

SMART DELIVERABLE

Sustainability Hot Spot Analysis of two ready-made garments



We study the barriers and drivers for market actors' contribution to the UN Sustainable Development Goals within planetary boundaries, with the aim of achieving Policy Coherence for Development.

Project coordinator
University of Oslo

Project leader
Professor Beate Sjøfjell

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Author list: T. Lambooy, Nyenrode Business Universiteit M. Bosman, Nyenrode Business Universiteit S. Solaimani, Nyenrode Business Universiteit	
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End-to-end analysis of Sustainability Hot Spots in the Ready-Made Garment Industry

**Interim Report of findings in Work Package 3,
Sustainable Market Actors for Responsible Trade (SMART)**

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Authors:

Tineke Lambooy | Nyenrode Business University | T.Lambooy@nyenrode.nl
Martine Bosman | Nyenrode Business University | M.Bosman@nyenrode.nl
Sam Solaimani | Nyenrode Business University | S.Solaimanin@nyenrode.nl

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Glossary of terms

Brand: A particular company with a distinctive identifying name. In this research for instance H&M, C&A, Levi Strauss.

Hot spot: A life cycle stage, process or elementary flow, which accounts for a significant proportion of the RMG's impact on a planetary boundary or a dimension of the social foundation.

Hot Spot Analysis: The rapid collection and analysis of information resources, such as LCAs, stakeholder interests, research, and expert opinions in order to identify and prioritise the most significant social and environmental sustainability impacts. The results of this qualitative process will then guide more detailed research.

Impact: A verified effect of an activity in a life cycle stage on the defined Planetary Boundaries or the social foundation.

Impact category: A category of actual negative impacts in a product's lifecycle.

Experts: Interviewees and stakeholders who have an expert knowledge of a specific environmental or social impact, or of the RMG industry. In this case people working for NGO's that have a specific interest in (parts of) the RMG sector, working for tripartite or multi stakeholder organizations.

Life cycle phase or stage: A phase or stage in the product life cycle: from raw materials to end of life.

Manufacturer: The company making a pair of jeans or a T-shirt from either raw materials or fabric.

Planetary Boundaries: The non-negotiable planetary preconditions that humanity needs to respect in order to avoid the risk of deleterious or even catastrophic environmental change.¹² The boundaries are climate change, novel entities, ozone depletion, aerosol loading, ocean acidification, biochemical flows, freshwater use, land-system change, and biosphere integrity. Between planetary and social foundation lies an environmentally safe and socially just space in which humanity can thrive.

Product lifecycle: The entire lifecycle of a product from raw materials, through manufacturing and consumer use to recycling or disposal of the manufactured product.

Risk: Refers to a potential impact, the risk of an impact occurring in a products life cycle, to individuals, other organizations, or communities in relation to the impacts mentioned.

RMG: Ready-made garment.

¹ Steffen, W. et al, 'Planetary Boundaries: Guiding human development on a changing planet', Science, vol. 347, no. 6223, p. 1258955, Feb. 2015

² Rockström, J. et al, 'A safe operating space for humanity', Nature, vol. 461, no. 7263, pp. 472-475, Sep. 2009

Social foundation: The minimum standards of living conditions and human rights below which people can be said to be living in deprivation. The twelve dimensions of the social foundation are derived from internationally agreed minimum social standards, as identified by the world's governments in the Sustainable Development Goals in 2015. The twelve social dimensions are food, health, education, income & work, water & sanitation, energy, gender equality, social equity, housing, political voice, peace & justice, and networks. Between the social foundation and planetary boundaries lies an environmentally safe and socially just space in which humanity can thrive.³

Stakeholders: Individuals, groups or organizations that have a direct or indirect interest or concern in one or more phases of the product's life cycle.

Sustainability Hot Spot Analysis: A tool for identifying and visualizing social and environmental hot spots.

Textiles: Meaning all things made from textile, which means not only garments but also bedding, towels etc.

³ K. Raworth, 'A Safe and Just Space for Humanity: can we live within the doughnut?', Oxfam discussion paper February 2012 <https://www.oxfam.org/en/video/2012/introducing-doughnut-safe-and-just-space-humanity> and Raworth K., Doughnut Economics, Seven Ways to Think Like a 21-Century Economist, Chelsea Green Publishing 2017

Executive Summary

This report presents the findings of two case studies which have been developed to assess the Sustainability Hot Spots (SHS) in the value chain of two different ready-made garments (RMG), thereby following the methodology presented by Bienge (Bienge 2010).

The case studies tracked a T-shirt and a pair of jeans from raw material to end of life, i.e. from the cotton fields in India and Turkey to the incineration and recycling in the EU. In both case studies, the SHS were identified by employing the Planetary Boundaries defined by Rockström et al (Rockström 2009) and afterwards by Steffen et al. (Steffen 2015) and the social foundation developed by Raworth (Raworth 2012 and 2017) as the underlying theoretical framework.

The findings of the two case studies indicate that the phases in which the raw materials and the garments were produced have the highest scores of SHS. As part of the case study, a stakeholders meeting was organised in Amsterdam. In this event, it became clear that knowledge on social impacts in the second tier (i.e. the network of partners that are not directly related to the garment manufacturing such as fabric mills) is scarce, which corroborates the insights gained from literature. More grey and academic literature is available concerning environmental and social impacts in the raw material and the manufacturing phases.

A striking outcome was that the impacts on climate change caused in the transport stages in the life cycle appear to be less material than the CO₂ impacts caused in the consumer use phase. Even though the value chain of the RMG implies that the product needs to travel long distances, the CO₂ emissions caused by transport were not identified as a SHS. The emissions emitted in other phases such as the manufacturing phase, the production of the fabric and the emissions due to the consumer use are much higher in comparison.

Based on interviews and discussions with stakeholders, the relationship between living wages and excessive overtime was mentioned. Workers often want to work more than their regular hours, so that they can earn more. The question however is, would they still want to work more if they were earning a living wage? The question is of importance as both the risk of not earning a living wage and the risk of excessive working hours are high in the phases in which the raw materials and the garments were produced.

Many stakeholders and interviewees indicated that restrictions on having the rights to form (or join) a trade union is a significant impact. The idea is that, when trade unions are widely accepted and workers do not have to fear repercussions for joining a trade union or for campaigning for their labour rights, unions can play an important role in the improvement of a multitude of impacts, such as wages, working hours and working conditions and workers autonomy to decide their priorities.

Finally, even though NGOs report that gender inequality in the garment industry is a considerable risk, the actual identification of such risk is extremely difficult, as people are not open about these sensitive topics and reliable data is scarce.

1. SMART research Work Package 3: scope of the research

As an integral part of the SMART research project, WP3 conducts two case studies on European products with an international supply chain. The overarching goal of SMART is to advance our understanding of how non-development policies and regulations reinforce or undermine development policies. We study the barriers and drivers for market actors' contribution to the UN Sustainable Development Goals within planetary boundaries, with the aim of achieving Policy Coherence for Development.

More specifically, the case studies help to improve our understanding of the global supply chains dynamism, as well as the complexities in sustainability-related issues that market actors in global supply chains experience. In sum, four case studies are conducted, two on the global supply chain of a mobile phone and two on the global supply chain of a ready-made garment (RMG). The former case studies are conducted by the Department of Informatics, University of Oslo. The latter case study with focus on RMG is a joint effort by Nyenrode Business University (NBU) (The Netherlands) together with BGMEA University of Fashion and Technology (BUFT in Bangladesh), and Cicero (Centre for International Climate Research, Norway). This report will focus on the RMG case studies.

The main objective of all the case studies is to identify Sustainability Hot Spots (SHS) in the supply chain. With respect to the RMG line of research, two studies are conducted by BUFT, to analyse a white T-shirt Product Lifecycle (PLC) and the inherent supply chain (Annex III), while Cicero performed an analysis on CO₂ emissions (Annex II). NBU on the other hand, conducted a case study on a T-shirt and a pair of jeans

In sum, the main goal of the study is twofold:

- RQ1. To identify SHS in the PLC of two ready-made garments;
- RQ2. To identify the legal, socio- economic and environmental constraints and opportunities that the garment sector is facing in the transition towards a more sustainable market behaviour.

This report concerns research question I (RQ1).

1.1 Boundaries of the research

Drawing on a preliminary round of interviews with several stakeholders (mainly retailers), the main sustainability-related impacts in the supply chain seem to be fabric-related (the base-material), rather than caused by the other items. The buttons, leather patch, the label and tags are not a part of the definition and valuation of the phases and impact categories related to fabric, and as such remain beyond the scope of this study.⁴

⁴ The 'base' material of the garments in question is fabric. Both literature on LCAs and interviewees concentrate on the fabric of the garment.

1.2 Methodology approach

The identification of hotspots is structured in accordance with the Sustainability Hot Spot Analysis of Biengen (SHSA).⁵ The framework of the Planetary Boundaries and the social foundation are the prime analytical foundation on which the SHSA will be performed. The SHSA is a methodology that helps focus on priority issues, the right life cycle phases and actors.

The data collection in both the pair of jeans and T-shirt are based on several semi-structured interviews with value chain actors (including cotton fields companies, denim mills, manufacturers, retail businesses and end of life companies), (local) experts and stakeholders (such as NGO's and government officials) from various PLC phases.⁶ Several field visitations at the sites (including but not limited to raw material, fabric manufacturing, garment manufacturing and the brands main office and, downstream to a recycling company) were needed. The interviews, together with company-specific documentations, collected via company-based liaisons and websites, as well as a review of existing academic and grey literature (e.g., reports from NGO's, documentaries) provided the basis of the case studies. Finally, stakeholder meetings were used to verify the findings.

The research in the case studies was divided into different phases. First, the key global Sustainability Risks in the textile industry were identified based on which an overview of the risks, phases and actors were developed. The identified sustainability risks together with phases and actors were discussed in the stakeholders meeting in Amsterdam.⁷

After the general identification of phases and risks in the RMG industry, it is zoomed in on the key SHS in the life cycle of the selected T-shirt and the pair of jeans. As such, both the level and unit of analysis, and the unit of observation, changed as the research progressed; i.e., from a general, global approximate understanding of where the most significant risks in the RMG industry as a whole could occur, to a product-level, micro understanding of SHS (level of analysis).

⁵ Biengen, K., Von Geibler, J., Lettenmeier, M., Biermann, B., Adria, O., Kundt, M., Darnhofer I., and others, 'Sustainability Hot Spot Analysis: A streamlined life cycle towards sustainable food chains', in *9th European IFSA symposium in Vienna 2010*, pp. 4-7

⁶ The case studies protocols are available upon request.

⁷ Report of the stakeholders meeting in Amsterdam (March 2017) is available upon request.

2. Overview of the RMG industry

This chapter elaborates on various characteristics of the RMG industry, briefly outlining the history, actors and the main importing and exporting countries, to help create a more holistic picture of the industry.

2.1 Global supply chain

International trade in textiles has been around for centuries. As early as Roman times, cotton from India was traded in the eastern regions of the Roman Empire.⁸ The globalization of textile production started in the 19th century, with textiles made in China, Japan and India. It was only after the Second World War that the globalization in textiles intensified and accelerated. Since the 1960's – 1970's most of the textile production was outsourced to developing countries. Since the 1980's, the same applies to garments and footwear (Van Nederveen Meerkerk 2010).

The main reason for shifting production locations, then and now, has to do with competitiveness. In developing countries, the labour costs involved in manufacturing garments are significantly lower. In 2000, labour costs made up about 40% of the total production costs of textiles made in the EU. In other parts of the world, the percentage of labour costs in the total production costs was considerably lower, e.g. about 10% in China % (in 1997) and about 5% in India (also in 1997, Van Nederveen Meerkerk 2010). The number of clothes sold each year is still growing: in the UK, for instance, from 3.1 million tonnes in 2012 to 3.6 million tonnes in 2016.⁹

With increasing globalization and the emergence of the trend of fast fashion, which results in shorter lead times, the ready-made garment supply chain became more challenging in terms of transparency¹⁰, making it more difficult to exercise control over environmental and human rights risks. Acute awareness of the negative effects of this state of affairs was raised due to the Rana Plaza disaster in 2013. Several major western brands had their clothes made at Rana Plaza and the disaster painfully highlighted some of the negative social impacts of the garment sector.

Four years after the Rana Plaza disaster, the global garment industry has made steps to increase transparency in the global supply chain, including initiatives like the Bangladesh Accord¹¹, the Dutch¹² and German¹³ Agreements towards a more sustainable garment

⁸ Gelopen race of glansrijke doorstart? De effecten van globalisering op de Nederlands textielindustrie, 1960-2010, Elise van Nederveen Meerkerk, in *Patronen in beweging. Veranderingen in de Nederlandse textielgeschiedenis, 1960-2010* (Stichting Textielgeschiedenis & Uitgeverij verloren, 2010)

⁹ WRAP, Valuing Our Clothes: The cost of UK fashion, July 2017

¹⁰ In line with Richero, P. and Ferrigno, S., DAI Europe, A Background Analysis on Transparency and Traceability in the Garment Value Chain, Final report, EU Project No. 2016/378769, Version 1, pg. 4.

¹¹ Accord on Fire and Safety in Bangladesh, <http://bangladeshaccord.org/>

¹² Sustainable Garment and Textile Agreement the Netherlands, signed in 2016, <https://www.internationalrbc.org/garments-textile>

¹³ Federal Ministry for Economic Cooperation and Development (BMZ) Division for Public Relations. "The Partnership for Sustainable Textiles, Germany." Accessed March 20, 2017.

https://www.textilbuendnis.com/images/pdf/Publikationen/BMZ_Info_brochure_Partnership_for_Sustainable_Textiles_en_December_2014.pdf.

industry and the OECD guidelines for Due Diligence in the Garment and Footwear Industry¹⁴ were set up. However, to be able to understand the complexity of the SHSs, a global, more holistic understanding of the RMG industry is necessary.

To this end, a short explanation regarding the actors and the export and import market will be provided in the next paragraph. The term ‘actors’ refers to any entities involved in the activities of the garment manufacturing chain.

2.2 First tier actors

Conventionally speaking, the first upstream actor is the fibre producer and the last in the chain are the retailers. In this case study, however, a cradle-to-cradle (or ‘closing the loop’) approach is pursued, which means that also the actors beyond the retailer are taken into account (figure 1).



Figure 1: RMG value chain

Depending on the buyer’s business and sourcing model, actors and their roles across various stages of the value chain, can be integrated. For example, it is possible that the garment manufacturer has a spinning mill and a fabric mill on site (integration of actors 2, 3 and 4), or that the retailer and the buyer are the same company (integration of actors 6 and 7 in figure 1).

The main value chain actors are supported by several supporting actors and facilitators (i.e., 2nd tier suppliers). In random order, these supporting and facilitating actors are shown in figure 2. Some of these actors, particularly 14 – 19 are active in multiple phases of the value chain (e.g., customs play a role every time a material or product crosses a border).

¹⁴ OECD. “OECD Due Diligence Guidance for Responsible Supply Chains in the Garment and Footwear Sector,” 2017. <https://mneguidelines.oecd.org/OECD-Due-Diligence-Guidance-Garment-Footwear.pdf>.



Figure 2: Supporting actors in the RMG value chain

Finally, there is a category of actors indirectly involved in the value chain (figure 3). This category influences or works with the main actors in different phases of the PLC. For instance, Better Work in Vietnam working with RMG manufacturers to improve working conditions or NGO's reporting on child labour and thereby influencing buyers and brands to take action to avoid buying from factories employing children.



Figure 3: Indirect actors in the RMG industry.

The constellation of actors can vary across value chains given the differences in products and peculiarity of designs. Which actors are actually involved, also depends on the sourcing model that the brand or retailer uses (for a better understanding of the supply chain, the involved actors are briefly described in table 1).

Table 1: Description of actors in the RMG value chain.

<i>Fibre producers:</i>	The farms, cooperatives and factories making the raw material, e.g. man-made fibres (like nylon, rayon, fleece) or natural fibres (wool, cotton, Tencel, etc.).
<i>Spinning mills</i>	Factories making yarn. Their raw materials are either man-made or natural fibres.
<i>Fabric mills</i>	Factories making fabric from yarn, either through knitting in the case of the T-shirt or weaving as is the case with the jeans.
<i>Garment manufacturers</i>	Factories producing the garment. In garment exporting countries, the characteristics of manufacturers vary extensively. Some manufacturers are individuals working from home, while, in countries like China and Bangladesh, large manufacturing factories can employ over 20,000 workers.
<i>Buyer</i>	There are various types of buyers. ¹⁵ Buyers can source their garments directly or indirectly from the garment manufacturer. If they source their garments indirectly, they will employ the services of buying houses acting as their importing agents. In that case the transparency of the chain is at a minimum,

¹⁵ For instance, two sourcing models of the OECD's due diligence guidance can be taken into consideration:

- Direct sourcing, in which a buyer has a direct contractual relationship with the manufacturer, or,
- Indirect sourcing, in which the buyer sources products (e.g. raw materials or finished goods) through an intermediary actor, for example a buying house.

* Please note that it could well be that retailers or brands combine different sourcing models or have different sourcing strategies for different regions and/or product categories.

	and, the retailer selling the garment in the EU usually does not know the origin of the garments.
<i>Retailers</i>	The consumers that buy their ready-made garments: for instance, online retailers, brands with their own stores, high street shops, supermarkets, department stores, etc.
<i>Brand</i>	A trademark or distinctive name identifying an organization. It could be a product that has its own name, and is made by a particular company.
<i>Multi-stakeholder initiatives and policy-makers (MSI)</i>	Initiatives with multiple stakeholders such as for instance Better Work, where multiple stakeholders participate (unions, manufacturers, government).
<i>Institutions and associations</i>	Institutions and associations with a relation to the RMG industry with direct or indirect influence. For instance, trade unions or employers' associations, MVO Nederland (CSR Netherlands) and others. ¹⁶
<i>Governments and International organizations</i>	In addition to the EU and individual governments, also government institutions such as CBI (the Dutch Centre for the Promotion for Imports from Developing Countries) and SER. ¹⁷ Other examples are BCI, the World Bank and the ILO.
<i>NGO's</i>	Non-Governmental Organizations with a relation to the RMG Industry. In the Netherlands, the main NGO's connected to the RMG industry are Solidaridad, SOMO, Clean Clothes Campaign, Unicef, The Bangladesh Accord, Fair Wear Foundation, Stop Kinderarbeid.

