Weaving 'social' into LCA: a methodological comparison of Social Life Cycle Assessment with purely qualitative social sustainability assessment



Master's thesis Master of Science in Industrial Ecology

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Weaving 'social' into LCA: a methodological comparison of Social Life Cycle Assessment with purely qualitative social sustainability assessment

A case study in the textile industry

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Master thesis submitted to Leiden University and Delft University of Technology, in partial fulfilment of the requirements for the degree of Master of Science in Industrial Ecology.

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To be defended in public on 15-03-2023

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Executive summary

Social Life Cycle Assessment (S-LCA) evaluates potential or actual social impacts affecting stakeholders involved along a product's life cycle. The bridge for linking S-LCA with E-LCA, for the ultimate goal of LCSA, is the maintenance a methodological uniformity. This uniformity takes from through a FU, system boundaries, and combination of using both generic and primary data. Through molding S-LCA in an E-LCA-like framework, however, many barriers arise that S-LCA currently still is dealing with.

In this research it is evaluated what the value-added is of S-LCA over purely qualitative ways of assessing social sustainability. This is done through a case study of a product range in the textile industry. This product is an apparel range commercialized by a European fashion brand and produced in Bangladesh by a Tier 1 manufacturer. Most of its material inputs is cotton and viscose yarn, which is sourced from a Tier 2 yarn supplier in India. This product range is assessed through a purely qualitative social risk and performance assessment, a generic S-LCA and a company-specific S-LCA.

Qualitative social risk and performance assessment — results and evaluation

In social sciences, many different approaches are identified to assess social sustainability, mostly focusing on projects instead of products. The Roadmap to CSR Risk Management (MVO Nederland, 2020) and the IFC Guidelines (IFC, 2012) are identified as hands-on frameworks to assess (i) social risks related to the product system and (ii) the social performance of prioritized organizations involved in different processes in the product system. These methods take a stakeholder approach to assess certain sectors and involved organizations, thereby focusing on the social context of a specific product system.

Through following the Roadmap to CSR Risk Management (MVO Nederland, 2020), identified sector-level risks are complemented with company-level characteristics and allowing for a specification of these risks to specific companies. This provides insights as a basis for companies to trace their supply chain on identifying aspects where attention should be put on in terms of improving social sustainability. The IFC compliance assessment addresses companies involved on their policy-level compliance to certain requirements related to human resources policies and procedures, working conditions and health and safety. A possible responsibility on supply chain workers is also considered.

Sectorial risks are identified for cotton cultivation and yarn production in India as well as the garment manufacturing in Bangladesh. In the Indian cotton fibers and yarn production industry, noticeable risks are found on fair business practices and labor rights. For the garment industry in Bangladesh, sectorial risks are identified on fair business practices, human rights and ethics, and labor rights. These sector-level risks are scaled to the specific company in the case of the Tier 1 garment manufacturer in Bangladesh—this step is not executed for the Tier 2 yarn supplier in India due to insufficient data availability. This identified social risks arising on the Tier 1 manufacturer company-level concerning freedom of association, long working weeks, insufficient earnings to cover living expenses, and gender inequality in terms of female workers having less opportunities then men in terms of working positions.

Results of the IFC compliance assessment show that both the fashion brand and Tier 1 manufacturer have set adequate policies regarding employees and workers. Through unavailability of sufficient data, not all requirements could be assessed on desired level, meaning this should be further evaluated.

Data needs for this qualitative assessment are a generic overview of the product's supply chain, knowing which (main) companies are involved, their social policies, management systems, reputations, and supplier relationships. It was found that for the specific case in this study, insufficient data was available to conduct a complete assessment on both the Roadmap to CSR Risk Management as well as the IFC Compliance assessment, especially for the Tier 2 yarn manufacturer. No further expertise is needed to conduct these assessments, which can be seen as a major benefit of this method.

