recycling technologies. One of many examples of such programs is Resyntex, a project that aims at improving the amounts and effectiveness of textile waste collection and develops new methods for high-value recycling, in order to create a closed-loop for textile fibers. The EU-funded project Trash-2-Cash focuses on the separation of fibers and a consequent spinning of the fibers into new yarns (Gulich, 2016).

Next to the state support, companies from the textile value chain in Europe have teamed up in order to research together for solutions in textile recycling. The project Mistra Future Fashion for example unites 12 research institutions and more than 30 industry partners along the textile value chain, among them H&M and the Red Cross, in order to find solutions to close the loop in the textile value chain (Mistra Future Fashion, 2017). Another cross-value-chain initiative is Fibersort, a project with stakeholders from Belgium, the Netherlands and the UK that develops a technology to separate clothing based on their fiber qualities (Interreg North-West Europe, 2017). These examples show how important collaboration along the value chain is. Furthermore there are independent research institutes such as the Saxonian Textile Research Institute (STFI) in Germany that push research along the textile value chain forward.

An overview of the activities can be seen in figure 7. It is shown that the increased research from all different stakeholders leads to innovative textile recycling solutions, which in turn lead to an increased textile recycling activity.
A consequence of the lack of highly developed technology is that Brazilian textile-recycling companies need to import most of their machinery. However, as there theoretically is a Brazilian producer of the machinery available on the market, high import tariffs are in place, making the acquisition of machines significantly more expensive. According to the general manager of JFFibras the availability of a Brazilian player creates problems when trying to import used-machinery. He states that when the company tries to import used machinery from another country, it will in most cases not be possible to get the machine out of the port once it arrives in Brazil due to the import barriers. Fees to get them out of the harbor would be that high, that it would be equally expensive to buy a completely new machine from Europe.

"So because of the existence of a national producer we are not able to bring used machines to Brazil. So either you buy a new machine from abroad, or you just don’t buy a machine at all. Because when you bring a used machine, it enters here into the port but it will not be allowed to enter the country. So then you would have to pay high fees to be able to get the machine out, and then the value will be equal to a new machine. So our industry generally does not have any incentive whatsoever to innovate"

- General Manager JFFibras -
This in turn according to the general manager of JFFibras leads to a discouragement to innovate. This lack of innovation among some textile recycling firms in Brazil is what the Brazilian sales representative of LaRoche sees as another principal barrier in textile recycling in the country. According to him Brazilian companies often use old technologies and are reluctant in buying innovative machinery that would actually make them better off. These investments, as he says, are often postponed until the last minute. He gives the example of a Brazilian textile recycling company that had bought 40-years old machinery from Argentina and asked him to update these machines. After he told them it was not possible they tried to do it on their own. When they then wanted to further increase their capacity shortly after, they bought a new innovative machine from Europe and were surprised to see the huge differential in quality, capacity, productivity and energy cost. Consequently they discarded the 40-year old machine and bought a second machine from Europe. According to the representative there is a lack of companies doing these cost-benefit analyses to recognize that innovation pays off quickly.

However, it might be too shortsighted to only put the responsibility for innovation on the producers of recycled fibers. A typical textile-recycling machine is a significant investment for textile recycling companies. According to the foreign trade director of the Turkish Textile Recycling Machinery Company a full new production line for fiber recycling costs around 600,000 Euros (±2.3 mn Brazilian reais\(^2\)). As interest rates are very high in Brazil, such an investment can turn out even more expensive, when it must be financed. Asked if there exist any incentives to innovate in forms of fiscal benefits by the government the general manager of JFFibras states that there is no support at all by the government. The consequence of all this is textile recycling technology in Brazil, that is not state of the art in many companies and presents a bottleneck in the recycling process. However, there are companies such as JFFibras that despite all these barriers steadily invest in new technologies and push the Brazilian textile recycling industry forward.

The ABIT (2012) has recognized the importance of innovation in the sector. The association states that new fibers and new technologies are at the base of a more sustainable production in the textile sector. Therefore the government should incentivize the private sector through tax incentives to innovate in the short-term and through research support for

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\(^2\)Values translated into BRL with EUR/BRL exchange rate from 22\(^{nd}\) of October 2017 of EUR 1=BRL$ 3.75 (XE, 2017)
machinery producers in the long-term, so that the country could build its own large-scale machinery without being dependent on imports from Europe.

Next to the aforementioned country specific issues, stakeholders in both Europe and Brazil mention other technology issues as a bottleneck for increasing the rate of textile recycling. The business development manager of the German Textile Collection and Sorting Company states that one of the main problems in the recycling of clothing is the length of the fibers, meaning that the reclaimed fibers are simply too short in order to create new clothes from it that would contain 100% recycled fibers. According to the sustainability manager of the large Brazilian fashion company the company is already using yarns from recycled fibers in their fabrics, however also not 100% due to the lower resistance of the yarn. It must therefore be mixed with a significantly larger part of yarn from virgin fibers (Around 85% according to the Brazilian sales representative of LaRoche). Through mixing recycled yarn with virgin yarn the large Brazilian fashion company is then able to produce products of the same quality as those from 100% virgin yarn. With recycling technologies that would not reduce the fiber length it could thus become possible to produce fine yarns and fabrics from 100% recycled fibers. Currently only grosser strings can be produced from 100% recycled fibers, as the Brazilian sales representative of LaRoche explains. The aforementioned company WornAgain is developing a solution for this problem, however it has not yet reached industrial scale. The innovation manager of one of Germanys leading textile-recycling companies sees these solutions as the key to future recycling that close the loop.