2.3 Main exporting countries in the global garment value chain

Most risk-based assessments entail assessing risks that A. generally occur in the industry and B. risks that typically emerge in the country of production. This is a useful way for a brand or retailer to assess risks in situations in which it is not (yet) know which company actually manufactures the ordered garment. For instance, if there is no direct relationship between the retailer and the manufacturing company, which is a fairly common way of sourcing in the ready-made garment industry.

The case studies are also based on a risk analysis of the garment product life cycle, therefore the major garment-producing countries are of great importance. In selecting the T-shirt and the pair of jeans for this study, it is ensured that the selected products entail a supply chain in the main garment producing countries (table 2 ranks the top-10 exporters in 2016).

Table 2: Top ten exporters of clothing in 2016 (WTO World Trade Statistical Review 2017).

Chart 4.10	Top 10 exporters of clothing, 2016	US \$ billion
1	China	161,4
2	EU (28)	117,0
3	Bangladesh	28,2
4	Vietnam	24,6
5	India	17,9
6	Hong Kong, China	15,7

¹⁶ Website: <https://mvonederland.nl/csr-netherlands>

¹⁷ The Socio-economic Council of the Netherlands that advises the Dutch Government and Parliament on key points of socio-economic policies: <https://www.ser.nl/en/>

7	Turkey	15,1
8	Indonesia	7,4
9	Cambodia	6,3
10	United States of America	5,7

At the other side of the trade, it is relevant to note that the EU is the biggest overall importer of knitted T-shirts, with over 42% of the total imported value of \$38 billion in 2015.¹⁸ The base material for the pair of jeans and the T-shirt is cotton; thus the main cotton producing countries were also taken into account (table 3).

Table 3: Main cotton producing countries (source International Cotton Advisory Committee).¹⁹

Country	Cotton production in %, 2015/2016
India	27%
China	23%
USA	13%
Pakistan	8%
Brazil	6%
Uzbekistan	4%
Turkey	3%
Australia	2%

¹⁸ Importers of knitted T-shirt in 2015, source: Atlas Media MIT:
https://atlas.media.mit.edu/en/visualize/tree_map/hs92/import/show/all/6109/2015/

¹⁹ Presentation of the International Cotton Advisory Committee to the WTO:
https://www.wto.org/english/news_e/news15_e/cdac_26dec15_e.pdf

3. Hot Spot methodology

To address the research question, posed on pg. 8, the SHSA approach is adopted as the baseline approach, while the extension of SHSA by Rohn et al. (2014)²⁰ and the guidelines of the UNEP/SETAC Life Cycle Initiative Method are taken into consideration. Table 3.1 provides an overview of how these three approaches commonly systematize the hot spot identification process. It is noteworthy that after the initial two steps, the methods vary in their approach. The Biengen's method incorporates the assessment of phases in the identification of hotspots in step 3, while the UNEP/SETAC Life Cycle Initiative method identifies various possibilities of identifying hot spots and leaves it to the assessor to decide on an option.

Table 4: SHSA methodologies & SMART research steps.

Biengen (Biengen <i>et al</i> 2010)	Rohn (Rohn <i>et al</i> 2014)	UNEP/SETAC Life Cycle Initiative Hotspots Analysis: an Overarching Methodological Framework	SMART Research steps included in the case studies
Step 1 Defining life cycle phases and categories	Step 1 Definition of the life cycle phases and categories	Step 1 Define, clarify and solicit agreement of the goal and scope	Step 1 Define life cycle phases and categories, goal and scope
Step 2 Gather data Assessing the relevance of each aspect in each phase of the product life cycle	Step 2 Literature review Step 3 Company and Factory visits Step 4 Surveying suppliers along the value chain; consideration of existing, internal standards Step 5 A Analysis and evaluation of the specific and generic data including assessment	Step 2 Gather data (literature review, primary data) Seek expert insight Knowledge building; and Analysis	Step 2 Gather data: A general Literature review Identifying gaps Seek expert insight B product specific Documents review Company and factory visits, interviews with stakeholders and experts along the supply consideration of used standards Analysis of data per life cycle phase and risk category. General and product-specific. Assessing the relevance of each aspect in each phase of the product life cycle
Step 3 Assessing the relevance of each phase	Step 5 B Analysis and evaluation of the specific and generic data including assessment and identification of sustainability hot spots		Step 3 Assessing relevance of each phase

²⁰ Rohn H., Lukas M., Biengen K., Ansoorge J., Liedtke C., Utilization as Customized Management Tool towards Sustainable Value Chains of Companies in the Food Sector, Agris on-line Papers in Economics and Informatics Agris on-line Papers in Economics and Informatics, Volume VI, no 4, 2014

Step 4 Define the sustainability hot spots		Step 3 Identify and validate hot spots (hot, warm and cold spots)	Step 4 Identify and validate hot spots
Step 5 Verify hot spots through stakeholder meeting	Step 6 Presentation and discussion of results with internal and associated stakeholders (selected companies of the value chain or direct suppliers)		Step 5 Verify phases Verify aspects Verify weighing of phases and aspects Election of hot spots for further analysis
		Step 4 Responding to data and stakeholder gaps Are there data gaps? Are there stakeholder gaps? What to do with the identified gaps?	Identification of data gaps through a review of steps 2 and 3
	Step 7 Develop measures and afterwards implementation	Step 5 Identify and prioritize actions Reduce impact of hot spots, priority based on impact and feasibility	Creating a greater depth of analysis through a regulatory ecology mapping of a selected set of hot spots, by answering RQ2 (hence not in this report)
		Step 6 Review initial findings From steps 1 – 5 with experts and key stakeholders	Review initial findings
		Step 7 Presentation and communication to a wider audience	Presentation and communication: - starters guide with stakeholders, WP1 and WP5 of the SMART project - hot spots analysis and regulatory ecology maps to WP 1, 2 and 5 of the SMART project Results to be shared with stakeholders, policy-makers and public at a later stage, after answering RQ2
	Step 8 Recommend update of the hot spot analysis. Update of data and of stakeholder dialogue	Step 8 Revisit identified hot spots and actions	

In addition, the SHSA methodology is different from the commonly known and vastly used Due Diligence methodology, which prescribes a risk assessment method to identify actual and potential adverse impacts of enterprises' activities and operations. Examples are, the

Guiding Principles on Business and Human Rights²¹, the OECD Guidelines for Multinational Enterprises²², the OECD Guidelines for Due Diligence in the Garment and Footwear Sector²³ and the Dutch Agreement Sustainable Garment and Textiles.²⁴ The first steps in both the Due Diligence and the SHSA are the same: identifying the main risks of adverse impacts.

Because the Due Diligence method also identifies risks, the risks indicated by the OECD Guidelines for Due Diligence in the Garment and Footwear Sector and the Dutch Agreement on Sustainable Garment and Textiles, as well as the adverse impacts analysed by the RMG retailers themselves were included in the research.

Following the SHSA first the risks of impacts are identified and categorized. Than the impacts of the PLC are assessed (step 2) and a weighted assessment of the different phases is taken into account (the 3rd step of the Bienge method). Ultimately, the impacts with a maximum effect on the PLC are identified as SHS. This is different from the supply chain approach adopted in the Due Diligence method where prioritizing is based on the impact of the risk and the relationship between the company and that impact (cause – contribute – directly linked). The method of defining hot spots in this research will therefore vary from the more commonly used Due Diligence.

3.1 Life Cycle phases in the textile industry: General

The first step in the SHSA methodology is to define PLC phases, categories, goal and scope. The goal and scope of the research are included in the research proposal and detailed in chapter one (pg.8-9). The categories are discussed in chapter 3.2 (pg. 20). With respect to PLC phases Bienge (2010) has proposed a generic model and used it to identify SHS in a strawberry network of suppliers (figure 4).



Figure 4: Generic phases of a PLC.

The phases in the RMG life cycle are extensively diverse and fragmented, cutting across multiple geographical borders. To address this issue, several production phasing common in the RMG industry are extracted from academic articles, case studies and reports, for instance the PLC by Muthu (figure 5).²⁵



Figure 5: Phases in the PLC by Muthu.

²¹ Guiding Principles on Business and Human Rights, Implementing the United Nations “Protect, respect and Remedy” Framework, United Nations New York and Geneva 2011, http://www.ohchr.org/Documents/Publications/GuidingPrinciplesBusinessHR_EN.pdf

²² OECD Guidelines for Multinational Enterprises, 2011 Edition

²³ OECD Due Diligence guidance for Responsible Supply Chains in the Garment and Footwear Sector, 2016

²⁴ Sustainable Garment and Textile Agreement the Netherlands, 2016

²⁵ Muthu, S.S. Sustainability in the Textile Industry, Introduction, Springer Nature Singapore 2017

Alternatively, for a study on environmental impact Kozłowski et al. (2012)²⁶ propose a different PLC (figure 6).



Figure 6: Phases in the PLC by Kozłowski et al.

Yet another PLC is proposed by True Price for the cotton production in India²⁷, which, to a large extent overlaps with the model proposed by Robesin (figure 7).²⁸



Figure 7: Phases in the PLC by Robesin.

And finally, leaving out the distinction between yarn and fabric production, Levi Strauss (2015)²⁹ proposes a PLC in the assessment of a pair of jeans (figure 8).

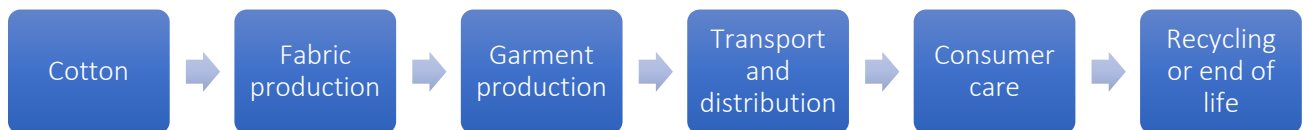


Figure 8: Phases in the PLC by Levi Strauss.

In choosing one of the models, it is important to note that geographical borders would be crossed within a single phase if the phases were to generally chosen (e.g., in the production phase the product would be transported from Turkey to Vietnam). This implies that different national regulations and different country-specific risks are at stake. A too detailed PLC model can hardly be matched to the impacts since the impacts are not specified either. Moreover, in face of the conducted literature review, the environmental and social risks in the life cycle of a RMG appear to vary substantially from one phase of the life cycle to the next. For instance, in the fabric production, environmental issues are mentioned frequently, while, in the RMG manufacturing phase, the social issues are mentioned frequently. Finally, given the comprehensive scope of the SMART research project, the consumers and recycling phase need to be a part of the study.

²⁶ Kozłowski, A., Bardecki, M., Searcy, C., Environmental impacts in the Fashion Industry, A life Cycle and Stakeholder Framework, JCC Greenleaf publishing 2012

²⁷ The True Price of Cotton from India, joint report by IDH and True Price, <http://trueprice.org/wp-content/uploads/2016/04/TP-Cotton.pdf>

²⁸ Robesin, M.A., Katoen en waterschaarste. De verantwoordelijkheid van bedrijven en overheden voor de vermindering van de watervoetafdruk in de katoenketen, Boom Juridische uitgevers 2014.

²⁹ Website Levi Strauss: <http://levistrauss.com/wp-content/uploads/2015/03/Full-LCA-Results-Deck-FINAL.pdf> visited 22 Februari 2017

Hence, building upon the existing models and adding the insights gained in the first stakeholders meeting, the following PLC model can be proposed (figure 9):



Figure 9: Phases in the PLC for this case study.

Raw materials: the cotton is planted, grown, harvested, delivered to the ginning facility and ginned (seeds are separated from the fibre of the cotton plant), as well as cleaned and bailed for further transport.

Yarn production: cotton lint is spun into yarn. At the fabric production stage, the yarn is either woven or knitted into fabric, as well as dyed.

Manufacturing: the fabric is made into a RMG. The fabric is cut, sewn and treated (washed, dyed, lasered, printed) to produce the desired look and feel.

Consumer: the consumer buys, wears and washes and eventually discards the RMG.

Recycling: the discarded RMG ends up in a recycling container or in a waste bin to be sent to underdeveloped countries or converted into reusable material.

In the stakeholders meeting organized in Amsterdam (March 2017), all the phases and the underlying processes were discussed. A vast majority of stakeholders were unanimous in adding design, procurement and transport as highly relevant processes in the RMG PLC. More specifically, design and procurement phases can have a major impact on the materials (including chemicals) and production lead time, and recyclability.

With regard to transport, the stakeholders argued that transport has major environmental impact on (e.g., CO2 emission, fossil fuel usage) across the value chain, and should therefore be considered as a separate life cycle phase (figure 10).

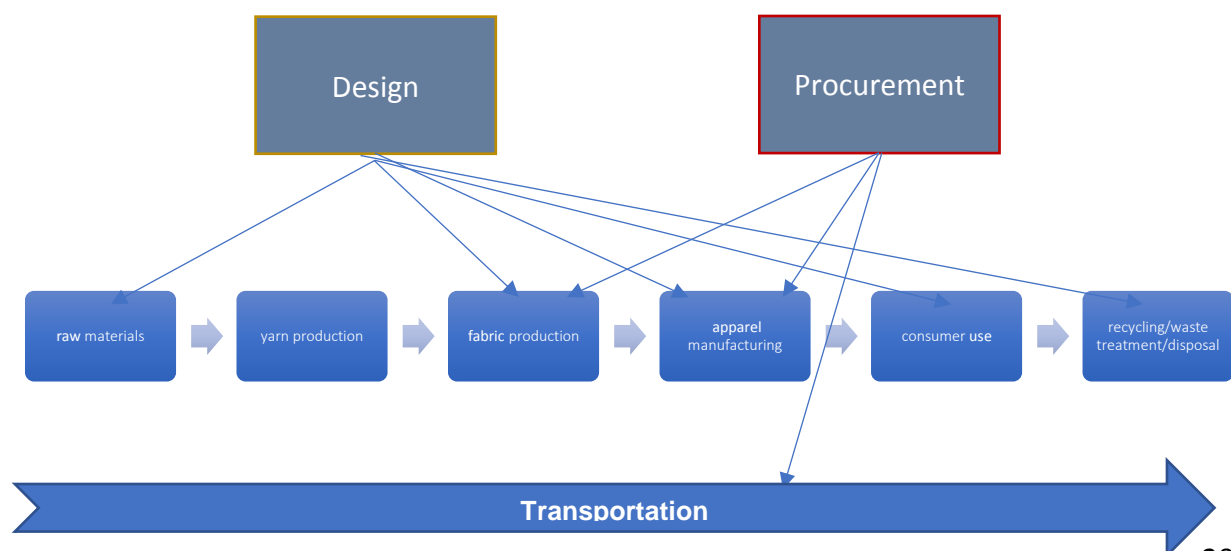


Figure 10: Phases and processes after the stakeholders meeting.

However, there are difficulties with respect to adding an extra transport phase. Bienge (2010) includes the impacts of transport to the following life cycle phase. For instance, the impacts of transportation from the raw materials phase yarn production phase, is contributed to the yarn production phase. In the case of pair of jeans, however, transportation takes place almost at every stage. It is, therefore, decided to integrate transportation as a separate phase so its total environmental impact can be calculated. In fact, an analysis on the region-specific legal constraints (as required in RQ2) becomes more difficult by having one phase that crosses multiple borders as is the case in the transportation phase. In RMG case study, design and purchase are part of the retailer phase, which are included as a separate phase in the product-specific case studies.

3.2 Categories

The methodology of Bienge (Bienge 2010) proposes that once the phases are, the sustainability aspects of interest need to be defined. In doing so, the SMART projects leading sustainability frameworks, namely the Planetary Boundaries (Steffen et al 2015) and the social foundation (Raworth 2017) are used.

After the initial literature research and the stakeholders meeting in Amsterdam, it became clear that several specific impacts identified in the case study had to be interpreted from the Planetary Boundary and the social foundations perspective. In Annex I, various impacts drawn from the literature, preliminary interviews and the initial stakeholder meeting in Amsterdam, are integrated into the framework of the Planetary Boundaries and social foundation.

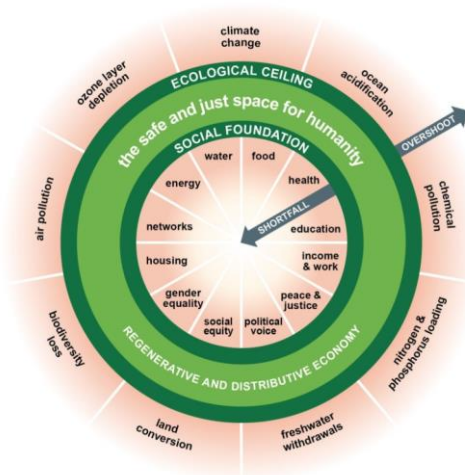


Figure 11: A safe operating space for humanity, K. Raworth 2017.

With respect to social impacts, ‘violation of land rights’ and ‘corruption’ were unanimously added as important potential risks. From an environmental viewpoint, loss of biodiversity is a risk that is difficult to quantify. In the stakeholder meeting³⁰, it was signalled as an impact

³⁰ Stakeholders’ meeting March 2017, Amsterdam

that often occurs as a result of another impact, like land change, chemical pollution or fresh water use. Table 5 integrates the industry specific impacts into one single framework.

Table 5: Framework and impact categories.