Generic Social Life Cycle Assessment — results and evaluation

S-LCA can take the level of a generic- and company-level assessment, or be a mix of the two. Through using a social database, generic sector-level data helps for quantifying sector-level risks. These risks are related to a certain product system using an activity variable. Social flows are scaled to a specific company using the amount of worker-hours performed to produce a certain amount of output (reference flow) in relation to a certain FU, or through a direct quantification method presented by Ciroth (2020). This method provides social indicators through their respective units, whereas for the worker-hour method these are addressed through the 'worker-hours' unit.

The direct quantification is a promising method in terms of its ability to adapt the social flows for 'workers' and 'local community' to a specific company at unit process-level. The unit process-level risk evaluation can provide insights regarding this specific company and the social risks that occur in its context. As this method stays at the level of risk-identification, no implications for 'potential social impacts' of a certain product are made. The impact assessment results of the direct quantification method show that a very high risk is identified for 'Trade union density', 'Extraction of biomass', 'Level of industrial water use', and 'Indigenous people rights protection index'. High risks are identified in terms of 'Living wage', 'Embodied CO2 footprint', 'International migrant stock', 'Number of asylum seekers', 'Promotion of social sustainability', 'Contribution to economic development', and 'Public expenditure on education'. A notable aspect is found on indicators used in the PSILCA database and the overlap with certain indicators—e.g., 'Embodied CO2 Footprint'—with environmental indicators.

Through the direct quantification, no contribution analysis is possible. When a 'very high risk' is identified it does not allow for any analysis which processes actually contribute to this risk classification. Through the worker-hour assessment this is possible, but results are presented in an incomprehensible 'med risk hours'. Therefore, these results only provide insights when this specific product is compared to another product, or through sensitivity analysis. However, social databases are still very underdeveloped, thereby not including data on very many different sectors. This means that conducting sensitivity on specific aspects is not always straightforward. The UNEP Guidelines and PSILCA database refer to results of this method 'potential social impacts'. The use of this terminology should be carefully evaluated as the worker-hour activity variable only reflects—to a certain extent through which this variable is able to reflect a social issue—worker-related social flows, while so far, it has been applied as an activity variable over all subcategories in S-LCA.

Data needs for this assessment are material-, energy- and transportation flows for all unit processes in terms of their monetary values, as the PSILCA database is monetary-based. Most likely no data on the monetary value is available, where thus an additional step should be taken transforming the mass

quantities to monetary values—a process highly sensitive for error. Company specific data is needed to evaluate social flows for the direct-quantification method to reflect the specific company better, and the amount of hours workers work on the specific production process needs to be calculated from—preferably—company-specific data as well. Whereas the UNEP Guidelines provide a some guidance, expertise is required from a practitioner on performing an S-LCA. The process of understanding S-LCA, a social database, and understanding S-LCA terminology is a time consuming process.

Company-specific Social Life Cycle Assessment — results and evaluation

Through SAM social performance of companies is assessed, further aggregated through the worker-hours activity variable as product' social performance. Data is needed on policies, documentations of proof, as well as supplementing questionnaires and interviews. Different performance levels can be assigned through the scoring framework developed by Ramirez et al. (2014). As company-specific data is required and no generic data can be used, this requires and extensive data gathering process. However, as this is highly time consuming, certain processes and companies should be prioritized. For this study, the fashion brand, Tier 1 manufacturer and Tier 2 yarn supplier are assessed. Company-specific performance is analyzed assessed on an A to D level on certain prioritized subcategories related to the stakeholder category 'workers'. Both the a prioritization of companies as well as subcategories for feasibility purposes lead to the assessment 's scope being narrowed down from the beginning on.

The performance of the product is assessed for the stakeholder 'workers'. Here, a lower performance is identified on 'freedom of association and collective bargaining', 'fair salary' and 'working hours'. This performance is reflected through the Tier 1 manufacturer's performance as a company, because of its 86% contribution to the system in terms of labor hours. Results do not reflect the actual system where also several other companies (i.e., chemical, dyes and elastic suppliers, and transportation and distribution parties) are involved, excluded due to data unavailability.