Overall it can thus be said that in Brazil textile recycling technology needs an upgrade, which can only happen if the government gives incentives and supports research, and if companies show themselves open to new technologies. Those companies that will continuously update their technologies and invest in research and development are most likely to survive and strive in the long-term. However, for recycling companies to invest in new technologies, they need a positive perspective about the market for their recycled fibers, which will be discussed in the next section.
7.5. Market Perspective

The market perspective for textile waste can be divided into two main areas: Firstly, second-hand clothing and secondly the target industries of the recycled fibers, as discussed in sections 5.5. and 6.5.

When it comes to used clothing, it was already discussed that in Europe there are specialized firms that collect this clothing, sort it and export it to Africa. In Brazil this does not exist, yet. First of all, according to several Brazilian stakeholders interviewed, in Brazil there is a strong culture of donating used clothing. As then the second-hand user of the product most often wear it until it cannot be used as clothing anymore, the market perspective of exporting the used clothing to poorer countries does not exist. Data of what percentage of used clothing is actually donated and how much directly goes to landfills without second-hand use is not available. Secondly, the quality of clothing generally depends on the wealth of a country, so in wealthier countries clothing is more durable, which makes it more attractive for export after use, as it is still in a good state. The business development manager of the German Textile Collection and Sorting Company states that already within the European Union quality differences can be seen, going in hand with wealth differences in the countries. As Brazil is still a comparably poorer country, exports of used textiles thus seem rather unattractive. However with a rise in incomes in the future, this option could become attractive, if the rise goes along with higher consumption of high-quality textiles. However, it must also be discussed that it cannot be a globally sustainable solution to simply export post-consumption clothing to poorer countries. Even though the clothing receives a second life, at one point it will also turn into waste. Therefore the waste problem in the exporting country, like Germany, is not solved but rather shifted to the poorer countries. The real solution would be fiber-to-fiber recycling, that closes the loop.

When it comes to the market perspectives for recycled fibers, the situation looks different. According to the CEO of the Brazilian Textile Scraps Exchange Company in Brazil there is a general lack of demand for products from recycled fibers. According to her, there need to be more products that can be produced from recycled fibers. However, this does not seem to be a particular Brazilian problem, but rather a global problem. In their study on barriers in textile recycling among European textile recycling companies, Elander and Ljunkfist (2016) find that when it comes to market perspectives in Europe there is an insufficient demand for recycled fibers from the fashion industry, textile producers as well as
recyclers. The business development manager of the German Textile Collection and Sorting Company states that technology needs to improve, in order to broaden the market for recycled fibers. In that she specifically mentions that new large-scale recycling solutions are needed that do not make fibers shorter, so that they can be 100% used in new garments. As currently technology is a bottleneck concerning fiber length it keeps the applications both in Brazil and in Europe limited to the B2B applications discussed in 5.5. and 6.5. with a strong focus on the car industry. The general manager of Stienemann GmbH estimates that in Germany around 80% of the recycled fibers go into the automotive industry. According to the general manager of JFFibras this used to be the same in Brazil, before the current crisis. Now around 60% of recycled fibers still go into the automotive industry, and the remaining 40% are divided between other industries, with an increasing focus on yarn and strings.

In Europe there are start-ups working on B2C applications of recycled fibers, however they are still not producing at large scale. The startup Steelcase for example has collaborated with a material design company, a textile manufacturer and a recycling company in order to develop furniture from recycled fibers (The Guardian, 2013). It is one more example from Europe, how collaboration along the textile value chain can have positive impacts on textile recycling. Also in Brazil there are similar initiatives by now. One of Brazils leading textile-recycling companies for example is working with clothing manufacturers in order to develop more products from recycled fibers.

As was discussed earlier, even though it is not possible to use 100% recycled fibers for the production of clothing, there exists the opportunity to use a small share of recycled fibers without sacrificing quality. Halimi, Hassen & Salki (2008) find that 15%-25% of recycled fibers can be used in new garments, without sacrificing quality. Two stakeholders interviewed in Brazil state that even though this opportunity exists, the textile industry in Brazil is very conservative and hesitates to use recycled fibers.

“There is a very conservative culture in the Brazilian textile industry. The industry is very old here, many times in the third generation. So they always produced and used yarn with virgin fiber, so it is difficult to tell them “if you use 1% recycled fibers, it will not make a difference in your final product”. They will not accept it.”

- General manager of a large Brazilian textile recycling company -
However, there appears to be an incipient awareness that recycled fibers can be used. As discussed in section 7.4. Grupo Malwee is already using yarns from recycled fibers in some of their products (EXAME, 2017). Also in Europe the use of recycled fibers in the industry is still incipient. H&M is using between 20% and 30% of recycled cotton fibers in their conscious collection, admitting that a larger share is not yet possible, as it would decrease quality (H&M, 2017). However it by far is still not a standard to use a share of recycled fibers.

Next to company initiatives another interesting approach to improve market perspectives for recycled fibers are government incentives to increase the recycled content in textile products. As EY (2012) explains, France has introduced incentives in its EPR schemes to use a larger share of recycled content in various product categories, among them in textiles. The incentive states that products with more than 15% recycled fibers receive an EPR fee reduction of 50%. Such incentives can lead to increased research in how to best use recycled fibers in textiles through producers.