Environmental risks, based on the Planetary Boundaries	Social boundaries with specific Human Rights and social risks	
Climate Change <i>CO₂ emissions</i>	Income and work <i>Minimum income and decent work</i>	Forced Labour
		Substandard working conditions
		Excessive working hours
		Below minimum wage
		Below living wage
Land system change <i>Deforestation</i>	Networks <i>Access to networks of social support</i>	Migrant workers
Freshwater abstraction <i>Excessive water use</i>	Water and sanitation	
Loss of Biosphere integrity also soil degradation <i>Loss of biodiversity</i>	Education <i>Right to an education</i>	Child labour
Stratospheric Ozone depletion <i>Ozone depletion</i>	Political Voice	Restrictions on the right to form and join a trade union
		Restrictions of collective bargaining
		Violation of land rights
Atmospheric aerosol loading Air pollution: smoke, dust, pollutant gasses	Peace and Justice	Corruption
Release of novel entities: Chemical pollution, Water pollution		Discrimination
Ocean acidification Due to fossil CO ₂	Health	Occupational health and safety impacts
Biochemical Flows: Nitrogen and phosphorus cycles (pesticides, fertilizers)	Gender equality	Gender-related discrimination and violence
	Energy	
	Food	
	Housing	

3.3 Risks of adverse impacts in the textile industry: general

The main potential adverse impacts are mapped by analysing grey and academic literature³¹, reports and findings from policy-makers, multi-stakeholder initiatives and NGO reports, interviews with experts and stakeholder meetings. However, in line with Muthu³², virtually no academic literature on adverse social impacts in the ready-made garment industry could be found. There are, however, various NGO's reporting on adverse social effects.³³ In addition, the risks of adverse impacts considered by brands (table 6) were included. The frontrunners in sustainability announce their CSR targets and monitor the risks and their

³¹ List of literature added as Annex IV.

³² Muthu also comes to the same conclusion in: Muthu, S.S., Evaluation of Sustainability in the Textile Industry, Springer Nature Singapore 2017, and also Bahareh Zamani, Gustav Sandin, Magdalena Svanström, Greg M. Peters, Hotspot identification in the clothing Industry using social life cycle assessment – opportunities and challenges of input-output modelling, April 2016, Springer International Journal of Life Cycle Assessment

³³ For instance SOMO, Fiar Wear Foundation, Greenpeace and Solidaridad.

performance (table 6 is developed based data collected from brands websites and their CSR reports).³⁴

Table 6: Risks mentioned by Ready-Made Garment Brands, reports 2015.

	G-Star	H&M	Levi	C&A	Inditex
Excessive water use	+	+	+	+	+
Land system change	+			+	
Chemical pollution	+	+	+	+	+
Ocean acidification					+
Climate change	+	+	+	+	+
Stratospheric ozone depletion					
Loss of Biosphere integrity				+	
Biochemical Flows: (pesticides, fertilizers)				+	
Atmospheric aerosol loading					
Risk of forced labour	+	+	+	+	+
Risk of Excessive working hours	+	+			
Risk of Substandard working Conditions	+	+	+		
Risk of below minimum wage	+	+	+	+	+
Risk of below living wage	Legal minimum wage + Overtime	Fair living wage			
Risk of Occupational health and safety	+	+	+	+	+
Water		+			
Risk of Child labour	+	+	+		
Risk of Gender related discrimination or violence	+	+	+	+	+
Risk of other discrimination	Discrimination				
Risk of restriction of freedom of association	+	+	+	+	+

³⁴ As indicated in the social reports and on the brands' websites: H&M, the H&M Group Sustainability Report 2015, G-Star Sustainability https://www.g-star.com/nl_nl/about-us/responsibility, The life cycle of a jean, understanding the environmental impact of a pair of Levi's 501 jeans, <http://levistrauss.com/wp-content/uploads/2015/03/Full-LCA-Results-Deck-FINAL.pdf>, Levi Strauss & Co sustainability guidebook, <http://www.levistrauss.com/wp-content/uploads/2014/01/LSCO-Sustainability-Guidebook-2013--December.pdf>, Inditex website on sustainability, http://static.inditex.com/annual_report_2015/en/our-priorities/the-quality-of-our-products/more-sustainable-design-and-raw-materials.php, C&A Global Sustainability Report 2015

(* a plus (+) sign means that the impact is mentioned as a sustainability issue on either the brands' website, social year report, and/or other documents on their website, e.g., standard agreements with suppliers. Included in the table are the sustainability frontrunners in the industry

The first stakeholder meeting shows that risks in the cotton phase and manufacturing phase were better known than the risks in the yarn- and fabric production. Insight into risks beyond the first tier – cotton production excluded – was limited. The risks involved in the transportation and recycling phases were the least known.³⁵ Based on the foregoing discussions, a list of risks (from literature and pinpointed by stakeholders) relevant for this case study could be developed.³⁶

3.4 Materiality of impacts

Once the potential adverse impacts were mapped, the impacts are ranked following a three-item scale:

0: can mean that:

- the category does not apply or
- no data were found.

1 – I: an impact category does occur but is of low relevance.

2 – II: the impact category occurs and is of medium relevance.

3 – III: the impact category is of high relevance.

Bienge (Bienge 2010) however does not explain how the actual ranking should be performed, especially how the assessment can be objectified. As a result, the assessor can deliberately or unintentionally influence the assessment and manipulate the data. The problem deteriorated in the first stakeholder meeting (March 2017, Annex I), where the assessment was performed in various groups where the individuals' judgements were strongly influenced by group dynamics. As such, there is a large subjectivity and skewness involved in the data, however, the triangulation of methods and sources used in this case study should cancel out some of the biasness.

In order to validate the assessment, materiality assessments other than Bienge's (Bienge 2010) were considered. Conform with the Danish institute for Human Rights, which is a prominent organization in preserving and monitoring human right aspects, has developed an Arc of Human Rights Priorities.³⁷ The Arc of Human Rights Priorities also has a division into high, medium and low priority human rights issues connected to the business of a company. It evaluates the influence sphere of the company (i.e., is the company solely responsible or is the responsibility shared with others? Is the company the actor or a third party?), and it evaluates impacts on human rights where the severity of the impact (the form of abuse and number of people affected) is taken into account. Concerning the severity of the form of abuse, a difference in abuse hierarchy is made; human rights defined as fundamental, non-derogable, are giving the highest priority. An evaluation of Human Rights Priorities results in a mapping of the relevant human rights issues in the form of an arc: risks with a low level of

³⁵ Report Stakeholders meeting Amsterdam March 2017.

³⁶ For a description of risks see Annex I and the Stakeholders meeting report, Amsterdam March 2017.

³⁷ Baab M., Jungk M. The arc of human rights priorities - introducing a new model for managing human rights risk in business, The Danish Institute of Human Rights, <https://www.humanrights.dk/publications/arc-human-rights-priorities-introducing-new-model-managing-human-rights-risk-business>

severity and a low level of influence on the part of the company results in low priority. Risks for which the company is solely responsible and that concern severe human rights impacts, result in priority.

In the OECD Due Diligence Guidelines for Responsible Supply Chains in the Garment and Footwear sector, a difference is made in the relationship that a company has to the impact (i.e., cause, contribute, directly linked) and its likelihood and severity.

In the UNEP/SETAC Life Cycle Initiative's Hot Spot Analyses (see chapter 3), the materiality of impacts can be determined in various ways, one of them being subjective selection, based on the knowledge and priorities of stakeholders.

For the identification of sustainability hot spots in this part of the research it is not important to know what influence the retailer can exert on the impact; the identification of hot spots applies to the entire life cycle. The severity of the impact, however, is of importance.

4. Case studies

In the case studies the PLC of two specific RMG's were followed. The selection, PLC phases and impacts are described in this chapter.

4.1 Choice of garments

The RMG's for the case studies are a pair of jeans and a T-shirt. The reason for selecting these particular garments was the diversity of their supply chains the different knowledge and skills that are needed in manufacturing process. Such diversity enables a broader exposure to suppliers current operations and conditions. Furthermore, a pair of jeans would take longer to design and manufacture, making it a 'slow-fashion' item, while T-shirt in contrast can be assumed to be a 'fast-fashion' item. In choosing a specific pair of jeans and T-shirt the sales figures of the garments and their respective manufacturing countries were studied. For the pair of jeans, the most sold model in the collection was chosen. For the T-shirt a model with different suppliers and sourcing countries from the pair of jeans was chosen. By selecting these particular RMG items, a diverse chain of supply in various top garment and cotton producing countries had to be studied.

4.2 Best practises in the case study

The sustainability-related risks in the garment sector are mostly documented with a risk or impact based angle. The perspective that is missing, is the difference between the potential adverse impacts and the best practice within the sector (as compared to the general risks identified in the preliminary study and the literature research).

The brand-selling actor in the case study was chosen to highlight the difference between the general hotspots within supply chains and the hotspots in what current best practices in that same supply chain can accomplish.

The findings of this case study might help to answer RQ2 which focuses on support that can be provided to companies in meeting their sustainability objectives. Furthermore, this information set is shared with the WP5 of the SMART project. For WP5, the best practices versus indicated risks can be important in their endeavour in developing sustainability assessment models.

4.3 Phases in the case studies

The life cycle phases in the case studies involving the T-shirt and the pair of jeans, are different from the general phases (chapter 3.2).

The T-shirt is produced in a vertically integrated factory in Bangladesh. This means that in the phases of the yarn production, fabric production and RMG manufacturing are performed by one single actor.

Compared to T-shirt, the pair of jeans has an additional phase, i.e. the weaving of the denim. In this case study, the phases of the yarn production and fabric production take place in one factory, the denim mill.

4.3.1 Pair of jeans

The pair of jeans included in our study is a pair of jeans with 99% (organic) cotton and 1% elastane, dyed with synthetic indigo. The belt loops, waistband, back panel, pockets and leggings are all made of indigo-dyed denim. The buttons are made of steel. The pair of jeans has a leather patch and the label is made of polyester. Tracing the cotton to its origin (actual production site) proved to be the most difficult part.

In the second phase, cotton is bought on the stock market and from different sources, which is necessary to be able to create a mix of fibres in the thread that is durable and strong. This means that, in one thread of cotton, there will always be cotton fibres from multiple sources. If the cotton used is conventional cotton, the cotton cannot be traced back to its country of origin. The cotton is bought on the stock market through wholesalers (like Cargill), and there is no indication as to its country or field of origin. Organic Cotton can be traced back. There are two reasons for this. First, the cotton receives a certification that should prove that it is organic. Second, after a batch of certified organic cotton is traded, for each transaction, a so-called 'transaction certificate' is issued. These certifications make it possible to trace the origin of the organic cotton from the manufacturer back to the mill, and then further back to the cotton trader. In this particular instance, the cotton for the pair of jeans was produced in Turkey.

In the second phase the denim is woven from the raw materials. The cotton is bought by and shipped to a denim mill, which can be located in different countries. In this study, it is focused on the mills that produce the denim for the jean; the mill is located in Turkey and another mill producing denim for the brand is located in Italy.

The third phase for this jean is the manufacturing phase. After fabric production, the denim is shipped to a manufacturing site in Vietnam, where the fabric is cut, sewn, washed and treated to create the look that the brand has ordered.

The fourth stage is the retail phase. From Vietnam, the jeans are shipped to one of five different logistic warehouses, from where further distribution takes place. The jeans sold in the EU are shipped to the EU warehouse in Amsterdam, from where they are either sold online or sent to stores. For this case study, sales in the Netherlands are considered.

The fifth phase is the consumer stage, during which the consumer buys, wears, washes and finally discards the jeans.

The sixth phase starts when consumer discards the pair of jeans. After the consumer phase, there are different ways the pair of jeans can be discarded:

- donation to one of the many textile containers, resulting in re-use or recycling, or,
- throwing the jeans away with the garbage, resulting in incineration.

Table 7 on the next page presents all the life cycle phases.

Table 7: Life cycle phases of the pair of jeans.

Raw Material	Fabric production	Manufacturing	Retail	Consumer use	End of life	Transport
Includes growing, harvesting and ginning of cotton	Includes the spinning, weaving and dyeing of the yarn into denim	Includes cutting, sewing, washing, treating from fabric to jeans	Includes, design, sourcing, purchase, warehouse and selling	Includes buying, using and washing	Includes Waste bin or donation for second life	Includes all transport between different phases
Turkey	Turkey and Italy	Vietnam	EU: NL	EU: NL	EU: NL	Different phases
Organic Cotton Textile exchange	Organic cotton	Organic Cotton Bluesign				
Interviews	Interviews and field visits	Interviews and field visits	Interviews and visits			Interview and visit
	Site specific documents	Site specific documents				

Figure 12 represents a flow chart of the jeans life cycle.

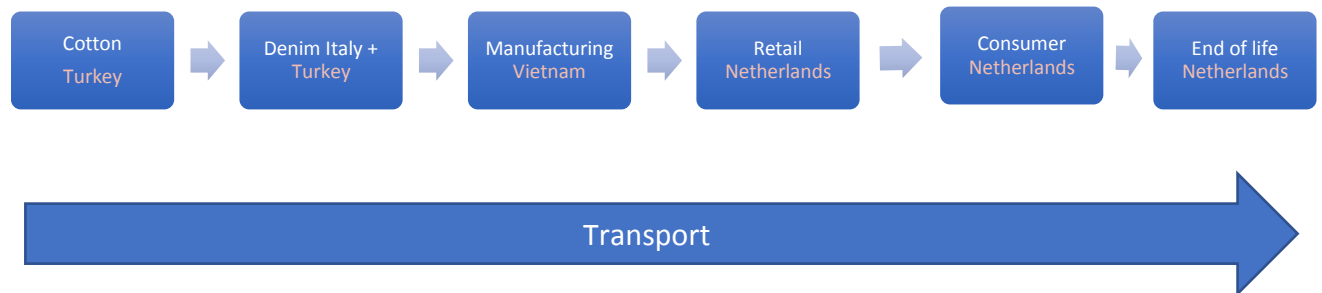


Figure 12: Life cycle phases of a pair of jeans.

4.3.2 T-shirt

The T-shirt included in this study is made of 100% organic cotton and is embroidered with the brand's own name.

The first phase is the raw material phase is production and ginning of cotton. The (organic) cotton for the T-shirt comes from India.

The second phase involves manufacturing the T-shirt, which is knitted, cut, sewn, embroidered and washed in a vertically integrated manufacturing facility in Bangladesh.

After the manufacturing phase, the phases are the same as those of the jeans (table 8).

Table 8: Life cycle phases of the T-shirt.

Raw Material	Manufacturing of T-shirt	Retail	Consumer use	End of life	Transport
Includes growing and harvesting and ginning of cotton	Includes spinning, knitting, cutting, sewing, washing, embroidering	Includes, design, sourcing, purchase, warehousing and selling	Includes buying, using and washing	Includes Waste bin or donation for second life	Includes all transport between different phases
India	Bangladesh	EU: Netherlands	EU: Netherlands	EU: Netherlands	Different phases
Organic Cotton and BCI Cotton					
Interviews and field visit	Interviews and field visit	Interviews and visits			Interview and visit

Figure 13 represents a flow chart of the jeans life cycle.

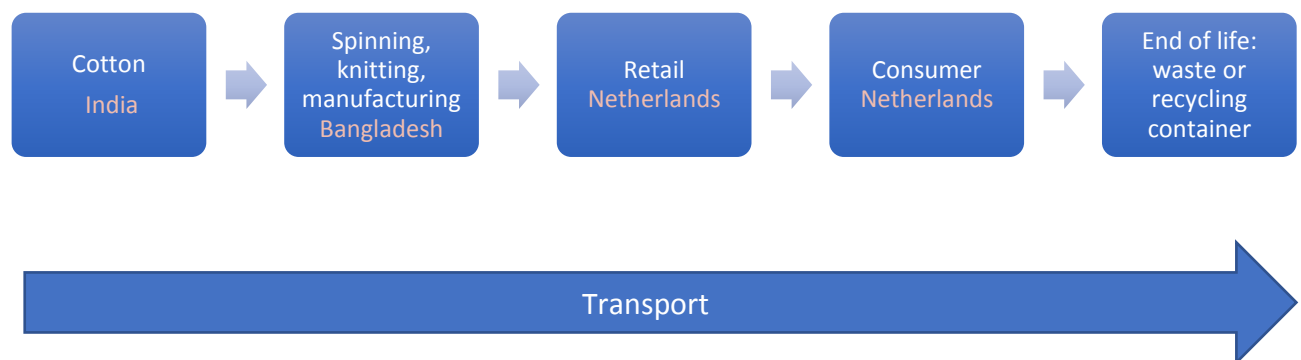


Figure 13: Life Cycle phases of a T-shirt.

4.4 Risks and impacts identified in the case studies

4.4.1 Pair of jeans

Table 9 on the next page shows the results of the SHSA for the pair of jeans case study. There are two different categories; a number for jeans produced in the countries of the PLC (In the table under G, General), a roman number indicating the valuation of the impact of the actual pair of jeans C (in the table under C, Case study), based on literature, stakeholders' opinion and interviews. A zero means that the category does not apply or no data were found.

Table 9: Results of the assessment of impacts per stage for the jeans case study.