In terms of the Tier 1 manufacturer, performance can be improved on the mentioned aspects where lower performance is identified. Generally, however, the company is performing relatively well as compared to the local garment industry, where many more systemic changes should be implemented for bettering the sectorial social performance. The fashion brand performs well in terms of internal performance on all subcategories. Their supplier monitoring on the Tier 2 yarn supplier should, however, be evaluated to see whether more specific information can be found on this Tier 2 supplier. Currently, this stakeholder is not properly assessed due to data unavailability.

In the case of this study—when only having assessed three companies—the life cycle identification of the product's social performance is not providing an added value over the company-performance identification. Through using the worker-hours variable as a scaling factor for amount of the labor hours each company is performing, the product's life cycle performance is set equal to the performance of the Tier 1 manufacturer, due to its predominant share in amount of labor-hours. Therefore, whereas the method does seem promising, it requires a very time consuming data gathering process on both the company aspect—as many companies should be included—and related to subcategories. In this assessment only the life cycle calculations for the stakeholder category 'workers' were assessed.

Conclusion

Relevant insights are obtained through conducting a purely qualitative social sustainability assessment, where no initial expertise is needed for. However, an extensive data-collection process lies at its basis: data should be gathered on the product's supply chain, company policies, as well as a general understanding of the company's management systems and supplier relationships is needed.

The UNEP S-LCA Guidelines focus on product-S-LCA, which through aligning methodological uniformity with E-LCA comes with methodological issues:

- Using an activity variable as worker-hours is not directly linked to social flows which are not related to labor activities as e.g., an illiteracy rate, but is currently used as a variable for these flows as well. This causes both redundant and incorrect information in life cycle calculations;
- Social flows are not always causally linked to a specific product or the responsibility of an organization, but rather stem from higher-level issues related to the sector or country in which the organization or process operates. This is not adequately addressed in the Guidelines;

Ultimately, it can be concluded that the qualitative nature of social impacts, and their relation to organizations involved is not sufficiently reflected through quantitatively relating social aspects to the function a product delivers. Bringing together the three pillars of sustainability for purposes of LCSA will lead to many inconsistencies between the three assessment methods. Due to the quantitative and qualitative difference in nature between environmental and social issues, reaching a full alignment between E-LCA and S-LCA for LCSA purposes is found to be unlikely. Reflected through its importance as identified in this study, the organizational aspect of social issues should be addressed in social sustainability assessments, going beyond the product-focus of the Guidelines.

Other approaches to S-LCA through taking an organizational perspective—like SAM—, seem to be more fitting to the nature of social aspects. Still, the issue of using a quantitative activity variable to relate the performance of organizations to a specific product system causes some difficulties. However, comparing this approach to purely qualitative ways of assessing social sustainability, it does provide a link with a specific system and saying something about the social performance of a product can be of additional value for decision-making on one product over the other. A purely qualitative way of assessing social risks or performance does not provide this extra step, thereby staying at the level of company-level risks and performance—without being able to say anything about the product itself.

Comparing SAM to the purely qualitative ways of assessing social sustainability, SAM does provide a link with a specific product system, whereas the Roadmap and IFC compliance assessments stay at company-level risks and performance. Addressing the social performance of a product can be of additional value for decision-making on one product over another.

Keywords
Life Cycle Sustainability Assessment • Social Life Cycle Assessment • Social Impact Assessment • Social sustainability • Qualitative social assessment • Supply chain • Value chain • Textile industry • Ready-made garment

Preface

This thesis presents my final work for the degree of Master of Science in Industrial Ecology at Leiden University and the Technical University of Delft. I am very grateful for having pursued this degree, which I have attended with great satisfaction and engagement.

After completing a variety of courses on environment sustainability, I have spent the past few months exploring the social pillar of sustainability. This exploration has allowed me to better understand various aspects of LCSA, and understand life cycle assessment from both an environmental and social perspective. I view this knowledge as a valuable asset as I begin my career as an Industrial Ecologist. While still far from being able to call myself an expert, the exponential learning curve during this thesis has greatly enhanced my understanding of the social aspect of sustainability assessment. I have been particularly intrigued by the fashion industry and hope to contribute to its improvement in terms of sustainability on both environmental and social aspects in my future career.