An interesting question in terms of market perspective is if textile companies would generally switch to recycled fibers, if the raw material prices for virgin fibers increased, as discussed in 4.2. As Elander and Ljunkfist (2016) find in their study, the currently low market prices for virgin textile fibers are a barrier in the B2C market perspective of recycled fibers. The currently low virgin fiber prices lead to low prices of “virgin” textile products and thus to a discouragement of end-consumers to buy the more expensive products from recycled fibers. Recycled fibers in Europe cannot yet compete with these currently low prices. However the authors also state that this has been different some years ago, when virgin cotton fibers used to be more expensive. However, according to the general manager of JFFibras, in Brazil recycled fibers are significantly cheaper, which might make them more attractive in the country. The general manager of Stienemann GmbH makes the general case that a rise in raw material prices had given the industry a strong push in Germany after the Second World War, as raw materials for the textile industry were rare and costly. The general manager further says that in the European carpet industry the use of recycled fibers has become very attractive in the past years, due to increasing raw material fibers for virgin fibers. The Brazilian sales representative of LaRoche confirms a similar development in the carpet industry in Brazil. The sustainability analyst of the large Brazilian fashion company agrees that also for use in more textiles it could become attractive, once prices for virgin fibers reach a certain level. However, he adds that in Brazil this price level has not yet been reached.
Overall the market perspectives in Brazil and Europe seem to be similar and are mostly limited to B2B applications. However, with an improvement in technologies and rising raw material prices use of recycled fibers could become more attractive. This would have the positive consequence that also prices for recycled fibers would most likely rise, which in turn leads to higher prices for textile waste, incentivizing waste generators to better separate and recycle their textile scraps. Furthermore the currently small margins on recycled fibers that are a consequence of limited market demand are a problem when it comes to bringing textile waste from larger distances to recycling facilities as both in Brazil and Europe logistics costs are rather high (General Manager of Stienemann; General Manager of JFFibras). With an increase in recycled fiber prices, margins would rise and it could become profitable to source textile waste also from regions of the countries where it currently is not yet profitable due to the distance, leading to an overall increase of recycling rates.

7.6. Cooperation among stakeholders along the value chain

The Boer Group Recycling GmbH (2016) states that the dialogue and exchange of information between the stakeholders along the entire value chain can support textile recycling. Also Carter and Rogers (2008) underline the importance of vertical coordination, as a consequence of rising resource dependence. Pagell and Wu (2009) propose that “managers of sustainable supply chains will collaborate with nontraditional members such as NGOs, regulators, competitors and members of the community” (p.52). It was already shown in section 7.4. that such collaboration among partners along the textile value-chain is already happening in Europe and is fostering innovation.

Two of the Brazilian stakeholders interviewed mentioned that there is room for improvement in the communication and collaboration among stakeholders of the Brazilian textile value chain. In Germany there is an organization, the BVSE, which represents the interests of the general recycling industry including the textile recycling industry. The association organizes congresses for its member companies and informs about recent developments in the industry. Furthermore the “Community for Textile Future” (German: Gemeinschaft für Textile Zukunft) is an association specifically formed by recycling and sorting companies such as the Boer Group Recycling GmbH, SOEX textile recycling and
other leading players from the industry, that promotes textile recycling (Gemeinschaft für Textile Zukunft, 2017).

Even though in Europe there already exists a decent level of cooperation among stakeholders, Elander and Ljunkfist (2016) find in their research among companies along the textile value-chain that each group of stakeholders sees the duty to overcome the most significant barriers in fiber recycling in different areas of the value chain than the own area. This in turn shows how interdependent the textile value-chain is and how important communication and cooperation is. Interestingly a similar impression was gotten in the interviews administered with Brazilian stakeholders. None of them saw its own part of the value-chain as a bottleneck, but other players. One textile producer stated that in entire Brazil there is actually no textile recycler that is able to recycle woven materials, as the technology does not yet exist in Brazil, even though it is available in Europe. Asking the general manager of JFFibras if that is correct, he said that this is not at all true and that he daily processes a lot of woven material in his factory. The point that shall be made here is that this example shows how important communication and information across the value chain is, in order to increase and improve textile-recycling activities in Brazil. It therefore also for Brazil strongly calls for increased cooperation among the stakeholders in order to improve the industry success as a whole.

7.7. Government Support & Programs

In 7.3. it was already argued that the government can positively influence textile recycling through recycling legislation. Section 7.4. about textile recycling technologies touched upon the advantages that government support of research programs in Europe brings. Government support can take three different forms, namely support through fiscal incentives, funding for textile recycling projects and operational support for recycling projects.

When it comes to the first two categories, according to all Brazilian stakeholders interviewed, there is no support by the government, neither on a country- nor on a state-level. According to the two sustainability managers of ABIT a proposal (Projeto de Lei 657/2013) to introduce a fiscal incentive for fiber recycling companies in São Paulo was declared unconstitutional and went back to the chamber. Currently it is being redesigned and there will be a second attempt to pass it. Interestingly the NPSW even calls for such incentives, as it
states in article 44 of the policy that “The Federal Government, the states, the Federal District and municipalities, within the scope of their competences, might institute norms aiming at granting fiscal, financial or credit incentives, (…) to industries and entities dedicated to reuse, treatment and recycling of solid waste produced within the national territory” (p.18). Currently as for the general implementation of the NPSW was shown also this aspect does not seem to be implemented.