Step 2. Assessing defined aspects within each life cycle phase															
		Life cycle phases pair of jeans													
		Raw material		Fabric		Manu- facturing		Retail		Consum er		End of life		Trans port	
		Turkey		Turkey		Vietnam									
		G	C	G	C	G	C	G	C	G	C	G	C	G	C
Climate Change	CO ₂ emissions	2	I	3	III	2	0	1	I	3	III	1	I	2	II
Land system change	Deforestation	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Freshwater use:	Excessive water use	3	I	3	III	3	I	0	0	1	I	0	0	0	0
Loss of biosphere integrity	Loss of biodiversity	3	I	0	0	2	I	0	0	0	0	0	0	0	0
Stratospheric ozone depletion	Ozone Depletion	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atmospheric aerosol loading	Microparticles emitted into the air	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Novel Entities	Chemical pollution Water pollution	3	I	3	I	3	0	0	0	1	I	0	0	0	0
Ocean Acidification	Ocean acidification due to fossil fuel CO ₂	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biochemical flows	Pesticides and fertilizers	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Work & Income	Forced labour	3	I	2	0	1	0	0	0	0	0	0	0	0	0
	Substandard working conditions	3	I	2	0	2	0	0	0	0	0	0	0	0	0
	Excessive working hours	2	I	2	0	2	0	0	0	0	0	0	0	0	0
	Below minimum wage	3	I	1	0	2	0	0	0	0	0	0	0	0	0
	Below living wage	3	II	3	II	3	III	0	0	0	0	0	0	0	0
Network	Migrant workers	2	II	2	0	3	II	0	0	0	0	1	I	0	0
Education	Child labour	3	I	2	0	1	0	0	0	0	0	0	0	0	0
Voice	Restrictions to the right to form or join a trade union	2	I	2	0	3	III	0	0	0	0	0	0	0	0

Voice	<i>Restrictions of collective bargaining</i>	2	I	2	0	3	II	0	0	0	0	0	0	0	0
	<i>Violation of land rights</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Health	<i>Occupational health and safety impacts</i>	3	I	2	I	2	I	0	0	0	0	0	0	0	0
Gender equality	<i>Gender related discrimination and violence</i>	3	I	3	I	2	0	0	0	0	0	0	0	0	0
Social equity	<i>Discrimination</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peace & Justice	<i>Corruption</i>	2	0	2	0	3	0	0	0	0	0	0	0	0	0
		G	C	G	C	G	C	G	C	G	C	G	C	G	C
		Raw Material Turkey		Fabric Turkey		Manufacturing Vietnam		Retail NL		Consumer NL		End of life		Transport	

To identify the sustainability hot spots (3rd step of Biengen method), the relative importance of the phases as compared to each other is assessed. The assessment is conducted by adding a weighting per phase and per aggregated impact categories. This means that for instance the impact of excessive working hours in the raw materials phase, is multiplied by the assessment of the phase. Table 10 presents the weighting per phases.

Table 10: Weighting of the different phases, step 3 Biengen pair of jeans case study.

Step 3. Assessing defined aspects between the different life cycle phases														
Impacts	Life cycle phases pair of jeans													
	Raw Materials Turkey		Fabric Production Turkey		Manufacturing Vietnam		Retail		Consumer		End of life		Transport	
Environmental impacts	3	I	3	III	3	I	1	I	2	II	1	I	2	I
Social and Human Rights impacts	3	I	3	I	3	II	1	I	0	0	1	I	0	0

4.4.2. T-shirt

Table 11 shows the results of the SHSA for the T-shirt case study. A number for a T-shirt produced in the countries of the PLC (In the table under G, General) and a roman number indicating the valuation of the impact of the actual T-shirt (in the table under C, Case study), based on literature, stakeholders opinion and interviews. A zero means that the category does not apply or no data were found. A zero means that the category does not apply or no data were found.

Table 11: Results of the Sustainability Hot Spot Analysis impacts per stage, T-shirt case study.

Step 2. Assessing defined impacts within each life cycle phase													
	Impact category	Life cycle phases T-shirt											
		Raw material India		Manufacturing Bangladesh		Retail NL		Consumer NL		End of life NL		Transport Chain	
		G	C	G	C	G	C	G	C	G	C	G	C
Climate change	CO ₂ emissions	2	I	3	III	1	I	3	III	0	0	2	II
Land use change	Deforestation	0	0	0	0	0	0	0	0	0	0	0	0
Freshwater use	Excessive water use	3	I	3	III	0	0	1	I	0	0	0	0
Loss of biosphere integrity	Loss of biodiversity	3	I	2	I	0	0	0	0	0	0	0	0
Stratospheric Ozone Depletion	Ozone depletion	0	0	0	0	0	0	0	0	0	0	0	0
Atmospheric aerosol loading	Microparticles emitted into the air	0	0	0	0	0	0	0	0	0	0	0	0
Novel Entities	Chemical pollution Water pollution	3	0	3	I	0	0	1	I	0	0	0	0
Ocean Acidification	Ocean Acidification due to fossil fuel CO ₂	0	0	0	0	0	0	0	0	0	0	0	0
Biochemical flows	Pesticides and fertilizers	3	I	0	0	0	0	0	0	0	0	0	0
Work & Income	Forced labour	1	0	1	0	0	0	0	0	0	0	0	0
	Substandard working conditions	3	I	2	0	0	0	0	0	0	0	0	0
	Excessive working hours	3	I	3	I	0	0	0	0	0	0	0	0
	Below minimum wage	2	I	2	0	0	0	0	0	0	0	0	0
	Below living wage	3	III	3	III	0	0	0	0	0	0	0	0
Network	Migrant workers	0	0	3	III	0	0	0	0	1	I	0	0
Education	Child labour	3	I	2	0	0	0	0	0	0	0	0	0
Voice	Restrictions to the right to form or join a trade union	2	I	3	I	0	0	0	0	0	0	0	0
	Restrictions of collective bargaining	2	I	3	I	0	0	0	0	0	0	0	0
	Violation of land rights	0	0	0	0	0	0	0	0	0	0	0	0
Health	Occupational health and safety impacts	3	I	3	I	0	0	0	0	0	0	0	0
Gender equality	Gender related discrimination and violence	3	I	3	0	0	0	0	0	0	0	0	0
Social Equity	Discrimination	0	0	0	0	0	0	0	0	0	0	0	0
Peace & Justice	Corruption	3	0	3	0	0	0	0	0	0	0	1	0
		G	C	G	C	G	C	G	C	G	C	G	C

Table 12: Weighting of the different phases, step 3 Biengen, T-shirt case study.

Step 3. Assessing defined aspects between the different life cycle phases												
Impact category	Life cycle phases T-Shirt											
	Raw Materials India		Fabric Production And Manufacturing Bangladesh		Retail		Consumer		End of life		Transport	
Environmental impacts	3	I	3	II	1	I	2	II	1	I	2	I
Social and Human Rights impacts	3	I	3	I	1	I	1	I	1	I	1	I

5. Conclusions: Identification of Sustainability Hot Spots

5.1 Sustainability Hot Spots: pair of jeans

The identification of the SHS is assessed by multiplying the assessment of the impacts -tables 9 and 11- with the assessment of the phases, tables 10 and 12. According to Bienge (Bienge 2010) SHS with a total score of ≥ 9 can be considered as a SHS with high relevance and a score of ≤ 6 as a SHS of medium relevance. Impacts with a lower score are not considered to be SHS.

Table 13: Identification of Sustainability Hot Spots (step 4 and 5 Bienge), pair of jeans case study.

Step 4. Identification of Sustainability Hot Spots															
		Life cycle phases Pair of Jeans													
		Raw material		Fabric		Manufacturing		Retail		Consumer		End of life		Transport Entire Chain	
		TR		TR		VT		NL		NL		NL			
		G	C	G	C	G	C	G	C	G	C	G	C	G	C
Climate change	CO ₂ emissions	6	I	9	IX	6	0	1	I	6	VI	1	I	4	II
Land use change	Deforestation	0	0	0	0	6	0	0	0	0	0	0	0	0	0
Fresh water use	Excessive water use	9	I	9	IX	9	I	0	0	2	II	0	0	0	0
Loss of biosphere integrity	Loss of biodiversity	9	I	0	0	6	I	0	0	0	0	0	0	0	0
Stratospheric ozone depletion	Ozone Depletion	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atmospheric aerosol loading	Microparticles emitted into the air	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Novel entities	Chemical pollution Water pollution	9	I	9	III	9	0	0	0	2	II	0		0	0
Ocean acidification	Ocean Acidification due to fossil fuel CO ₂	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Biochemical flows	Pesticides and fertilizers	9	0	0	0	0	0	0	0	0	0	0	0	0	0
Work & Income	Forced labour	9	I	6	0	3	0	0	0	0	0	0	0	0	0
	Substandard working conditions	9	I	6	0	6	0	0	0	0	0	0	0	0	0
	Excessive working hours	6	I	6	0	6	0	0	0	0	0	0	0	0	0
	Below minimum wage	9	I	3	0	6	0	0	0	0	0	0	0	0	0
	Below living wage	9	II	9	II	9	VI	0	0	0	0	0	0	0	0
Network	Migrant workers	6	II	6	0	9	IV	0	0	0	0	1	I	0	0
Education	Child labour	9	I	6	0	3	0	0	0	0	0	0	0	0	0

Voice	<i>Restrictions to the right to form or join a trade union</i>	6	I	6	0	9	VI	0	0	0	0	0	0	0	0
	<i>Restrictions of collective bargaining</i>	6	I	6	0	9	IV	0	0	0	0	0	0	0	0
	<i>Violation of land rights</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Health	<i>Occupational health and safety impacts</i>	9	I	6	I	6	II	0	0	0	0	0	0	0	0
Gender equality	<i>Gender related discrimination and violence</i>	9	I	9	I	6	0	0	0	0	0	0	0	0	0
Social equity	<i>Discrimination</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Peace & Justice	<i>Corruption</i>	6	0	6	0	9	0	0	0	0	0	0	0	0	0

5.1.1 Raw materials phase

The raw material for the pair of jeans originates from Turkey. In table 14 the SHS for this phase are summarized.

Table 14. SHS raw materials pair of jeans case study.

<i>Sustainability Hot Spots Raw Materials pair of Jeans</i>		
	<i>General</i>	<i>Case study</i>
High	<i>Excessive water use</i> <i>Loss of biodiversity</i> <i>Chemical pollution/water pollution</i> <i>Pesticides and fertilizers</i>	
Medium	<i>CO₂ emissions</i>	
High	<i>Forced Labour</i> <i>Substandard working conditions</i> <i>Below minimum wage</i> <i>Below living wage</i> <i>Child labour</i> <i>Occupational health and safety impacts</i> <i>Gender related discrimination and violence</i>	
Medium	<i>Excessive working hours</i> <i>Migrant workers (refugees)</i> <i>Restrictions to form or join a trade union</i> <i>Restrictions to collective bargaining</i> <i>Corruption</i>	

General findings

In the raw materials stage, the environmental hotspots regarding regular cotton appear in five impact categories.

The production of regular cotton involves an excessive use of pesticides and fertilizers³⁸, as well as water usages through irrigation.³⁹ Water in the regular cotton cultivation is also heavily polluted through the use of pesticides, fertilisers and other chemicals.⁴⁰ Crop intensity and monoculture, together with the extensive use of chemicals also lead to soil degradation.⁴¹

Although less compared to fabric production and use phase (see fabric production and use (pg. 35 and 39), the impact on climate change in this phase is mainly caused by cotton ginning and the machinery used.

The impact categories of child labour, migrant workers, minimum wages and substandard working conditions in the raw material and fabric phases appeared to be largely affected by the Syrian refugees in Turkey. The refugees are vulnerable when it comes to earning a living. Reports mention refugees and their children working in textile sweatshops and in cotton fields with relatively low wages, under poor working conditions.⁴² For instance, living wage is about 3 times the minimum wage, with a family of four taken as the standard.⁴³ The salaries do not amount to that.

Workdays of 17 hours were observed⁴⁴ and informal contracts are used by intermediaries. Health and safety incidents are more likely to occur when agricultural pesticides and chemicals are used by untrained workers.⁴⁵

Case study

In the production of organic cotton, the use of pesticides, chemicals and fertilizers are strictly limited or not used at all. Compared to conventional cotton production, the LCA⁴⁶ of

³⁸ For instance: Lee, K.E., Environmental Sustainability in the Textile Industry, Sustainability in the Textile Industry ed. Muthu, S.S., Springer Nature Singapore 2017, Khan, Md M., Islam, MD M., Materials and manufacturing environmental sustainability evaluation of apparel product: knitted T-shirt case study, Textiles and Clothing Sustainability, Springer Open Journal 2015, Robesin M.A., Katoen en waterschaarste. De verantwoordelijkheid van bedrijven en overheden voor vermindering van de watervoetafdruk in de katoenketen. Duurzame handel in juridisch perspectief, Boom Juridische Uitgevers, 2014, Textile Exchange, The Life Cycle Assessment of Organic Cotton Fiber. A global average, 2014, Larsson, A., Buhr, K., Mark-Herbert, C., Corporate responsibility in the garment industry, Towards shared value, Sustainability in Fashion and Textiles, Values, Design, Production and Consumption, 2013, Esteve-Turrillas, F.A., de la Guardia, M., Environmental impact of Recover cotton in textile industry, Resources Conservation and Recycling, 2017

³⁹ See footnote 58.

⁴⁰ See footnote 58.

⁴¹ For instance: Food and Agriculture Organization of the United Nations, Measuring Sustainability in Cotton Farming Systems, towards a Guidance Framework, 2015, Solidaridad <https://www.solidaridad.nl/supply-chains/katoen>, stakeholders, KPMG, MVO Sector Risico Analyse, Aandachtspunten voor dialoog, 2014, Radhakrishnan, S. The Sustainable Apparel Coalition and the Higg Index, Roadmap to Sustainable Textile and Clothing, ed. Muthu S.S., Springer Science and Business Media Singapore, 2015

⁴² For instance: Fair Wear Foundation, Turkey Country Study 2015, Hidden Child Labour, How Syrian refugees in Turkey are supplying Europe with fast fashion, <https://www.theguardian.com/sustainable-business/2016/jan/29/hidden-child-labour-syrian-refugees-turkey-supplying-europe-fast-fashion>, Cheap and illegal, Syrian refugees show underside of Turkish refugee crises, Melig Aslan, Reuters, <https://www.reuters.com/article/us-mideast-crisis-refugees-turkey/cheap-and-illegal-syrian-workers-show-underside-of-turkeys-refugee-crisis-idUSKBN0TN1DA20151204>, and Child Labor in cotton supply chains, Action based Collaborative Project to Address Human Rights Issues in Turkey, Fair Labour Association, June 2017, DOL, Findings on the worst forms of child labour, https://www.dol.gov/sites/default/files/documents/ilab/reports/child-labor/findings/2015TDA_1.pdf

⁴³ Fair Wear Foundation Turkey Country Study 2016

⁴⁴ Fairlabor.org

⁴⁵ Child Labor in cotton supply chains, Action based Collaborative Project to Address Human Rights Issues in Turkey, Fair Labour Association, June 2017, interview

organic cotton shows a considerable reduction in the use of water and energy, as well as freshwater pollution.⁴⁷

To receive the organic cotton certificate, a farmer has to meet certain rules concerning child labour, health and safety, working hours, forced labour, trade unions, wages and discrimination. In the present case study on organic cotton, the health and safety risks associated with the use of pesticides and synthetic fertilizers are at a minimum.

5.1.2 Fabric production phase

The denim for the pair of jeans originates from Turkey. In table 15 the SHS for the fabric production phase are summarized.

Table 15: SHS fabric production phase pair of jeans case study.

<i>Sustainability Hot Spots Fabric Jeans</i>		
	<i>General</i>	<i>Case study</i>
<i>High</i>	<i>CO₂ emissions Excessive water use Chemical pollution/water pollution</i>	<i>CO₂ emissions Excessive water use</i>
<i>High</i>	<i>Below living wage Gender related discrimination and violence</i>	<i>n.a.</i>
<i>Medium</i>	<i>Forced labour Substandard working conditions Excessive working hours Migrant workers (refugees) Child labour Restrictions to form or join a trade union Restrictions to collective bargaining Occupational health and safety impacts Corruption</i>	

General findings

Production of fabric in the denim mill is an energy-intensive process.⁴⁸ Spinning of a strong thread for denim has higher energy consumption than the thinner alternatives.⁴⁹ The energy used is mainly provided by coal plants⁵⁰, and therefore adds to the CO₂ emissions.

In the production phases of a pair of jeans, the use of chemicals is considerably large. The chemicals are used in the production of the denim fabric and in the manufacturing phase. In

⁴⁶ Textile Exchange: The Life Cycle Assessment of organic cotton fiber, a global average, http://textileexchange.org/wp-content/uploads/2017/06/TE-LCA_of_Organic_Cotton-Fiber-Summary_of-Findings.pdf and Baydar, G., Ciliz, N., Mammadov, A., Life Cycle Assessment of cotton textile products in Turkey, Recourses Conservation and Recycling, 2015

⁴⁷ Rana, S., Karunamoorthy, S., Parveen, S., Fangueiro, R., Life cycle assessment of cotton textiles and clothing, Handbook of Life Cycle Assessment (LCA) of Textiles and Clothing, ed. Muthu, S.S., Woodhead Publishing 2015

⁴⁸ Roos, S., Zamani, B., Sandin, G., Peters, G.M., Svabström, M., A life cycle assessment (LCA)-based approach to guiding an industry sector towards sustainability: the case of the Swedish apparel sector, Journal of Cleaner Production, 2016

⁴⁹ Peters, G., Svanström, M., Roos, S., Sandin, G., Zamani, B. Carbon Footprints in the textile industry, Handbook of Life Cycle Assessment (LCA) of Textiles and Clothing, ed. Muthu, S.S., Woodhead Publishing 2015

⁵⁰ For instance: Environmental Sustainability in the Textile Industry, Kyung Eun Lee, Springer Nature Singapore Pte Ltd. 2017 S.S. Muthu (ed.) Sustainability in the Textile Industry, or Julian M. Allwood, Søren Ellebak Laursen, Cecilia Malvido de Rodriguez, Nancy M.P. Brocken, University of Cambridge Institute for Manufacturing, Well Dressed?

The present and future sustainability of clothing and textiles in the United Kingdom, interviewees, stakeholder meeting

this stage, first all the cotton is spun and warped into thread. Denim is a fabric woven with two sort of thread: a coloured warp and a weft. To colour the denim, the warp is dyed with synthetic indigo. After dyeing chemicals are used for finishing as well. The production of denim is water intensive, mainly due to dyeing.