I would like to speak my most profound appreciation to my supervisors. Jeroen Guinée, for actively thinking along during the process and continuous support. I can only express my gratitude in your guidance and provision of critical insights which have led to a significant improvement of my thesis. Next, I would like to express my gratitude to Carlos Blanco Rocha. You perplexed me by your ability to combine your extremely busy academic schedule with addressing many insightful points of discussion on S-LCA during our meetings, and helping me get a grasp of PSILCA. I've felt very welcome for asking for any support and only received punctual, friendly and insightful help. Lastly, I would like to thank Susana Toboso-Chavero for your constructive feedback on my approach and your ability to provide me with insights in the fashion industry. Also for your warm welcome during the few weeks I've spent in Barcelona, for which I am very grateful of having had such a wonderful opportunity during the course of my research.

A special thanks to Eco Intelligent Growth, especially to Aglaia Gomez and Zaida López, for generously providing me with data. It's been a real pleasure working with you and I am sincerely grateful for your cooperation on questions I've had and your involvement in the contact with both the fashion company and the manufacturer in Bangladesh. Furthermore, I extend a special thanks to the people involved from the fashion company, manufacturer in Bangladesh as well as from the independent external auditor in Bangladesh, for their willingness to cooperate and provide me with relevant data during the questionnaires and interviews conducted.

Nina van Dulmen

March 2023

List of Acronyms and Initialisms

AoP	Area of Protection
BoM	Bill of Materials
BR	Basic Requirement (specific PRP of more importance used in SAM)
CE	Circular Economy
CoC	Code of Conduct
CSR	Corporate Social Responsibility
C2C®	Cradle to Cradle®
EIA	Environmental Impact Assessment
E-LCA	Environmental Life Cycle Assessment (also known as LCA)
FU	Functional Unit
GDP	Gross Domestic Product
GRI	Global Reporting Initiative
GTAP	Global Trade Analysis Project
IAIA	International Association for Impact Assessment
IP S-LCIA	Impact Pathway Social Life Cycle Impact Assessment
ISO	International Standardization Organization
LCA	Life Cycle Assessment (in this thesis referred to as E-LCA)
LCC	Life Cycle Costing
LCT	Life Cycle Thinking
OEDC	Organization for Economic Co-operation and Development
PSIA	Product Social Impact Assessment
PSILCA	Product Social Impact Life Assessment
PRP	Performance Reference Point
RMG	Ready-made garment
RS S-LCIA	Reference Scale Social Life Cycle Impact Assessment
SAM	Subcategory Assessment Method
SDG	United Nations Sustainable Development Goal
SELCA	Social and Environmental Life Cycle Assessment
SETAC	Society for Environmental Toxicology and Chemistry
SHDB	Social Hotspot Database
S-LCA	Social Life Cycle Assessment
S-LCIA	Social Life Cycle Impact Assessment
UNEP	United Nations Environmental Programme
UNGC	United Nations Global Compact

Glossary for S-LCA terms

A clear definition of terminology adapted in this thesis is presented, derived and adapted from descriptions in literature. When relevant, examples are provided in Table 1.