The third category, which is operational support for recycling projects, does exist in Brazil. The project Retalho Fashion has entered into a partnership with the municipality of São Paulo, which will provide a physical space for the project. It is a good example of how a public-private partnership can lead to positive impulses for textile recycling. Interestingly the NPSW (2010) actually even calls for such partnerships, as it establishes as its principle VI under article six the “cooperation among the different levels of the Public Authority, the entrepreneurial sector and other segments of society” (p.3.).

It can overall be said that Brazil is running behind what it set itself as targets in terms of government support through the NPSW. Incentives and support in various forms need to be introduced in order to make textile recycling more attractive. As mentioned in the previous sections, margins in textile recycling are very thin and can turn a lot of promising projects unprofitable. However, with government support these projects that bring a benefit for society at large could be realized, as the example of Retalho Fashion in São Paulo perfectly shows.

7.8. Social aspects in Textile Waste Recycling

The foregoing analyses evolved mainly around environmental and economic sustainability of textile waste management. However, as shortly touched upon in 7.1.2. (Consumer awareness) there is also a significant social aspect in the collection of textile waste, especially in the Brazilian context. As opposed to the European directive 2008/98/EC the Brazilian NPSW (2010) clearly recognizes the social value that recycling creates. Principle eight of the plan is the “recognition of recyclable and reusable solid waste as an economic asset with social value that generates jobs and income and promotes active citizenship” (p.3) and thus recognizes the important social importance of work related to solid waste.
In Brazil these social aspects are divided into three different areas. Firstly the donation of clothing, secondly the work of NGOs and social businesses around textile waste and thirdly the value it creates for catadores and cooperatives.

With regard to the donation of clothing it was already discussed in 7.1.2. that according to the stakeholders interviewed there is a strong culture of donating used clothing to poorer people in Brazil. As according to both the European and the Brazilian waste hierarchy reuse is to be preferred to recycling, this culture of donating clothes and extending its life is very beneficial for social and environmental sustainability. Extending a clothing product’s life by three month already decreases its water and carbon footprint by five to ten percent. As it can be assumed that in Brazil donated clothes are worn longer than only three month, the positive aspects for the carbon footprint of the products are even larger. Furthermore the success of Meias do Bem shows how susceptible Brazilians are for donations through reverse logistics systems of companies. Paired with the right marketing that convinces the people that they are doing good through their action, such initiatives could have a large potential for the future. According to Grupo Malwee (2015) the initiative initially was actually only an internal one where the brand collected socks with defects and textile scraps from the production process to then recycle the fibers and make blankets from it. As the initiative turned out to be a great success, the brand decided to involve its customers. It shows how small initiatives can actually grow into large movements creating an impact for many underprivileged people in the Brazilian society.

In Brazil there are furthermore several NGOs and social businesses working with textile scraps and the management of post-consumption clothing. Among them there is Projeto Arrastão, which works collaboration with the Instituto Campana. Since 2014 the two organizations collaborate together and help people from underprivileged areas produce furniture and other products from textile waste originating from the production of jeans. The furniture is then consequently sold and creates revenue for the people (Projeto Arrastao, 2017). Another NGO working in the area of creating awareness for responsible fashion consumption is the Instituto Ecotece. The institute has as a mission to change the logic of production and consumption so that fashion can be more ethical, cleaner and more inclusive (Instituto Ecotece, 2017). To reach this mission the NGO organizes different projects, such as Comunidade EcoFashion, which is a project that unites recycling, fashion, culture, environmental awareness creation, exposition and dance. The project is administered in schools and invites children to create their own clothing and reflecting on their own
consumption habits, thus sustainably influencing consumption behaviors of future generations. Next to the NGOs with Retalhar there also exists a social business working with the goal to increase sustainability in the textile value chain. As mentioned earlier the company collects used professional uniforms and prepares them for recycling. That the country has a lot more opportunities to offer when it comes to textile recycling and social initiatives gets clear in a thesis cited by Sinditextil (2014). The thesis suggests that the large amounts of police uniforms discarded in Brazil each year could actually be used to start a social project with prisoners who could transform the uniforms into handicraft products like small bags or toys. These could then be sold in a store next to the prison and the revenue would go to the prisoners.

Besides all the foregoing discussion of professionalizing and improving textile recycling in Brazil, it also must not be forgotten that in Brazil generally waste management contains an important peculiarity, which are the catadores and cooperatives. For them the collection of recyclable material creates revenue that sustains their families. This is a reality, which does not exist in Europe. Waste-pickers and cooperatives are such an integral part in Brazilian waste-management, that they are mentioned in the NPSW (2010) various times as a fixed element that needs to be supported and respected. One of the objectives of the policy even is the “engagement of waste-pickers collecting reusable and recyclable material in actions that involve shared responsibility over products’ life cycle” (p.4). One of the instruments of the NPSW are incentives to form and grow cooperatives. In order to do so article 44 of the policy states that authorities can grant fiscal and financial incentives to projects that include cooperatives created by low-income citizens. Article 42, section three calls for support for cooperatives through authorities in form of physical infrastructure and equipment. It thus clearly shows the importance of the inclusion of waste-pickers and cooperatives in recycling activities. The project RetalhoFashion discussed earlier is one of the first projects tackling textile waste from a social perspective, integrating cooperatives in their approach and putting the above-mentioned policies of the NPSW into action. Whereas currently one could get the impression that the catadores especially in Bom-Retiro and Brás represent a problem in proper waste management, they certainly need to be part of the solution. This could for example happen through empowering the catadores through education and integrating them into future waste management activities of companies in the area.