Information about Syrian refugees working in the garment industry in Turkey was collected from different sources.⁵¹ In this respect, the risks of child labour and underpayment (below minimum wages) of adults appears to be high (see raw material phase). The reports of NGO's concentrate on the garment manufacturing phase, which can be different from the fabric manufacturing phase, depending on the integration of phases (see chapter 2.2, pg.12). Reports and news articles mention sweatshops where the garments are cut, sewed and finished, not specifically the fabric mills where the spinning and weaving takes place.

In Turkey the living wage is about 3.5 times the minimum wage (Fair Wear Foundation Turkey Country Study 2016). However, the freedom to form or join a trade union in Turkey is guaranteed. The Fair Wear Foundation Country Study for Turkey⁵² mentions a risk concerning the application to and withdrawal from union membership. The current Turkish system has a risk of exposing union members and making them vulnerable to reprisals (Fair Wear Foundation Turkey Country Report 2016). There are legal thresholds when it comes to taking part in collective bargaining⁵³, which is a restriction to collective bargaining.

Health and safety risks are mainly caused by dust and noise, working with chemicals and dyes and injury from machines. In general, excessive overtime is an industry broad risk and Turkey is no exception, however amongst the employed Syrian refugees, the risk of excessive overtime is higher (e.g., Fair Wear Foundation Turkey Country Report 2016).

About 40% of the registered workers in the industry are female. Although it is difficult to shed light on gender discrimination, it is reported to be a problem (see Fair Wear Foundation Turkey Country Study 2016).

As indicated by Transparency International⁵⁴ and the Trace Bribery Risk Matrix⁵⁵ corruption appears to be a medium risk.

Case study

In the case study, the mill in Italy showed that the use of chemicals can be drastically reduced and that less invasive chemicals can be used. The denim mill in Italy, can save up to 33% of water and 50% of chemicals compared to conventional dyeing techniques. Denim can be coloured with less invasive chemicals for certain washings (lighter coloured jeans). Waste water can be treated before it is released back to the environment.

In the denim mill in Italy, waste water was treated. In this mill, there were no social impacts.

⁵¹ BBC Panorama october 2016, <http://www.bbc.co.uk/programmes/b0813kpg> , <https://business-humanrights.org/en/panorama-undercover-the-refugees-who-make-our-clothes>, Fair Wear Foundation on Turkey, interviewee and <https://www.fairwear.org/wp-content/uploads/2017/02/Turkey-Refugee-Guidance-February-2017.pdf>

⁵² Fair Wear Foundation, Turkey Country Study 2015

⁵³ See footnote 69

⁵⁴ https://www.transparency.org/news/feature/corruption_perceptions_index_2016

⁵⁵ <https://www.traceinternational.org/trace-matrix>

In the case study denim mill in Turkey, a collective labour agreement with a trade union was negotiated and applied.

The mill has a health and safety organization where workers and the trade union are participants. The mill conducts risk assessments and applies the recommendations from the assessment, trains the employees and distributes protective equipment. Workers are paid by the standards of the collective labour agreement and the wages can rise above the minimum wage. In the case study, the factory case study is located in a part of Turkey where migrants, internal and international are rare, in the mill there are no migrants employed.

The spinning and weaving is an energy, water and chemicals intensive phase. The mill in Turkey does not use solar energy, it treats its wastewater and has all the necessary environmental certificates.

5.1.3 Manufacturing phase

The pair of jeans is manufactured in Vietnam. In table 16 the SHS for the fabric production phase are summarized.

Table 16: SHS manufacturing phase pair of jeans case study.

<i>Sustainability Hot Spots Manufacturing Jeans</i>		
	<i>General</i>	<i>Case study</i>
<i>High</i>	<i>Excessive water use Chemical pollution/water pollution</i>	
<i>Medium</i>	<i>CO₂ emissions Land use change/ deforestation Loss of biodiversity</i>	
<i>High</i>	<i>Below living wage Migrant workers (only internal) Restrictions to form a trade union Restrictions to collective bargaining Corruption</i>	
<i>Medium</i>	<i>Substandard working conditions Excessive working hours Below minimum wage Occupational health and safety impacts Gender related discrimination and violence</i>	<i>Below living wage Restrictions to form a trade union</i>

In the manufacturing phase of a pair of jeans, the fabric is cut, sewn, treated and washed. The treatment and washing methods depend on the look that the brands wants for the pair of jeans: varying from dark to light and from an unscathed to a destroyed look.

The look can be created through various techniques such as laser-treatment, PP (Chemicals), washing techniques and sanding. Depending on the treatment the use of water, chemicals and energy will vary, but the impact usually is significant.

General findings

The energy use in the manufacturing phase is not as high as in the fabric production phase, but still is significant.⁵⁶ The manufacturing stage is water intensive and, as stated above, chemicals are used to create the desired look.

From interviews, we learned that in Vietnam new industry parks are build, to accommodate the factories.

The risk of earning below minimum wage is not a risk for the standard work week, but for the calculation of overtime. The remuneration for overtime is not always correct (CNV 2016, Fair Wear Foundation 2015, interview, Better Work).⁵⁷

The minimum wage is low, workers want to work overtime. The trade unions calculations are that the minimum wage is substantially below the living wage. Workers really want to work overtime and will switch factories for that.⁵⁸

Vietnamese law states that workers can work a maximum of 300 hours overtime per year. But most factories work more than the 300 hours/year and this seems to be accepted (CNV 2016, Fair Wear Foundation 2015).

During the manufacturing stage, again, the chemicals pose a potential health and safety risk. Health and safety and working conditions risks are the same as the general risks in this respect: fire safety is an issue as is the storage of chemicals.⁵⁹

Internal migrants form a big part of the workers in the ready-made garment industry in Vietnam. There are no international migrants and no refugees.⁶⁰

In Vietnam there is one, government appointed trade union. There is no right to form another, independent trade union. The general opinion is that the union is allowed to make its concerns heard.

Opinions on gender based discrimination are mixed. The country report of the CNV and an interviewee of a Vietnam-based NGO voice their concerns. Another interviewees' opinion was that Vietnam is a country with a different attitude towards women compared to most other Asian countries, and a country of mixed beliefs, resulting in a more open-minded society.

Case study

At the manufacturing phase of this particular pair of jeans, the use of chemicals was reduced to the minimum. Wastewater was treated and for 99% recycled. The factory of the case study, is a Bluesign certified factory, meaning the factory uses the most environmentally sustainable production methods currently available.

⁵⁶ For instance WRAP 2017, Wang, C., Wang, L., Liu, X., Du, C., Jia, J. Yan, Y., Wu, G., Carbon footprint of textile throughout its life cycle: a case study of Chinese cotton shirts, Journal of Cleaner Production 2015

⁵⁷ Better Work Vietnam, Thematic Sythesis Report on Compensation 2015, <https://betterwork.org/vietnam/?p=4301>

⁵⁸ Interviews, Do Quynh Chi, Vietnam country study, Labour standards in the Garment Supply Chain, CNV Internationaal, June 2016, <https://www.cnvinternationaal.nl/Resources/Persistent/c693cde01921991a984c192d70c887f75412dcde/CNV-Vietnam-Garment-Supply-Chain-web%20clickable%20ENG%20DEF.pdf>, Fair Wear_Foundation Vietnam Country Study 2015

⁵⁹ Better Work at <https://betterwork.org/vietnam/?p=4301>

⁶⁰ Common opinion of all interviewees.

In the case study, involves a factory that does not use any fossil fuel at all, therefore not adding to the CO₂ emissions. Furthermore the factory plants trees on its own property, and on the industry park, enhancing biodiversity and diminishing CO₂ effects.

The manufacturer is a member of Better Work Vietnam, a global partnership program between the ILO and the IFC. Better Work monitors and evaluates companies on labour standards. All social based risks are monitored and amended where necessary.

5.1.4 Consumer use phase

General and case study

The consumer phase of the jeans case study has a significant impact on climate change.⁶¹ The effect on climate change depends on the washing temperature, the washing frequency and whether or not a tumble dryer is used.⁶² Recent studies show that washing at a lower temperature and washing less frequently leads to a significant reduction in energy use (WRAP 2017).

5.1.5 Transport phase

At the stakeholders meeting in Amsterdam stakeholders were of the opinion that transport was a big contributor to climate change. Transportation was added as a separate life cycle phase.

In the life cycle of this pair of jeans, the cotton is transported by truck from within Turkey (cotton production to fabric production). From the denim mill by truck to a port. The fabric is then shipped to Vietnam. After the manufacturing phase, it is shipped to the Netherlands, transported by truck to the warehouse and from the warehouse to the stores.

Cicero calculated the impact on climate change in the case study, following this route.⁶³

Transport is a contributor to CO₂ emissions. In the case of the RMG industry however, it is not the biggest contributor. In comparison, other phases are substantially bigger contributors to climate change. For example, H&M states that 2% of CO₂ emissions in the total life cycle is transport related.⁶⁴ The raw materials stage accounts for 11% of the total CO₂ emissions. The fabric and yarn production for 47%, manufacturing 17% and use 18%: all these phases have a substantially bigger impact than the transportation phase.

In the life cycle analysis of RMG's, the indications of climate change contributions of H&M's report, are confirmed. Transport, even taking into account the enormous distances, is a

⁶¹ For instance: Levi's LCA of a 501 jeans, Steinberger J.K., Friot, D., Joliet, O., Erkman, S., A spatially explicit life cycle inventory of the global textile chain, The international Journal of Life Cycle Assessment 2009, WRAP, Valuing our clothes, the cost of UK Fashion, July 2017, http://www.wrap.org.uk/sites/files/wrap/valuing-our-clothes-the-cost-of-uk-fashion_WRAP.pdf,

⁶² The life cycle of a pair of jeans, understanding the environmental impact of a pair of Levi's 501 jeans, Levi Strauss & Co, <http://levistrauss.com/wp-content/uploads/2015/03/Full-LCA-Results-Deck-FINAL.pdf>

⁶³ See Annex VII

⁶⁴ The H&M group sustainability report 2016: report: 2% = transportation, 11% = raw materials, 47% = fabric and yarn production, 17% = manufacturing, 5% = sales, 18% = use

relatively small contributor to climate change in the total climate change impact in the PLC compared to other phases in the life cycle of a RMG.^{65 66 67 68}

5.1.6 End of life phase

A life cycle phase without a sustainability hot spots, is the end of life phase. This phase will become even more important when the consumption of garments increases, as it has done in the last decade. The end of life phase can contribute to life cycle thinking and acting in the RMG industry.

Separate collection of used garments can contribute to lessening the effect of the industry on the environment and contribute to closing the loop. Estimates on the amount of textile collection vary and state that between 30 to 50% of textile waste in the Netherlands is collected separately.⁶⁹ In the UK it is estimated that this is 25%.⁷⁰ As in the Netherlands almost all waste is recycled and there are almost no landfills anymore, the non-collected textiles end up in the incinerator. From the collected garments, between 50- 60%⁷¹ will have a second life as a garment, either in the EU or Africa and to a much lesser extent, Asia. The remainder of the collected textiles is sold. For instance, to make polishing rags, fibers for carpets or isolation material. Clothes that cannot be worn again are frequently shipped to Asia for further recycling. The question is if shipment to Africa can be continued in the future as a number of African countries has declared to install a ban on importing second hand clothes.⁷²

It is still very difficult to upcycle garments to new raw material for garment production. Usually virgin materials are necessary for that, when a garment is made of a mix of materials (for instance cotton and elastan for stretch), recycling is much more difficult. From literature and interview it transpired that more research needs to be done on recycling of textile fibers in order to be able to close the loop.⁷³ As a best practice, a machine has now been installed in one of the recycling halls in the Netherlands that can validate and sort the material of the garment in an instant. In the near future the machine will be sorting the various materials by color as well, thereby increasing the usability of second hand textiles for recycling.⁷⁴

⁶⁵ Steinberger, J.K, Friot,D., Jolliet, O., Erkman, S., A spatially explicit life cycle inventory of the global textile chain, The international Journal of Life Cycle Assessment, July 2009

⁶⁶ Valuing our clothes, the cost of UK Fashion, WRAP 2017

⁶⁷ C. Wang, L. Wang, X. Liu et al.,Carbon footprint of textile throughout its life cycle: a case study of Chinese cotton shirts ,Journal of cleaner production 108, (2015) 464-475

⁶⁸ M. Munasinghe, P. Jayasinghe, V.Ralapanawe, A. Gajanayake, Supply/value chain analysis of carbon and energy footprint of garment manufacturing in Sri Lanka, Sustainable Production and Consumption Elsevier

⁶⁹ G.J. van de Vreede, M.N. Sevenster, Milieuanalyse textiel, Ten behoeve van prioritaire stromen ketengericht afvalbeleid, CE Delft and Sander Jongerius, Textiles4Textiles, Contribution to Cluster Workshop Sensor based sorting, 2010

⁷⁰ A.C. Woolridge, G.D. Ward, P.S. Philips, M. Collins, S. Gandy, Life cycle assessment for reuse/recycling of donated waste textiles compared to use of virgin material: An UK energy saving perspective, Resources Conservation & Recycling 46 (2006) 94-103

⁷¹ Estimates vary: 60% by Textiles4Textiles Sander Jongerius, 60% by Vreede and Sevenster 2010, 55% by Een betere wereld dankzij tweedehands kleding, textile collecting company, http://boergroep.nl/fileadmin/user_upload/downloads/Een_betere_wereld_dankzij_tweedehands_kleding_NL.pdf , 49% by another textile collecting company: <http://www.gebotex.nl/producten/>

⁷² De Volkskrant 15 March 2016, Kaya Bouma, "Hogere importheffing zou slimmer zijn", impart bans: South Africa, Nigeria, Etiopia, Zimbabwe and from 2019 Kenya, Oeganda, Burundi, Tanzania and South Soedan

⁷³ S.S. Muthu, Y. Li, J.Y. Han, L. Ze, Carbon Footprint Reduction in the Textile Process Chain: Recycling of Textile Materials Fibres and polymeres 2010, Vol. 13, No 8, 1065-1070, Prevention of Textile Waste

N. Tojo, B. KÖgg, N. Kiørboe, B. Kjaer, K. Aalto, Nordic Council of Ministers Material flows of textiles in three Nordic countries and suggestions on policy instruments, 2012 and interviews

⁷⁴ Wieland Textiles, http://www.wieland.nl/wieland/index.php?option=com_content&view=article&id=59&Itemid=60

5.2 T-shirt

The identification of the sustainability hot spots is assessed by multiplying the assessment of the impacts from Table 11 with the assessment of the phases from Table 13. Sustainability Hot Spots with a total score of 9 are of high relevance, while impacts with a score of 6 are of medium relevance. Impacts with a lower score are not considered to be a SHS.

The phases after the manufacturing phase, are not discussed here since they are the same as the phases in the PLC of the pair of jeans.

Table 17: Sustainability Hot Spots of a T-shirt.

Step 4. Identification of Sustainability Hot Spots													
	Life cycle stage Impact category	Life cycle phases T-shirt											
		Raw material India		Manufacturing Bangladesh		Retail NL		Consumer NL		End of life NL		Transport Chain	
		G	C	G	C	G	C	G	C	G	C	G	C
Climate change	CO ₂ emissions	6	I	9	VI	1	I	6	VI	0	0	4	II
Land use change	Deforestation	0	0	0	0	0	0	0	0	0	0	0	0
Freshwater use	Excessive water use	9	I	9	VI	0	0	2	II	0	0	0	0
Loss of Biosphere integrity	Loss of biodiversity	9	I	6	II	0	0	0	0	0	0	0	0
Stratospheric ozone depletion	Ozone Depletion	0	0	0	0	0	0	0	0	0	0	0	0
Atmospheric aerosol loading	Microparticles emitted into the air	0	0	0	0	0	0	0	0	0	0	0	0
Novel entities	Chemical pollution Water pollution	9	0	9	II	0	0	2	II	0	0	0	0
Ocean Acidification	Ocean Acidification	0	0	0	0	0	0	0	0	0	0	0	0
Biochemical flows	Pesticides and fertilizers	9	0	0	0	0	0	0	0	0	0	0	0
Work & Income	Forced labour	3	0	3	0	0	0	0	0	0	0	1	0
	Substandard working conditions	9	I	6	0	0	0	0	0	0	0	0	0
	Excessive working hours	9	I	9	I	0	0	0	0	0	0	0	0
	Below minimum wage	6	I	6	0	0	0	0	0	0	0	0	0
	Below living wage	9	II	9	III	0	0	0	0	0	0	0	0
Network	Migrant workers	3	0	9	III	0	0	0	0	1	I	0	0
Education	Child labour	9	I	6	0	0	0	0	0	0	0	0	0
Voice	Restrictions to the right to form or join a	6	I	9	I	0	0	0	0	0	0	0	0

	<i>trade union</i>												
	<i>Restrictions of collective bargaining</i>	6	1	9	1	0	0	0	0	0	0	0	0
	<i>Violation of land rights</i>	0	0	0	0	0	0	0	0	0	0	0	0
Health	<i>Occupational health and safety impacts</i>	9	1	9	1	0	0	0	0	0	0	0	0
Gender equality	<i>Gender related discrimination and violence</i>	9	1	9	0	0	0	0	0	0	0	0	0
Social equity	<i>Discrimination</i>	0	0	0	0	0	0	0	0	0	0	0	0
Peace & Justice	<i>Corruption</i>	9	0	9	0	0	0	0	0	0	0	1	0
		G	C	G	C	G	C	G	C	G	C	G	C
		Raw material India		Manufacturing Bangladesh		Retail NL		Consumer NL		End of life NL		Transport Chain	

5.2.1 Raw materials phase

The raw material for the T-shirt originates from India. In table 18 the SHS for this phase are summarized.

Table 18: SHS raw materials case study T-shirt.