For Brazil even though many of the social activities are yet rather small scale, they can definitely create a great impact in the future. With more support of the government and
increased collaboration among them, they have the potential to grow significantly larger. The example of Meias do Bem by Grupo Malwee has shown how a small initiative can actually quickly grow to something big, once it receives the necessary support.

In Europe the social role of textile recycling can be divided into the aspects of NGO activities, social businesses and job creation. Most of the social value is created through second-hand clothing.

In section 6.4 it was explained that the Red Cross and other charity organizations in Europe collect textile waste or license their names and then consequently sell the collected material to sorting companies that commercialize it mostly in Africa. The licensing fees and revenues from the sale of the collected textiles are significant financial sources of the organizations and finance social projects. However, not all of the clothing is actually sold. A small share of it also remains in the respective countries and is donated or cheaply sold through second-hand shops to underprivileged people. In Germany for example, the Red Cross operates more than 800 so-called “Kleiderkammern”, benefitting more than two million people per year in the country (German Red Cross, 2017a). As around 10% of the collected textiles from the containers is not sold to the commercial companies, the organization can fall back on a significant amount of clothing (German Red Cross, 2017b). People with low incomes can go to these establishments, where they get clothing for free or against a small donation.

Similar to Brazil, also across Europe there are social businesses in the area of textile recycling. One of them working with second-hand clothing in Europe is Humana. The company works similar to the textile collectors and sorters mentioned earlier, however it strongly focuses on creating social value. The company collects clothing in containers and aims at selling as much as possible of it in Europe as second-hand clothing. To do so the company operates more than 20 second-hand shops across Europe. As a social business the company reinvests all its profit into human and environmental development (Humana, 2014).

Another, rather general social factor around textile waste management is the creation of jobs in the industry. Both in Brazil and Europe, jobs are being created through the growth of the industry. This does not only create social value from the perspective of the person getting out of unemployment, but also for the state. In France for example the state pays around 20,000 Euros annually to help an unemployed person. However, to integrate an unemployed person in the area of textile collection, reuse and recycling the country only needs to pay 10,000 Euros. This is not only a single payment as opposed to the annual help
payment, but it is also an investment in sustainable jobs and a skilled workforce (Zacune, 2013).

Overall it should thus become clear that the work around textile waste creates significant social value in Europe and Brazil. It is important that this social value is acknowledged by the authorities and integrated in legislations around waste management. Brazil has already done so, however Europe still seems to lack this consciousness.

<table>
<thead>
<tr>
<th>Category</th>
<th>Brazil</th>
<th>Europe/Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness &amp; Education</td>
<td>- Lack of awareness among consumers and companies</td>
<td>- Company wareness as result of economic advantage they can get</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Consumer awareness depends on rigidity of waste legislations</td>
</tr>
<tr>
<td>Waste Management</td>
<td>- Company separation level varies across regions &amp; depends on size</td>
<td>- Separation is commercially beneficial</td>
</tr>
<tr>
<td></td>
<td>- Limited options to separate text. waste</td>
<td>- Extensive textile collection infrastructure e.g. in Germany</td>
</tr>
<tr>
<td>Legal Aspects in Textile Recycling</td>
<td>- Lack of fiscalization of NPSW</td>
<td>- Binding overall recycling targets indirectly incentivize textile recycling</td>
</tr>
<tr>
<td></td>
<td>- Law exempts small producers</td>
<td>- Possibility of EPR for textile</td>
</tr>
<tr>
<td>Recycling Technology &amp; Research</td>
<td>- Very limited national offering of technology and little research</td>
<td>- Market leadership in technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Strong investment into research in several countries</td>
</tr>
<tr>
<td>Market Perspective</td>
<td>- Limited to recycled fibers in specific industries</td>
<td>- Limited to recycled fibers in specific industries</td>
</tr>
<tr>
<td></td>
<td>- More applications needed in order to increase recycling activities</td>
<td>- More applications needed in order to increase recycling activities</td>
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<tr>
<td></td>
<td></td>
<td>- Commercialization of used clothing</td>
</tr>
<tr>
<td>Cooperation among Stakeholders</td>
<td>- Lack of cooperation</td>
<td>- Cooperation supported through stakeholder initiatives and industry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>associations</td>
</tr>
<tr>
<td>Government Support &amp; Programs</td>
<td>- No specific support programs for textile recycling</td>
<td>- Several funding programs from member states and EU</td>
</tr>
<tr>
<td>Social Aspects in Textile Recycling</td>
<td>- Used clothing donation creates strong social value</td>
<td>- Lack of transparency in donation of clothing</td>
</tr>
</tbody>
</table>

Table 6: Overview of analysis results by category
8. FUTURE OF TEXTILE RECYCLING

After the analysis of the interviews and related secondary data, this section will give a short outlook on the future of textile recycling based on review of secondary data from companies and newspapers.

The future of textile recycling will mostly depend on two factors: the development of new technologies in fiber recycling as well as an expansion in products in which recycled fibers can be applied.

Companies like Teijin, Lenzing or re:newcell are developing chemical and biochemical recycling technologies that are promising when it comes to the fiber length (Boer Group Recycling Solutions GmbH, 2016). Other startups like WornAgain or Evrnu are startups backed by prestigious companies such as H&M and Puma, that also develop a chemical, instead of a mechanical recycling technology. The chemical process enables the reclaiming of fibers in their original length, thus solving the fiber-length problem explained earlier (Sueddeutsche Zeitung, 2017). Once this barrier is overcome and these technologies are able to recycle fibers on a large scale, a completely new market for recycled fibers will open up, namely the use of 100% recycled fibers in textiles.

Until this happens it is important that further product applications are developed, in order to increase the global demand for recycled fibers. Already today new applications are being developed, such as the use of textile waste cardboard for the construction of furniture. The British designer Max Lamb has teams up with a textile company and another startup to produce furniture from textile scrap. They use solid textile board (STB) to build furniture. STP is an upcycled construction material from recycled fibers mixed with binder, which are then pressed into sheets (AD - Architectural Digest, 2017). The final product can be seen in annex 6. The development of more applications for mass markets will increase the demand for recycled fibers, which in turn leads to a larger demand of textile waste and increases the textile-recycling rate.
9. CONCLUSIONS AND RECOMMENDATIONS

Concluding, this research has shown that in Europe there is a solid industry and established practices for the recycling of textile waste, even though also the European textile industry faces challenges and has potential to improve. What has become most apparent is that for Brazil, there are several levers on how the country could improve textile waste recycling. As the most relevant levers the fiscalization of the law, the need for innovation in technology and national research, the cooperation among stakeholders and the improvement of the market perspective for textile waste and its derivative products have been identified, where the latter aspect however seems to be an international and not a specific Brazilian problem. In terms of social aspects in textile waste recycling it seems like there are certain lessons that Europe could learn from Brazil, e.g. respecting and integrating the social value (textile) waste recycling can create for the society.

As the main objective of this research was to give Brazilian and European companies from the textile industry as well as policy makers insights on how they can improve the recycling processes in their respective countries and potentially capitalize the findings this section will give actionable recommendations for both regions derived from the analyses and discussions done in section seven. These recommendations have a focus on Brazil but also include Europe and answer more specifically the research question how governments and stakeholders along the textile value chain in Brazil and Europe can learn from each other.

The analysis indicates that in Brazil there is a lack of awareness about the value of textiles and the recycling possibilities. Generally recycling begins with the awareness of consumers about the value of recycling (WRAP, 2017). As also textile-recycling starts with such an awareness of the potential of processing the textile waste, the creation of awareness should be supported.

**Recommendation 1:** In Brazil there need to be awareness campaigns for companies, their employees and consumers stressing the environmental impact textile production has and teaching the value that both pre-consumption and post-consumption textile waste have.

From an internal waste management perspective data has shown that in many Brazilian textile companies waste is not yet being separated, a circumstance that can actually easily been changed with a very positive effect on recycling.
Recommendation 2: Both in small and large Brazilian confections, separate waste collection has to be implemented. Industry associations and the government have to show companies that it can make economic sense to separate the waste.

Abbasi and Sheikh (2016) show that monetary aspects influence the motivation to recycle and separate waste. For many small Brazilian producers textile recycling might on first sight just be an expensive undertaking, creating no or little value.

Recommendation 3: It might be interesting to present the business case to entrepreneurs of how much they could get for their textile waste. For small companies it could even be interesting to pool their waste in order to commercialize it. Here it could also be taught that there does not have to be a special employee taking care of textile waste management. If the company administration makes it part of the company culture to separate the textile waste, all employees will do it.

External waste management in Brazil still seems to be rather opaque and it is hard to follow waste streams. More organization that creates transparency is needed.

Recommendation 4: In order to increase textile recycling and proper waste management, more transparence needs to be created concerning disposal of waste.

Domina and Koch (2002) investigated accessibility to recycling as a predictor for recycling frequency and found that among others convenience resulting from easy access to recycling, is a significant predictor for the frequency of peoples’ recycling activities. In Brazil from a consumer perspective there are no easily accessible collection points for post-consumption textiles available, as they exist in Europe. As a consequence it is hard for consumer to correctly discard their textile waste.

Recommendation 5: In Brazil fixed collection points such as containers for the collection of textile waste could be set up in order to increase convenience for consumers. This will require a significant logistics effort, which could be done by textile recycling companies, municipalities or even by producers, based on obligations through extended producer responsibility. This way high-quality products can be collected for donation as well as end-of-life products, which can be channeled, to textile recycling companies.
One of the main problems identified in textile-waste recycling in Brazil, especially for pre-consumption waste, is the non-fiscalization of the NPSW, which disincentives compliance with the law by companies and research for innovative textile recycling solutions.

**Recommendation 6:** In Brazil there needs a stricter fiscalization of the NPSW in order to increase textile recycling activity and innovation in the sector. Furthermore binding targets for the recycling of textile waste both in Europe and in Brazil could be introduced, as long as they are designed in a flexible way, so municipalities can adapt policies to their own needs. The law should also be universally applied without exceptions for small producers. An overview of the legal suggestions can be seen in figure 8.

![Figure 8: Legal suggestions to increase textile recycling](image)

**Recommendation 7:** Brazilian textile-recycling companies have low incentives to innovate in terms of machinery, as it is costly and there is no national competitive production of the necessary machinery, as it exists in Europe.