<i>Sustainability Hot Spots Raw Material T-shirt</i>		
	<i>General</i>	<i>Case study</i>
High	<i>Excessive water use Loss of biodiversity Chemical pollution/water pollution Pesticides and Fertilizers</i>	
Medium	<i>CO₂ emissions</i>	
High	<i>Substandard working conditions Excessive working hours Below living wage Child labour Occupational health and safety impacts Gender related discrimination and violence Corruption</i>	
Medium	<i>Below minimum wage Restrictions to form a trade union Restrictions to collective bargaining</i>	

General findings

The cotton for the T-shirt stems from India. It is unclear from what part of India exactly the cotton originates. The origin of the cotton and the method of irrigation is defining for the amount of water used. To assess the impacts in the raw materials stage, India specific data was taken into account where possible.^{75 76}

In the production of cotton, the use of pesticides and fertilizers is common (see raw materials phase case study pair of jeans, pg. 35-36). Pesticides not only have an environmental impact, but they can also have an impact on the health of people working with them, which for instance became clear last October when over 50 farmers died of unsafe use of pesticides.⁷⁷ The risk of occupational health and safety is closely linked to the improper and unprotected use of pesticides and chemicals.

Cotton growing in India is mostly done on smallholdings, where complete families work, increasing the risk of children working.⁷⁸ There is also a risk of children participating in the most hazardous work, the production of hybrid seeds.⁷⁹

Case study

As in the case of the jean, the T-shirt is made of organic cotton. In the production of organic cotton, pesticides, chemicals and fertilizers are either not used at all or their use is strictly limited. In the case study, the precise location of the cotton production in India was unknown. The fields visited were BCI and organic cotton fields. At the visited organic cotton field, the cotton was irrigated with water from wells. Considering these findings, combined with the findings in literature, fresh water use is still an impact but considerably less water is used in the biological production of cotton than in the production of conventional cotton.

In the production of organic cotton pesticides and chemicals aren't used and in the field visit it was clear that the farmers and workers were regularly trained.

Organic Cotton prohibits child labour. During the fields visits it was clear that there was no child labour. However, the risk of child labour was also noted during the field visit to cotton fields in India, where the farmers mentioned that the education at the local school was not very good. Doubt on the use of school-education, could lead to keeping children at home.

5.2.2 Manufacturing phase

The T-shirt is manufactured in Bangladesh. In table 19 the SHS for this phase are summarized.

Table 19: SHS manufacturing phase case study T-shirt.

⁷⁵ Bevilacqua M., Ciarapica F.E, Mazzuto, G, Paciarotti, C, Environmental analysis of a cotton supply chain, Journal of Cleaner Production (2014), 154-165: "Compared to Egypt, China and USA, Indian cotton production has the highest impact on climate change."

⁷⁶ The Life Cycle of Organic Cotton Fiber – a global average, Textile Exchange, November 2014

⁷⁶ The True Price of Cotton from India, IDH and True Price, 2016, <http://trueprice.org/wp-content/uploads/2016/04/TP-Cotton.pdf>

⁷⁷ BBC news, 5 October 2017, <http://www.bbc.com/news/world-asia-india-41510730> last visited 23 November 2017

⁷⁸ Measuring Sustainability in Cotton Farming Systems. Towards a Guidance Framework, Food and Agriculture Organization of the United Nations, International Cotton Advisory Committee, Rome 2015, and Cleaner, greener cotton, impacts and better management practices, WWF, and The True Price of Cotton from India, IDH and True Price, 2016

⁷⁹ DOL USA, pg. 531

<i>Sustainability Hot Spots Manufacturing T-shirt</i>		
	<i>General</i>	<i>Case study</i>
<i>High</i>	<i>CO₂ emissions Excessive water use Chemical pollution/water pollution</i>	
<i>Medium</i>	<i>Loss of biodiversity</i>	<i>CO₂ emissions Excessive water use</i>
<i>High</i>	<i>Excessive working hours Below living wage Migrant workers Restrictions to form or join a trade union Restrictions to collective bargaining Occupational health and safety impacts Gender related discrimination and violence Corruption</i>	
<i>Medium</i>	<i>Substandard working conditions Below minimum wage Child labour</i>	

General findings

There are now 4482 garment factories and 4 million workers in the garment industry in Bangladesh.⁸⁰ In one of these factories the T-shirt for the case study is made.

The stage of T-shirt manufacturing in this PLC also includes spinning and knitting.

Spinning and knitting is an important contributor to climate change. A lot of energy is needed for the spinning and dyeing of the yarn. Often the energy used, comes from coal fired plants.

The finishing step and the weaving, and in this case knitting of the fabric, is an important user of fresh water. The water is used to wash, dye and finish textiles. The World Bank calculated that the textile mills in Dhaka may consume as much groundwater as is supplied to the entire megacity of over 12 million habitants. Groundwater over-abstraction has dropped the water level more than 70 meters from the surface in some locations.⁸¹

The dyeing and finishing stage of textiles is an important user of chemicals. The waste water is highly polluted. The World Bank concluded that most surface water in Dhaka and its region was unfit for human use, and likely to be dangerous for livestock (World Bank 2014).

The impacts on climate change, water levels and water pollution indicate that the biosphere is affected. In the stakeholder meeting, loss of biodiversity was noted as a major impact.

⁸⁰ <http://www.bgmea.com.bd/home/pages/TradeInformation>, last visited 6 November 2017

⁸¹ The Bangladesh Responsible Sourcing Initiative. A new model for green growth? The World Bank. April 2014

One of the most significant impacts in both the raw materials stage as in the manufacturing stage is the risk of workers not earning a minimum or a living wage.

The wages in the garment industry in Bangladesh are amongst the lowest in the world⁸². Excessive overtime is also a major concern, as voiced by stakeholders and interviewees and as reported in grey literature and in the latest EU reports.⁸³

Child labour has always been associated with garment production. In Bangladesh effort has been made to eradicate child labour from the industry. Which does not mean that there is no more child labour in the garment industry in Bangladesh. As interviewees and SOMO's⁸⁴ research pointed out, there still is child labour. For instance, at subcontracting companies. It has however as good as disappeared from the factories producing for western brands (SOMO, interviewees).

A significant impact was found regarding the acceptance of (the work of) trade unions in Bangladesh. There have been incidents with retaliations for employees and union representatives after demonstrations⁸⁵, the EU reported that Bangladesh does not meet the objectives set by the EU (EU Status report October 2017).

In the garment industry in Bangladesh a lot has changed in the past years after the Rana Plaza catastrophe, mainly on fire and building safety. Government, BGMEA and brands have taken several steps to improve working conditions. There still are impacts that warrant the working conditions to be a SHS. Examples given were: not providing drinking water, no hygienic toilets, no air circulation.

Working routine has not changed, the work mostly has a repetitive nature and can be strenuous, resulting in physical risks.⁸⁶

There is still a significant risk to gender based discrimination and abuse in the RMG industry in Bangladesh. Garment workers are mostly women from rural areas with little education. The supervisors and management are usually male, women in higher positions are scarce (Fair Wear Foundation Country Study). In a study of World Bank Group⁸⁷ it was mentioned that women working outside their home in low income jobs, like factory work in India and Bangladesh, are regarded as 'bad women' who have lost virtue and thus deserve harassment. In interviews with experts other gender related issues were mentioned, such as long hours of standing when pregnant and a lack of the possibility to have regular toilet-breaks when having your period.

Case study

⁸² Source: <http://emergingtextiles.com/?q=art&s=130718-apparel-worker-wages&r=free&i=samplearticle>

⁸³ EU Implementation of the Bangladesh Compact Technical Status Report October 2017, http://trade.ec.europa.eu/doclib/docs/2017/october/tradoc_156343.pdf

⁸⁴ SOMO, Branded childhood 2017, Emma Vogt, Martje Theuws, Virginia Sandjojo, "Branded Childhood - SOMO," 2017, <https://www.somo.nl/nl/wp-content/uploads/sites/2/2017/01/Branded-childhood-web.pdf>. "Although there are an estimated 690,000 children engaged in child labour in Dhaka Division, child labour at export-oriented garment factories in Bangladesh has been greatly reduced over the past few years".

⁸⁵ Clean Clothes Campaign, Update on labour rights crisis in Bangladesh, <https://cleanclothes.org/resources/publications/update-bangladesh-foa-april-2017> and <https://cleanclothes.org/resources/publications/european-union-and-the-bangladesh-garment-industry-the-case-for-a-trade-investigation> and EU Implementation of the Bangladesh Compact Technical Status Report October 2017,

⁸⁶ <http://bangladeshaccord.org/wp-content/uploads/Accord-Public-Disclosure-Report-1-Nov-2017.pdf>, Fair Wear Foundation, Bangladesh Country Study 2015, stakeholders and interviews.

⁸⁷ Violence against women and girls: Lessons from South Asia, World Bank Group, South Asia Development Forum J.L. Solotaroff, R. P. Pande, 2014.

The brand in the case study has its own local CSR manager in Bangladesh and carries out its own audits. The CSR manager and team visit the factory regularly and are free to interview workers. There is no sign of unauthorized subcontractors.

The factory in Bangladesh uses as little chemicals as possible and treats its wastewater, therefore considerably reducing its impact on the environment.

Field visits to other factories, which also work for major western brands, like H&M and C&A reinforced the case study's findings regarding the factory where child labour, working conditions and health and safety issues are concerned. The findings concerning child labour in factories producing for western brands, were correspondent with the opinions expressed in the interviews with stakeholders and experts in Bangladesh.

A recent study of SOMO showed that child labour was as good as eradicated from the factories producing garments for the bigger Western brands (SOMO Branded Childhood 2017).

In the factory where the T-shirt is manufactured a worker - management dialogue is installed and working. There have been no anti-union incidents. There are no reports on discrimination or underpayment. The factory pays above the minimum wage and has a well-functioning Human Resources department.

6. General conclusions

Overall, it can be concluded that the most SHS appear in the raw materials and manufacturing stage.

At all phases, irrespective of country or case, not earning a living wage is a high-risk impact.

In many interviews and discussions with stakeholders, the relationship between (living) wages and excessive overtime was underscored. To earn more, workers often want to work more than the regular hours. If employers do not provide overtime possibilities and extra payments, sometimes employees change jobs for better terms.

Several stakeholders and interviewees indicated that the rights to create or join a trade union are extremely important. The general opinion is that when trade unions are widely accepted and workers do not have to fear repercussions for joining a trade union or campaigning for their labour rights, unions can help to improve several impacts. For instance, better working conditions and better salaries, and workers autonomy to decide their priorities.

An unexpected result of the case study is that the international transportation throughout the life cycle of the studied RMGs does not lead to an environmental hot spot. Though international transportation does contribute to CO₂ emissions, other phases in the PLC of a RMG have substantial larger impact on climate change.

From the case studies it appears that impacts can be diminished. For instance, by using other, less aggressive chemicals or using less or no chemical fertilizers and pesticides as BCI and organic cotton showed. The use of water and chemicals in the manufacturing stage can be greatly reduced as the manufacturing factory in Vietnam and Bangladesh, and also the denim mill in Italy showed. Waste water can be treated before releasing it back into the environment again. These practises are already available.

The CO₂ emissions the manufacturing stage can be reduced by using solar power and by using the already available heat to dry clothes.

The consumer or use stage, is a relevant contributor to climate change. Research showed that different wearing, washing and drying methods can have a big impact on the total CO₂ emission. Consumer education can contribute to a more sustainable way of treating our garments as research by WRAP (WRAP 2017) showed.

ANNEX I. Planetary Boundaries and Social foundation

Definitions of phases and explanation of Planetary Boundaries and social foundation categories and impacts are provided in this annex.

Phases:

Raw Material	Planting, growing and harvesting of cotton, ginning, cleaning and baling of cotton
Fabric production	Spinning of lint into yarn and knitting or weaving of the yarn into fabric. Including dyeing of the yarn and/or fabric.
Garment manufacturing	Cutting and sewing and treating the fabric. Also the washing, embroidering, printing, dyeing. Sometimes referred to as CMT (Cut – Make – Trim)
Retail	Design, purchase, distribution, warehousing, and selling of the garment
Consumer	Starts with the consumer buying the garment. Also wearing, washing and drying the garment
End of Life	Post first consumer life. Limited to two options: incineration or second life as either garment or recycled goods
Transport	Transport from cotton field to consumer: by truck- boat or aeroplane.

Planetary Boundaries and environmental impacts

Climate change	The present warming of earth's temperature that changes the climate ⁸⁸ . Mostly due to CO2 emissions from fossil fuel use. Energy used: electricity and fuel account for CO2 emissions.
Release of novel entities	Synthetic substances being released into the environment. Chemical substances used in the life cycle of a RMG, for instance in the bleaching and dyeing of the yarn and fabric. Emissions to fresh water, turning fresh water into waste water.
Atmospheric aerosol loading	Microparticles emitted into the air, air pollution.
Biochemical Flows: Nitrogen and phosphorus cycles	Mainly used in intensive agriculture and industries (fertilizers, pesticides) Fertilizers are different from the definition of chemicals as they contribute to a different Planetary Boundary. In chemical fertilizers phosphorus and nitrogen are used.

⁸⁸ For a comprehensive non-scientific explanation visit: <http://www.bbc.com/news/science-environment-24021772>: "What is climate change?"

Fertilizers	Any synthetic substance used to fertilize the soil.
Pesticides	A substance used for destroying insects or other organisms harmful to cultivated plants or to animals (Oxford dictionary) Usually contains chemicals and/or phosphor and/or nitrogen.
Fresh water use	The amount of fresh water extracted and used.
Fresh water	Blue water: water from rivers, lakes, reservoirs and renewable groundwater stores.
Land use change	Forest conversion to croplands, roads and cities. Deforestation.
Loss of Biosphere integrity	Disruption of ecosystems: impacted by human activities, loss of wild animal populations, including extinction of species. Loss of biodiversity.
Loss of stratospheric ozone depletion	The 'ozon-hole'
Ocean acidification	The GHG emissions from notably the production of RMGs contribute to climate change with ocean acidification as one of its impacts.

Social foundation and Social and Human Rights impacts

Child Labour	<p>The general minimum age for admission to employment or work is set at 15 years (13 for light work) and the minimum age for hazardous work at 18 (16 under certain strict conditions). (<i>ILO Minimum Age Convention, 1973 (No. 138)</i>)</p> <p>The term "child labour" is often defined as work that deprives children of their childhood, their potential and their dignity, and that is harmful to physical and mental development." It refers to work that:</p> <ul style="list-style-type: none"> • is mentally, physically, socially or morally dangerous and harmful to children; and • interferes with their schooling by; <ul style="list-style-type: none"> ○ depriving them of the opportunity to attend school; ○ obliging them to leave school prematurely; or ○ requiring them to attempt to combine school attendance with excessively long and heavy work. <p>(<i>ILO, Worst Forms of Child Labour Convention 1999, (No. 182)</i>)</p>
Forced Labour	<p>"All work or service which is extracted from any person under the menace of any penalty and for which the said person has not offered himself voluntarily." (<i>ILO Convention 1930 (No. 29)</i>):</p> <p>And</p> <p>Coercive labour: workers are indirectly forced to work more hours because their regular salary is too low for the normal living costs. (<i>Agreement on Sustainable Garment and Textile, 2016</i>)</p>
Migrant Labour	<p>Migrant labour includes International and inland migrant workers.</p> <p>Migrant labourers are more at risk of having to endure forced labour. Migrant labour also means that there is a higher risk of child labour (see <i>OECD Due Diligence Guidance for responsible supply chains in the Garment</i></p>

	<i>and Footwear sector, pg. 104 and 124).</i>
Risk on Occupational Health and Safety-impacts and Unsafe Working Conditions	<p>Occupational health and safety: The employer takes care of the health and safety of all its workers on all work-related aspects, and in that respect, makes sure that the work is thus organized that the workers do not experience any disadvantage on their health and safety. It also means that effective measures are taken for first aid at accidents, fire safety, evacuation of employees etc.</p> <p>This implies:</p> <ul style="list-style-type: none"> - safe and hygienic working conditions, - when working with dangerous chemicals and pesticides, appropriate safety measures are in place and carried out, - attention to appropriate measures where heavy and physically demanding work is carried out, - sufficient fire and building safety, - appropriate measures against air pollution, noise, heat and the use of chemicals, - proper utilisation of machinery and maintenance of equipment.
Risk of below Minimum Wages	<p>Wages below the minimum wages as laid down by (domestic) law for the country of production and / or unpaid overtime and the minimal wage should be sufficient to satisfy the basic needs of the workers and their families. (<i>OECD Guidelines V.4b</i>).</p>
Risk of below Living wage	<p>UN Declaration of Human Rights: “everyone who works has the right to just and favourable remuneration ensuring for himself and his family an existence worthy of human dignity”. The OECD and ILO also include the living needs of the workers family in their definition of what a just wage should amount to. More concise definitions are given by Social Accountability International (SAI), Asia Floor Wage and the Anker methodology. There is no consensus on how to calculate a living wage.</p> <p>The definition for this research is that of the SAI: “The remuneration received for a standard work week by a worker in a particular place sufficient to afford a decent standard of living for the worker and his or her family. Elements of a decent standard of living include food, water, housing, education, healthcare, transport, clothing, and other essential needs including provision for unexpected events.”</p>
Excessive Working Hours	<p><i>The definition is taken from the Ethical Trading Initiative (http://www.ethicaltrade.org/eti-base-code/6-working-hours-are-not-excessive);</i></p> <p>6.1 Working hours must comply with national laws, collective agreements, and the provisions of 6.2 to 6.6 below, whichever affords the greater protection for workers. 6.2 to 6.6 are based on international labour standards.</p> <p>6.2 Working hours, excluding overtime, shall be defined by contract, and shall not exceed 48 hours per week*</p> <p>6.3 All overtime shall be voluntary. Overtime shall be used responsibly, taking into account all the following: the extent, frequency and hours worked by individual workers and the workforce as a whole. It shall not be used to replace regular employment. Overtime shall always be compensated at a premium rate, which is recommended to be not less than 125% of the</p>