**Recommendation 7:** In the short term, to incentivize the acquisition of innovative textile recycling technology, the Brazilian government should give fiscal incentives to textile recycling companies. In the middle to long-term, the government and companies should invest in research for innovative textile recycling technologies, in order to develop competitive national technology.
A significant bottleneck in textile recycling are the low prices for the output material, which are recycled fibers. With more demand for these fibers prices for textile waste would rise and make textile recycling more attractive.

**Recommendation 8:** To make textile recycling more attractive, new applications for recycled fibers need to be developed both in Brazil and Europe. Industry associations as well as the government and companies could support such initiatives.

The Harvard Business Review (2014) states the importance of cooperation among stakeholders along value chains, in order to reach systemic change. In Brazil there still is a lack in such cooperation and communication among the stakeholders along the textile value chain. Europe gives good examples of how communication and cooperation can positively influence textile recycling.

**Recommendation 9:** In order to increase cooperation and communication among players along the textile value chain, it is recommended that in Brazil an industry association for textile recycling companies is established, following the example of the German BVSE, including companies related to the collection and processing of textile waste. Such an association would give the nascent industry a unified voice and could represent its interest facing the government and the textile producing industry. It is important that such an organization has a strong link to the ABIT, in order to stimulate the necessary cooperation along the textile value chain that is necessary to improve textile recycling.

In line with Carter and Rogers (2008) who introduce sustainable supply chain management it was discussed that textile recycling actually goes beyond only economic factors. The sector fulfills a significant social function, which shall not be ignored.

**Recommendation 10:** In designing future waste policies and actions, both governments and the private sector in Brazil and Europe shall acknowledge the social value it creates and actively integrate groups such as catadores or unemployed people in their actions.

Overall it is important that these recommendations are being implemented respecting the local peculiarities both in Europe and in Brazil. There are certain similarities in the markets but even more differences in the basic structure of the textile industries, which need to be respected.
10. FUTURE RESEARCH & LIMITATIONS

10.1. Future Research

With the course of the present research, potential fields of further future research have emerged. Firstly, future research could analyze textile recycling based on individual fiber types, in order to get a more detailed perspective of recycling of different fiber types. Secondly, it would also be of value for practitioners to investigate the potential introduction of extended producer responsibility for textiles in Brazil, as it exists in France. Such research could include an analysis of what role catadores and cooperatives could play in such an EPR scheme. Thirdly, research analyzing the involvement of social organizations such as churches and NGOs in the clothing collection could be interesting. The interviews conducted for this research have shown that little is known about the sector. Fourthly, following the example of this research, the Brazilian and European textile recycling industries could be compared to other countries. Lastly, it could be interesting to research how consumption patterns are changing towards fast fashion and how these patterns could be influenced and slowed down, consequently decreasing the amount of textile waste.

10.2. Limitations

Even though this research has been conducted with a high degree of care for objectivity and a correct representation of the textile recycling landscape in Brazil and Europe, it has certain limitations.

In each region around five stakeholders were interviewed, always one player from each individual part of the value chain. This makes the research relying to a certain degree on subjective perceptions of the people interviewed, which could potentially be biased. Another weakness of the research is that in Brazil the research was mainly focused on the south of the country. However, this should not be a significant problem, as 78% of the Brazilian textile industry is concentrated in this area (Lectra, 2014). Furthermore the data quality for textile recycling especially in Brazil is still rather low and estimates of key data widely differ.
11. CONTRIBUTIONS

The present research contributes to the existing literature both in Brazil and in Europe. Whereas existing literature in Brazil is limited to specific cases or regions, this research has analyzed the industry from various different perspectives and thus created a more holistic analysis of the industry. Furthermore the focus of the identified existing literature in Brazil was only the industry in Brazil, whereas this research sets the Brazilian and the European textile recycling industries into and international perspective. Additionally this research adds value for stakeholders across the textile recycling value chain in Brazil, as, to the best of our knowledge, it is the first to give specific recommendations in various different areas on how to improve textile recycling.

For Europe this research contributes especially in terms of comparing the textile recycling industry with a Latin-American country. It can thus potentially show European stakeholders how to support the Brazilian market and cooperate with Brazilian stakeholders.

Overall this research contributes especially to the improvement of processes related to the management and collection of textile waste. This research does not have the aspiration to be a contribution to the development of textile waste recycling technologies from a technical perspective, but rather from a process perspective.

12. FINAL CONSIDERATIONS

The present research has analyzed the Brazilian and European textile industries and derived recommendations on how both industries can learn from each other and increase the recycling activity. This is especially the case for Brazil. In doing so the research has shown that there exist severe differences when it comes to internal waste management activities and the fiscalization of recycling laws. Furthermore it was shown that the Brazilian government needs to make investment in recycling technologies more attractive, but also that companies both in Europe and Brazil have to invest in research about further applications of recycled textiles. The research has moreover shown the importance of communication and cooperation of players along the textile value chain in the two regions. Furthermore it was shown that textile recycling also always has a social component, which additionally to all economic analyzes
has to be analyzed, in order to create a true triple bottom line result of economic, social and environmental performance, leading to overall sustainability in the supply chain, as suggested by Carter and Rogers (2008).
ANNEX

Annex 1: Recycled fibers by Virgeflextx/Renovar Textil (Renovar Textil, 2017)
Annex 2: Textilmaq Products (TextilMaq, 2007)

**Desfiadeira**

Maquina para reciclagem e beneficiamento de apas de feltros e resíduos textis em geral.