	<p>regular rate of pay.</p> <p>6.4 The total hours worked in any 7 day period shall not exceed 60 hours, except where covered by clause 6.5 below.</p> <p>6.5 Working hours may exceed 60 hours in any 7 day period only in exceptional circumstances where all of the following are met:</p> <ul style="list-style-type: none"> - this is allowed by national law; - this is allowed by a collective agreement freely negotiated with a workers' organization representing a significant portion of the workforce; - appropriate safeguards are taken to protect the workers' health and safety; and - the employer can demonstrate that exceptional circumstances apply such as unexpected production peaks, accidents or emergencies. <p>6.6 Workers shall be provided with at least one day off in every 7 day period or, where allowed by national law, 2 days off in every 14 day period.*</p> <p><i>*International standards recommend the progressive reduction of normal hours of work, when appropriate, to 40 hours per week, without any reduction in workers' wages as hours are reduced</i></p>
Gender- and other Discrimination	<p>Sexual harassment, gender based violence, gender based discrimination, being:</p> <p>"any distinction, exclusion or restriction made on the basis of sex which has the effect or purpose of impairing or nullifying the recognition, enjoyment or exercise by women, irrespective of their marital status, on a basis of equality of men and women, of human rights and fundamental freedoms in the political, economic, social, cultural, civil or any other field."</p> <p><i>(UN convention on the elimination of all forms of discrimination against women).</i></p> <p>And:</p> <p>Discrimination: "Any distinction, exclusion or preference made on the basis of race, colour, sex, religion, political opinion, national extraction or social origin (among other characteristics), "which has the effect of nullifying or impairing equality of opportunity and treatment in employment or occupation (<i>ILO Convention (No. 111).</i></p> <p>In other words: "Discrimination is based not only on gender, but also on other (personal) characteristics such as being a member of an ethnic or other minority group, a religious group or a status conferred by third parties on account of birth, such as a specific caste, which are irrelevant in terms of doing the job." (<i>Agreement on Sustainable Garment and Textile, 2016</i>)</p>
Freedom of Association and Collective Bargaining	<p>The right to join and form trade unions and the right to collective bargaining, without intimidation of workers and anti-union behaviour.</p>

ANNEX II. CO₂ emissions in transport by CICERO

Jeans and T-Shirts

Internal report for the SMART project. Robbie Andrew, CICERO

Estimating supply-chain emissions for a specific supply-chain

Estimating the total emissions in the supply chain of a product requires a number of careful assumptions. The core reasons for this are as follows:

- Under-specificity may provide estimates that aren't applicable to the case study, e.g. use of input-output analysis
- Over-specificity can require enormous data-collecting effort and lead to limited usefulness, e.g. the specific aircraft, proportion of used freight capacity on specific flights, etc.

Assumptions that produce a trade-off between these two extremes are therefore necessary.

Jeans

Reminder: all figures here are approximations, some more approximate than others. Without the specific information required to perform these calculations, only approximations can be made.

Kyrgyzstan is a land-locked country, with no harbour. It is unclear whether the cotton would be trucked to the Black Sea or the Arabian Sea, but either would be a considerable distance by truck. If we assume the Black Sea, which would make the following sea journey to Izmir shorter, the distance by road to the port would be approximately 4000 km. Transport within Kyrgyzstan (from fields/ginning to border) could add up to 500 km.

It might be safe to assume that the trucks in Kyrgyzstan are not of the highest efficiency, and this would result in higher emissions per tonne-km. Let us assume the truck uses 50% more fuel than the average UK truck of the same class.

Does one assume that the trucks return empty or with a return load? If they return empty, then the entire two-way journey (total 9000 km by truck) must be assigned to the cotton, although the return journey of an empty truck would result in somewhat lower emissions (perhaps 20% lower).

In addition, baled cotton has a relatively low density (under 500 kg/m³) compared to other commonly transported goods, such that a 10-tonne truck probably isn't large enough to carry 10 tonnes of baled cotton. Even if this isn't accurate, there are other reasons to assume that the load isn't 100%. Without sufficient information we might therefore assume a truck of 10-tonne capacity carrying 7 tonnes, i.e. 70% of capacity.

With a one-way journey totalling 4500 km, and assuming a 10-tonne truck with 70% capacity and a fuel-efficiency 50% worse than the UK average for that class of truck, emissions would be about 800 gCO₂/kg of transported cotton. $[1.5 \times 0.8 \times 4500 / 7000]$

Transport by boat on the Black Sea to Izmir probably adds negligible impact, because of both short distance and generally very low (relative) emissions per tonne-km on boats.

The distance from the port in Izmir to the factory is probably negligible in this context.

From Izmir to Ho Chi Minh City by boat is about 12300 km. We don't know what sort of boat would be use here, but assuming a medium-sized container ship (2000-2999 TEU), with emissions of 20gCO₂/t-km, this would result in about 250gCO₂/kg of transported material. [12300*20/1000]

If the material were instead flown from Izmir to Ho Chi Minh City, the distance would be 8400 km. With an emission factor of 1.5kgCO₂/t-km this yields 12.6 kgCO₂/kg of material. [8400*1.5/1000]

From Ho Chi Minh City to Rotterdam by boat is about 17200 km. With the same medium-sized container ship, this would result in about 350gCO₂/kg of material. [17200*20/1000]

In the context of a 4500 km truck journey through central Asia, the truck travelling from Rotterdam to Amsterdam is negligible.

However, the consumer driving 30 km one-way to purchase the jeans is not negligible. The big question here is how much of the emissions of such a trip to assign to the jeans. If the consumer made the trip specifically and solely to purchase the jeans, meaning also that the consumer gained no enjoyment from the trip itself, then the entire emissions can be assigned to the jeans. However, this seems an unlikely scenario.

DEFRA's average UK petrol-fuelled passenger car emits 185 gCO₂/km (2017 edition). Using this figure for our scenario with a 60-km round trip would yield about 11 kgCO₂. Note that this would apply to one pair of jeans rather than 1 kg of jeans. [60*185]

Table:

Stage	CO ₂ (g/kg)
Trucks: within Central Asia	800
Boat: Turkey->Viet Nam	250
Plane: Turkey->Viet Nam	12600
Boat: Viet Nam->Netherlands	350
Car: house<->shop	Up to 11000

T-Shirt

Cotton production is spread widely across India. Without more specific information on location it is difficult to estimate distances travelled by truck within India and by boat to Bangladesh. Here we will take two examples to provide a range.

In the first example we assume cotton production in Gujarat in the west of India, transported by truck to the port at Navlakhi, say 160 km distant. This distance is negligible in the context. The distance by boat from Navlakhi to Chittangong in Bangladesh is about 4700 km. What sort of boat might be used is, again, unknown. Being intra-regional transport between two developing countries we will assume a small general cargo freighter, with

emissions of about 20 gCO₂/t-km. This would yield emissions of about 100 gCO₂/kg of material. [4700*20/1000]

In the second example we assume cotton production in Andhra Pradesh in the east of India, transported by truck to the port at Kakinada. Again the distance travelled by truck is insignificant in the context. The distance by boat from Kakinada to Chittangong is about 1200 km. With the same type of boat this would yield emissions of only about 25 gCO₂/kg of material. [1200*20/1000]

The distance travelled of the finished T-shirts by boat to Rotterdam is about 15500 km. On a medium-sized container ship this would yield emissions of about 300 gCO₂/kg of material. [15500*20/1000]

Truck transport from harbour via warehouse to store is again negligible. Again, a consumer travelling 30 km each way with the sole purpose of purchasing the T-shirt would add 11 kgCO₂, far outweighing all other transportation in the production and distribution cycle.

Stage	CO ₂ (g/kg)
Truck/boat: India to Bangladesh	100/25
Boat: to Rotterdam	300
Car: House<->Shop	Up to 11000

Average emission factors

Various organisations have put together simplified emission factors that can be used, without requiring detailed information on the type of vehicle used.

DEFRA

The UK's Department for Environment, Food, and Rural Affairs (DEFRA) has published emission factors that are recommended for business reporting in the UK, and these have been updated every year since 2002 based on both methodology changes and changes in the types of vehicles, planes, and ships present in the UK (DEFRA, 2013)⁸⁹. For freight, figures are given for dedicated freight flights for domestic, short-haul and long-haul distances, and for mixed passenger-freight flights.

Note that the emission factor declines with distance as a result of increasing load factor (greater utilization of freight capacity), increased time spent cruising compared with take-off and landing, and more efficient (larger) aircraft.

We use DEFRA figures for road transport and air transport.

International Maritime Organization (IMO)

The IMO's 'Second IMO GHG Study 2009' report lists emission factors for many different classes of ship (Buhaug et al., 2009). Efficiencies of boats vary enormously by type, from the largest bulk carriers and crude oil tankers below 3gCO₂/t-km to small tankers and container ships over 30 gCO₂/t-km.

⁸⁹ See <https://www.gov.uk/government/collections/government-conversion-factors-for-company-reporting>

The table below (reproducing only six rows of IMO's Table 9.1) shows those for container ships, which vary according to the size of the ship, with the largest container ships (over 8000 TEU) having emissions of about 12 gCO₂/t-km and the smallest (under 1000 TEU) emitting over 36 gCO₂/t-km.

Type	Size (TEU)	Average cargo capacity (tonne)	Average yearly capacity utilization	Average service speed (knots)	Transport work per ship (tonne- NM)	Loaded efficiency (g of CO ₂ /tonne-km)	Total efficiency (g of CO ₂ /tonne-km)
Container	8,000+	68,600	70%	25.1	6,968,284,047	11.1	12.5
Container	5,000–7,999	40,355	70%	25.3	4,233,489,679	15.2	16.6
Container	3,000–4,999	28,784	70%	23.3	2,820,323,533	15.2	16.6
Container	2,000–2,999	16,800	70%	20.9	1,480,205,694	18.3	20.0
Container	1,000–1,999	7,000	70%	19.0	578,339,367	29.4	32.1
Container	0–999	3,500	70%	17.0	179,809,363	33.3	36.3

Distances

For marine distances we have used the tool available on the Platts website.

For road transport distances we have used Google Maps.

For flight distances we have used

http://www.worldatlas.com/travelaids/flight_distance.htm. Flight distances are assumed to be non-stop, direct flights, even for long-distance travel. We could make assumptions about non-direct flights, but such assumptions are swamped by the uncertainty over what sort of aircraft is used.

International Civil Aviation Organization (ICAO)

The most detailed publically method available for emissions from flights is provided by ICAO (ICAO, 2016). This method provides emissions estimates specific to each aircraft currently in operation based on real data on fuel usage and load factor (proportion of filled seats and cargo). ICAO averages over load factors and provides a different emission estimate for each aircraft type and distance. The distance effectively incorporates assumptions on how load factors vary with different routes, how deviations from great-circle flightpaths typically vary with distance, and also incorporates the lower emissions of cruising speeds (higher emissions with take-off and landing).

However, the ICAO methodology has not been documented sufficiently for use with freight calculations. ICAO's method is specifically designed for estimating emissions for passengers, with no formula given for estimating emissions for freight. Data provided are total fuel consumption by distance and aircraft type, along with average passenger load factors and passenger-to-freight factors by aggregated routes (e.g. between Europe and 'Pacific South East Asia'). Additional information would be required on the passenger and freight capacity of the aircraft.

It might be possible to combine the information in the methodology report with the results given by the online passenger emissions calculator to produce estimates of emissions per tonne-km of freight, although we haven't attempted this yet. Such estimates would only apply to route with mixed passenger and freight manifests.

While we are unable to make use of the ICAO methodology in this case, it nevertheless demonstrates the level of detail required to estimate accurately the emissions associated with carriage of freight from one point on the globe to another.

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ANNEX III. Lifecycle Analysis of a White Cotton T-shirt

This case study is conducted by BUFT SMART Research Team

1.Introduction

1.1. Background

Cotton is the most dominating natural fiber in textile and apparel industry, with a global production of 24.5 million tonnes in 2013. Usually cotton cultivated throughout the world especially in the dry areas where other crops are mostly difficult to grow. Among the main producers of cotton are China (26.4%), India (20.5%), USA (13.9%), Pakistan (8.5%), Brazil (6.3%), Uzbekistan (4.1%), Australia (3.8%), and Turkey (3.3%) [1]. In many cases, the available data on environmental impacts associated in cotton production can be hardly found in the literature. Earlier studies shown that water consumption, land occupation, emissions, and usage and management of chemicals are the most challenging aspects to be assessed during the cotton production stage [2, 3]. An extremely large volume of water is needed for Cotton cultivation, including green water, which generates from precipitation, as well as blue water, from manual source of irrigation, and estimated as a 73% of the production. The cotton production consumes a 2.6% of global water which ultimately scaled down the freshwater inventories and resulted drought problems in the cultivation regions and a accustomed damage of the water environment [4].

The impacts from various textile productions including spinning, weaving, cutting, and sewing are remarkably elevated, counting the required electricity amount, which ultimately escalates the emissions of CO₂[5, 6]. Nonetheless,the environmental impact of cotton dyeing is comparatively higher than the aforementioned steps; this is the most pollutant parts in the whole cycle of textile process. Dyeing associated with the usage of huge amounts of energy, water, steam, and various chemicals like bleaching agents, dyes, wetting agents, soap, softener, and salts, in order to obtain the required shade of color [7, 8]. Additionally, it causes large volume of wastewater in the dyeing plants with destructive effects to the environment [8].

In the last few decades, distinct initiatives have been developed to lessen the adverse effects of cotton production. In that case, the cultivation of organic farming practices avoids the use of

fertilizers, herbicides, and insecticides [9]. The estimated total pesticide consumption in the cotton cultivation is an 11% of the world consumption, which is almost 50% in the developing countries. Hence, the practice of organic cultivation approach grants to greatly scale down the usage of chemicals and the detrimental environmental impacts [10].

Recently, a novel recovery method has been designed for the production of cotton yarns from recycled materials [11]. In this method, cotton growing is avoided, resulted to reduce the consumption of water, fertilizers and pesticides. Furthermore, dyeing steps is avoided since the color of the raw materials is similar to the final color of cotton, such a way that the use of water, dyestuff, wetting agents, softener, and any other related chemicals is also avoided. The use of this recovery technology prevents all the environmental impacts relevant to the cotton harvesting and dyeing of yarns, while as counterpart it includes the addition of a cutting/shredding step of recycled clothes prior to the spinning step, which have resemblance with traditional ginning method. The ginning method of cotton involves the separation of lint, seeds, and other plant residues, and it can be accomplished by various techniques, from manual to mechanical actions which generally include high energetic steps, like drying, cleaning and pressing [12].

1.2. Life-Cycle Assessment (LCA)

Life-cycle assessment (LCA) is an effective methodology, standardized by the ISO 14040:1996 and ISO 14044:2006 (ISO, 1997, 2006). This method mainly focused on the assessment of potential environmental impacts associated with the products through the appraisal of applicable inputs and outputs during the whole life of product including the raw materials and, treatments and processing and eventual disposal. As stated earlier, there is very limited peer reviewed literature available on LCA and are usually supported by different consultancy or research institutes. Previous LCA studies conducted on textiles made by different fibers such as Polyester, Nylon, Acrylic, and Spandex, but with the cotton fiber products showed greater environmental impact [13].

Since the cotton cultivation system considered as complex order, because the cultivation process depends on the environmental conditions in various regions and the findings may vary within a year, as well as from year to year and these may lead difficulties for right evaluation of LCA. Hence, it is too difficult to assess the impacts of cotton cultivation

globally because of the variability of different cotton crops chosen. However, few studies have been conducted for the LCA of cotton from different aspects, concentrated on individual portion of the entire process, such as: cultivation, yarn manufacturing, fabric manufacturing, dyeing, and so on.

An extensive evaluation on the impacts of cotton cultivation by LCA was conducted for both the traditional and organic harvesting system [2, 9, 14], likewise for various dyeing and finishing methods [7, 15]. Moreover that, very few LCA studies published on the reuse or recycling from the apparel waste [16, 17] and to till there is not any LCA report published specialized on the application of recovered cotton to be used for the industrial manufacturing of cotton yarn [18].

1.3. The frontier lines of producing cotton apparel product

The major process and discrepancies for the cotton product manufacturing by the conventional or usual and organic cultivation, and recovery are describing in the figure 1. To focus on the differences between the methods, three critical steps have been selected as: cultivation/collection of cotton, ginning/cutting, and dyeing[18]. Transportation of raw and produced materials for each production step was also considered and discussed. All the aspects related to the spinning of the yarn, textile production, selling and usage, and final disposal were not taken into account, considering that there are not differences in the process regardless of the type of cotton fiber employed (conventional, organic or Recover).

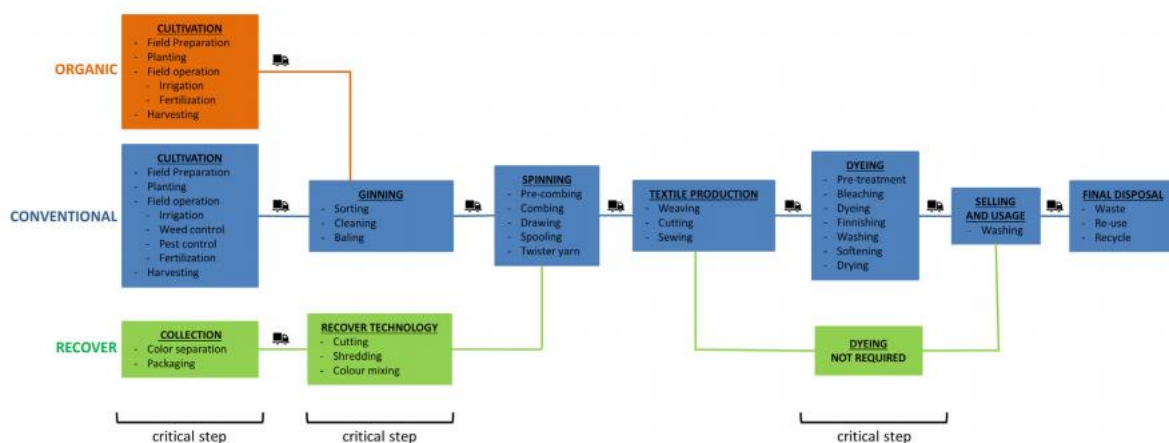


Figure 1: Summary of the main steps involved in the production of textile clothes using conventional, organic, and Recover cotton[18].