- Motor principal 30 a 60 hp
- Esteiras de entrada com moto redutor e inversor de frequência e reversão
- Esteiras em pvc
- Todos os pontos críticos da máquina com proteções
- Trava de segurança
- Exaustor coletor de pó com motor de 5 hp
- Beneficiamento de fibras textis

**Cortadeira tipo Guilhotina**

- Com faca e batente
- Com opções de tamanho em 450 mm e 550 mm de largura
- Esteira de entrada em PVC com variação de velocidade
- Corte de fibras textis
Annex 3: LaRoche Exel textile recycling machine (LaRoche, 2017b)
Annex 4: Clothing collection containers in Germany (Red Cross Bad Saulgau, n.a.)
Annex 6: Furniture from textile waste (Deezen, 2017)
Appendix 1: Interview Questionnaire

SURVEY

 '>' Introduce myself, explain why I am in Brazil and what my background is

 '>' Give following information before starting interview:

Dear Participant,

Thank you very much for your willingness to participate in this interview, which will take around 30-45 minutes [varies depending on stakeholder]. With this interview I am examining textile recycling (supply chain/industry/practices) in Europe and Brazil and how both countries/continents can learn from each other in terms of technology, market perspective, legislation and waste management. I will be more than happy to share my results with you once I complete my thesis in December.

For my purpose of note taking I would kindly like to ask you if I can record this interview so later on I can better analyse the results. The recordings will only be used for the purpose of this thesis and deleted afterwards.

Furthermore I would like to ask you if you wish to be cited anonymously in the thesis or if I can cite the information you provide with the company name?

In case you want to know more about the thesis feel free to contact me whenever you want.

Once again thank you very much for participating!

 '>' Hand over my business card for potential follow up questions
Complete these questions to understand background of interviewee:

What is your age? _______________

Are you: female / male

How many years have you worked for this organization? _______________ years

Which position do you currently hold? ________________________________

How many years have you held the position you currently hold? ___________ years

Indicate the sector in which company/organisation operates:

☐ Textile Producer ☐ Recycling Technology Producer ☐ Textile sorter/cooperative
☐ Textile Recycler ☐ Industry association ☐ Other: __________________________
General questions:

• Where do you currently source textile waste from? [Ask to sorters and recyclers]
  o Do you import most of the textile waste or get it from Brazil? If you get it from Brazil, where do you get it from? If you import it, why do you do so and where do you get it from? [Ask Brazilian Recyclers and Sorters]

• What are your most important markets? Why is that the case? Is the recycling industry especially welcomed there due to regulations/subsidies? [Ask Technology companies, sorters and recyclers]

• How does the recycling process of textile waste currently work in your company/country? [Ask textile producers and industry associations]

• What do you identify as the most significant barriers towards textile recycling in your country?

Questions related to technology:

• What technologies are you currently employing in textile recycling? [Question mostly relevant for textile sorters and recycling companies]
  o Test for sorting solutions
  o Test for mechanical solutions
  o Test for chemical solutions
  o Test for origins of technologies

• Where do you see the biggest challenges in textile recycling technology?

• What do you think will be the future of textile recycling? How promising is chemical recycling in order to reduce prices for recycled fibres, that also have the necessary length?

• Do you think that prices of recycling machines are a potential barrier for developing countries to acquire these technologies [mostly relevant for Brazilian stakeholders and European technology companies]

• Do you know of any countries subsidizing the acquisition of recycling technology? [Mostly relevant for European technology companies and international recycling companies]

Questions related to market perspective:

• How do you see the market for recycled fibres in the textile industry in your region? [Ask for Europe/Brazil respectively]
  o Often, the fiber length of recycled textiles is mentioned as a barrier for using it for the production of new textiles. Do you think that recycled fibres could be a potential input for the fast-fashion industry where durability of the clothes is not that important?
• Test for demand
• Test for sanity of margins

• With an increase in raw material prices, how likely do you think it is that textile producers would switch to recycled fibres instead of using virgin fibres in your country?

• How do you see the market for downcycled fibres in the textile industry in your region? [Ask for Europe/Brazil respectively]
  o Where do the downcycled fibres mainly go in your country?
    • Test for car industry
    • Test for furniture industry
    • Test for insulation industry
  o Test for demand
  o Test for sanity of margins

Questions concerning legislation and government:

• Do you think government intervention can help in increasing the recycling rate in your country?

• Do you have any experiences with countries where e.g. technology is subsidised or textile recycling companies get certain tax advantages?

• What is your experience with extended producer responsibility? Do you think it can increase the recycling rate?

• Which support would you wish from your government in order to overcome the most severe barriers in textile recycling in your country?
  o Test for dialogues among stakeholders
  o Test for legislation concerning separate collection

Questions concerning waste management:

• How does the collection of textile waste currently work in your country?
  o How do you think this could be improved/What are the biggest problems in the collection
  o Test for involvement of Churches or red cross as in the case of Germany
  o Test for cooperatives in the case of Brazil

• Do you know of any country where it works especially well?

• What would incentivize you to separate your textile waste? [Ask textile producers]
  o Test for law enforcement
  o Test for financial incentives
  o Test for environmental seal
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