The growing concern in “sustainable development” has driven many organizations to analyses the approaches in which they practice with environmental affairs [19]. To meet the goals, distinctive mechanism, approach and notions have been introduced over the last 20-30 years [10]. In this study a Life Cycle Assessment(LCA) method (cradle-to-cradle analysis)applied to assess the environmental impact associated to produce a cotton T-shirt.

Lastly, the analysis of sustainability hot spots may recommend relevant actions such as: the unified data or information from current research may facilitate the accuracy of directions for new cotton LCAs by upgraded methodology, evidence and systems understanding, the universal guidelines of cotton LCA studies, the environmental impact analysis may publish through communication strategies and moreover to make the commitment among the major stakeholders (4).

1.4. Objective

The main objective of this study is the determination of sustainability hot spots of a cotton T-shirt through cradle to cradle analysis with those obtained from the published literature about the production of cotton yarn obtained from virgin cotton produced through conventional and organic harvesting. The environmental disputes involved with consumption of textiles to examine broadly on product level in Lifecycle Assessment (LCA) studies. The social sustainability hot spots are also intended to investigate on the Cotton T-shirt manufacturing cycle. In a word, the purpose of this case study is to address the key social and environmental issues in the lifecycle of a white cotton t-shirt which is produced in Bangladesh and selling to EU. And secondly to identify the legal constraints that govern the most severe hot spots found in the case study of T-shirt.

2. Methodology: This case study has been carried out based on the information about the practices of social and environmental issues on every phases of manufacturing like- fiber farming, yarn manufacturing, fabric manufacturing, wet processing, garments manufacturing, transportation, use, recycle and disposal of a white cotton t-shirt of a particular brand, made in one of the 100% compliant and green garment industry of Bangladesh and selling to EU. The overall manufacturing stages and their analysis strategy can be classified in two major headings as given below-

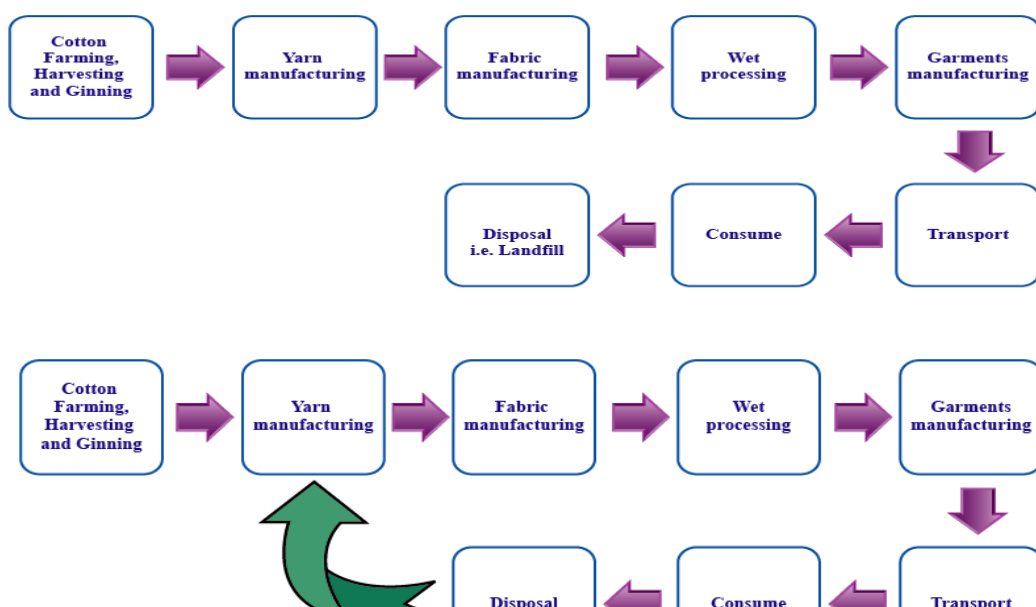


Figure 3: Cradle to cradle analysis

I. *Social and environmental hot spot analysis*: The sustainability hot spot analysis (SHSA) [20] will be applied to this case study as because it can identify key issues on analyzed categories such as resource use, ecological and social challenges along the whole value chain, in a quick reliable and lifecycle-phase-specific way. The results highlight so called ‘hot spots’ in the product chain and can be seen as starting point for detailed elaboration of efficient actions for improvement. In these cases, a hot spot is defined as a harm or risk at a particular point in the product lifecycle. The results of the SHSA will contribute to the development of the sustainability Assessment guidelines for subsequent work package.

II. *Qualitative case study methodology*: A case study is a qualitative inquiry in a contemporary phenomenon within its real-life context and it is especially relevant when the boundaries between phenomenon and context are not clearly evident [21]. It will help to achieve comprehensive understanding as well as play a supportive role in facilitative understanding of the overall project case i.e. the identification of environmental and social externalities in global value chains that undermine social and economic development and the policies and laws that make them possible.

3. Results and Discussion

According to methodology, the outcomes of analyzing the lifecycle of a white cotton t-shirt have been fragmented in two phases i.e. phase-A is about the finding of social and environmental risks and phase-B is about the findings of the most severe social and environmental hot spots in the lifecycle of this garment. The social and environmental issues are summarized in the table1 as given below-

Table 1: Social and environmental issues involved in the lifecycle of t-shirt

Social issues	Environmental Issues
<ul style="list-style-type: none">• Employment• labor/management	<ul style="list-style-type: none">• Materials❖ fertilizers

relations, (Occupational health and safety)	OHS	❖ pesticides
• Equal opportunity		❖ fungicides
• Equal remuneration		❖ auxiliaries
• Child labor		❖ raw materials
• Freedom of association		❖ packaging materials
• Security practices		• Energy
• Anti-corruption etc.		• Water
		• Biodiversity
		• Emissions
		• Effluent and waste
		• Transport
		• Supplier environmental assessment etc

3.1 Environmental Hot Spots

3.1.1 Use of chemicals: The following chemicals with the given quantity are used in the pre-treatment section of wet processing to make the garments white from grey fabric stage.

Table-2: Chemicals used during pre-treatment (Scouring, bleaching, neutralizing)

Chemical	Quantity in %
DEPICOL TLK LIQ	0.300
HASULYN NOF	1.000
OPTAVON MAX LIQ	0.700
SEQUION 48 98	0.300
RON LUBE PLUS C	0.500
KAPPAZON H 53 250	1.000
CAUSTIC SODA	2.000
HYDROZEN PEROXIDE	10.000
ACETIC ACID	1.000
TERMINOX ULTRA 50L	0.150
JQ-600	0.250
SYNO WHITE 4BK	0.315

Without this, in the Effluent Treatment Plant (ETP) the following chemicals are used based on the type of the plant i.e. Biological ETP or Membrane Bioreactor Plant (MBR)

Table-3: Chemicals used for Biological Plant

Name of Chemicals	Type	Use
Sulfuric Acid	Hazardous	Continue
Water Decolorant	Non-Hazardous	Discontinuous
Polyelectrolyte/Polymer	Non-Hazardous	If Needed
Anti foam	Non-Hazardous	If Needed
Nutrient	Non-Hazardous	If Needed

Table-4: Chemicals used for MBR Plant

Name of Chemicals	Type	Use
Sulfuric Acid	Hazardous	Continue
Water Decolorant	Non-Hazardous	Discontinuous
Citric Acid	Hazardous	MBR Filter Maintenance
Sodium Hypochlorite	Hazardous	MBR Filter Maintenance
Polyelectrolyte/Polymer	Non-Hazardous	If Needed
Anti-foaming agent	Non-Hazardous	If Needed
Nutrient	Non-Hazardous	If Needed

3.1.2 Treatment of effluents: The Textile Division of this particular industry has two effective Effluent Treatment Plants (ETP) known as biological ETP and membrane bioreactor ETP by which wastewater discharged from wet processing section is treated before it is released to environment so that environmental pollution is reduced. The undermentioned tables reveal the characteristics of untreated and treated wastewater for both types of plants-

Table-5 (A):Test result of Biological ETP treated wastewater of the 1st week of August'2017

Biological ETP														
Date	Inlet							Outlet						
	pH	Temp°C	DO	TDS	TSS	COD	BOD ₅	pH	Temp°C	DO	TDS	TSS	COD	BO D
1-Aug-2017	9.6	31.8	12.9	1314	-	-	-	7.8	33	6	1575	-	-	-
2-Aug-2017	9	36.2	0.6	1100	55	420	420	7.7	34.1	5.8	1478	8.1	100.0	6.2
3-Aug-2017	9.9	34.5	5.8	3020	-	-	-	7.8	33.3	5.9	1353	-	-	-
4-Aug-2017	10.2	38.3	0.8	1585	-	-	-	7.7	32.8	5.5	1354	-	-	-
5-Aug-2017	10.2	36.8	0.9	2128	-	-	-	7.7	33.6	5.7	1537	-	-	-
6-Aug-2017	8.7	34.7	6.2	334	-	-	-	7.8	34.6	6.2	334	-	-	-
7-Aug-2017	10	38.1	7.7	889	-	-	-	7.8	34.1	6.1	1621	-	-	-

Table-5 (B): Test result of Membrane Bioreactor ETP of the 1st week of August'2017

MBR ETP Plant														
Date	Inlet							Outlet						
	pH	Temp°C	DO	TDS	TSS	COD	BOD	pH	Temp°C	DO	TDS	TSS	COD	BO D
1-Aug-2017	9.9	40.4	1.4	2210	-	-	-	8.2	35.7	6.4	2082	-	-	-
2-Aug-2017	9.7	36.1	0.6	1848	76	770	344	8.2	36	6.8	2072	2.9	105.6	6.2
3-Aug-2017	10.2	39.2	6	1868	-	-	-	8.2	34.8	6.5	2090	-	-	-
4-Aug-2017	9.8	40.5	6.2	209	-	-	-	8.	35.4	6.4	208	-	-	-

				8				2			7			
5-Aug-2017	9.2	37.9	6.3	128 2	-	-	-	6	36.3	6.6	201 2	-	-	-
6-Aug-2017	9.9	34.5	5.9	271 0	-	-	-	8. 2	36.1	6.5	203 0	-	-	-
7-Aug-2017	9	37.6	6.3	605	-	-	-	8. 2	36.1	6.8	204 0	-	-	-

3.1.3 Consumption of energy and fresh water: The general consumption of fresh water and energy in producing a cotton t-shirt has been reported by Steinberger et al and van der Velden et al [22, 23] as given in the table-

Table-6: Consumption of energy and fresh water

Processing steps	Quantity	Yarn count (Ne)	Electricity (kWh)	Steam, natural gas, LPG, Diesel, LFO (MJ)	Water (L)
Conventional cotton production	1 kg	n/a	0.41	8.71	7103
Organic cotton production	1 kg	n/a	0.41	8.71	7103
Spinning (Combed yarn, Rieter ring spinning system including winding)	1 kg	30	3.34	-	-
Knitting (Mayer & Cie, circular knitting machines, 30-in. diameter, 24 gg, 96 Feeders)	1 kg	30	0.19	0.19	
Wet processing (pretreatment, dyeing and finishing)	1 kg	30	2.42	2.4	80
Garment	1 T-shirt		0.67		

manufacturing					
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Around 35-40 L freshwater is consumed in the pre-treatment section of wet processing which was 50-60 L before and this improvement has been achieved by process modification. Besides through the rain water harvesting system, the ground water consumption has been reduced. Energy consumption has been reduced by using transparent sheet in the production floor. Around 0.05 Kw is consumed in the scouring and bleaching section to treat 1 kg fabric. Besides energy efficient equipments like- T5 type tube light, direct drive servo Motors , motion Sensors to avoid unnecessary usage of light, digital energy meters, good quality steam traps to minimize the steam loss, digital Flow-Meters, VFD (Variable Frequency Drive) driven mechanical ventilation, VFD (Variable Frequency Drive) driven Air-Conditioning system, solar street lamps , solar water heating system to promote Green Energy, waste collection channel (Duct) to collect operational wastes and meters to monitor the inside temperature and CO₂ level in different areas have been installed to reduce energy consumption.

3.2 Social Hot Spots

3.2.1 Occupational Health & Safety: The selected company ensures healthy working environment for all and provides a safe and healthy workplace setting to prevent accidents and injury to health arising out of linked with or occurring in course of work or as a result of the operation of employers' facilities. It has adopted responsible measures to mitigate negative impacts that the workplace has on the environment. Besides, there is a good ventilation system which makes the working environment comfortable. Without it, the infrastructure of the factory facilitated the use of day light instead of electric bulbs. And a female doctor has been assigned for the treatments of female workers in the year of 2016 based on the request of workers.

3.2.2 Working Hours: Normal working hours is 8 and the average overtime is 2 hours. Overtime is usually seasonal especially when work load becomes extreme as well as urgency is needed. There are several reasons behind the overtime issues like reprocessing of the work or longer processing time, distortion in the supply chain and longer approval period. Besides there is a shifting system for maintenance workers, embroidery workers and security guard and Friday is the general holiday for all personnel.

3.2.3 Discrimination: First of all, personnel operation in the production and management for gender depends on the basis of the quality (whether personnel may be male or female). For example- welfare officer could be male or female. But for some exceptional area like loading and unloading, only male workers are preferable. This particular industry provides a workplace environment which is free of any sexual and/or other form of harassment, abuse and any corporal punishment. It rewards employees according to their individual performance' and maintain the equal opportunity policy in recruitment, training and development, promotion, transfer, compensation and benefits etc. without any form of discrimination such as race, caste, color, religion, sex (including pregnancy), marital status, family status, sexual orientation, regional origin, age, disability and veteran status.

3.2.4 Fair Salary: Employees are hired basically on the basis of their skill. Average payment is determined as per the “gazette of Bangladesh 2013”. Workers salary is paid monthly basis and overtime is paid to double of basic salary. Payment amount may be like per hour 40-50 taka.

3.2.5 Employment Facilities: This company is a heaven for its employees and workers because of enormous facilities providing by this organization to all. There are 20 flats (per flat is 3000 square feet) available for management and non-management employees and 75 dormitories for individual employees. Usually personnel live close to the factory. It provides leave with pay as per the followings-

Table-7: Leave types with respective values

Item of Leave	Days
Casual leave	10 days
Sick leave	14 days
Festival leave	12 days
Maternity leave	112 days

A project known as ‘Renu’ (fair price shop) has been established and successfully operated from January 2017 to provide basic commodities (43 items till date and will be raised up to 400) at 20% less price in comparison with local market maintaining good quality of the product. A field study was carried out during the whole period of 2016 to evaluate the feasibility of the project. All the personnel can buy product from this shop based on their respective income level. Besides employees as well as workers in the factory are being

provided snacks (bakery) by factory owned confectionary items. And some exceptional employment facilities are New Born Gift, Scholarship program, KHEA and turning the disability to ability of the workers. Management of this industry organizes view exchange meeting or social dialogue with workers regularly. Workers have this unique opportunity to seat and discuss issues with Managing Director. Such social dialogues motivate the workers as they get chance to talk to the Managing Director directly to share their views and feelings and even grievance without any hesitation. A special HR team spends 2 hr/month for every worker to discuss about different issues. Without this, workers can meet with Managing Director at once per 3 months. Besides, the company has implemented a concept of “Help Desk” in its production floor to provide official assistance, query and grievance. All employees receive this service in a native voice within short span of time. This concept serves the workers within their work floor and within their comfort level.

3.2.6 Freedom of Association: This organization appreciates forming and joining any registered association, trade unions and participation committee. It has a platform for the workers in the name of Worker’s Participation Committee (WPC) which is a unique team building initiative that helps to achieve objectives by creating direct bridge between the top management and workers. Worker’s Participation Committee (WPC) leaders regularly meet together to engage in open discussion to about any problematic issues as well as claim. The union leaders are not authorized to determine the salary because the Government of Bangladesh has already determined the standard salary structure for the worker and factory authority is maintaining that.

3.2.7 Risks assessment

Phases Risks	Raw Materials	Yarn production	Fabric Production	Garment Production	Transportation	Consumer Use	Waste/ recycling
<i>Child labour</i>	-	-	No	No	-	-	-
<i>Forced labour/ Migrant labour</i>	-	-	No	No	-	-	-
<i>Excessive working hours</i>	-	-	If needed	If needed	-	-	-
<i>Low wage</i>	-	-	No	No	-	-	-
<i>Health and safety risk</i>	-	-	No	No	-	-	-
<i>Gender- and other discrimination</i>	-	-	No	No	-	-	-
<i>(lack of) Freedom of association</i>	-	-	No	No	-	-	-
<i>(lack of) Collective Bargaining</i>	-	-	-	No	-	-	-
<i>Corruption</i>	-	-	No	No	-	-	-
<i>Violation of land rights</i>	-	-	No	No	-	-	-

Conclusion and follow-up activities: The social and environmental issues during manufacturing of a white cotton t-shirt in Bangladesh has been discussed in this case study in order to identify the footprints of Textile and RMG sector. Further information's on the social and environmental issues of Cotton farming in India and the uses, disposal and recycling scenario of a white cotton t-shirt in the Netherlands will be inserted by Nyenrode Business University (NBU), the Netherlands.

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ANNEX IV. Literature used in mapping of risks and report

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