Table 1. S-LCA glossary

Term	Definition	Example
Activity	Associated with a unit process, reflecting a social action belonging to this unit process (UNEP, 2020).	e.g., the unit process of yarn manufacturing, can be associated with the activity of workers harvesting cotton and spinning this into yarn.
Activity variable	Describes relevance of impacts caused by a certain process (Maister et al., 2020), thereby "*reflecting the share of a given activity associated with each unit process*" (UNEP, 2020). The variable is used to represent a product system giving an idea of the relative significance of each unit process in the whole system.	Worker-hours (the time spent by workers to produce a certain amount of product in the specific process) is currently the only activity variable practically used in S-LCA, as better suiting indicators for other stakeholders then workers are still being assessed (Maister et al., 2020).
Framework	Referred to as the UNEP Guidelines or PSIA Handbook, each presenting a framework for conducting S-LCA studies. These provide a framework as a conceptual structure intended to serve as a guide for performing S-LCA. Within their framework, the UNEP Guidelines build further on the ISO14040/44 standards.	The UNEP Guidelines and the PSIA Handbook on S-LCA
Functional unit (FU)	Quantified function provided by the product system, as reference basis in LCA (Guinée et al., 2002) and here in S-LCA when conducting a database assessment.	e.g., wearing 1 T-shirt over a period of three years.
Generic assessment	S-LCA using generic data on country/sector level, making use of S-LCA databases (UNEP, 2020). This assessment allows for a risk assessment only, as it is not company or site-specific, and comprises of lower resolution data.	Social databases are the PSILCA or SHDB social risk databases.
Impact category	A class representing certain social issues of interest to stakeholders and decision makers. These impact categories are logical groupings of S-LCA results and subcategories (UNEP, 2020). A further specification of impact categories is not provided in the UNEP Guidelines. The PSIA Handbook (Goedkoop et al., 2020) talks about 'social topics' in this regard.	e.g., 'Labor rights', grouping the Impact subcategories 'Child labor' and 'Forced labor'. These categories are not further addressed in this thesis, as a focus still lies on the subcategories in the S-LCA Guidelines (UNEP, 2020).
Impact Pathway S-LCIA (IP S-LCIA)	An impact assessment method that assesses the actual or potential social impacts using causal relationships between the product system and resulting social impacts. Along an impact pathway, consequences of activities are identified and tracked UNEP (2020).	
Inventory indicator	Also referred to as a 'social flow'. This indicator is directly linked to the product life cycle. It can be quantitative, qualitative, or semi-quantitative.	
Materiality assessment	A process to select topics of more importance to the S-LCA (e.g., stakeholders or subcategories), for the scope definition. However, the principle of materiality also is present in the Interpretation phase, where significant issues are further highlighted. This step can take the form of a contribution analysis, be conducted in the form of assessing the results to a benchmark, or done by examining the results in relation to the level of control the organization has on these using a ranking approach UNEP (2020).	When having assessed the social performance of a company, adding a materiality step by a benchmark comparison shows most significant issues. Having addressed the social risks of a product system through a generic database assessment, this step can take the form of a contribution analysis as known in E-LCA.
Method	LCA, S-LCA and Social Impact Assessment (SIA) are classified as methods for quantifying environmental and social impacts, social risk, and social performance. The method of S-LCA is the procedure assessing impacts and risks by taking a lifecycle approach, here following the framework by UNEP (2020).	(continued)

Performance reference point (PRP)	Thresholds setting different levels of social performance or social risk categorization (UNEP, 2020). These PRPs are often based on international standards, local laws, or industry's best practices.	In the Subcategory Assessment Method (addressed in section 5.2.1), a certain PRP is referred to as a basic requirement (BR).
Potential social impacts	Potential social impacts can be understood as a likely presence of a social impact, from activities and behaviors of organizations linked to the product system UNEP (2020). These impacts can be assessed through RS S-LCIA as well as IP S-LCIA. Through IP S-LCIA, the potential impacts are characterized and assessed as consequences resulting from the product system. When a normalization step is included, through RS S-LCIA social risks are used as indicators for potential social impacts, which are evaluated through the assessment of social risks of the product system against the social performance of the organizations involved in the system.	In this thesis, there are three ways in which the S-LCA will be conducted. Through the use of the worker-hours activity variable, this method assesses 'potential social impacts', though through the low resolution of data staying at sector level only.
Reference Scale S-LCIA (RS-LCIA)	RS S-LCIA assesses the social performance or social risk of a product system. The assessment is based on specific PRPs and categorization of activities of organizations in the product system.	
Semi-quantitative indicator	Indicator based on data which is given a ranking based value, or are based on a yes-no principle.	Presence of indigenous people (yes or no)
Site-specific assessment	Higher resolution data used for a site-specific S-LCA. In the case of this thesis, higher resolution data comprises of company-level data, therefore in this regard it is referred to as **company-specific assessment**.	A company-specific assessment assesses a company on its social performance.
Social hotspots	Social hotspots are defined by UNEP (2020) as the production activities or country-specific sectors in the supply chain of a product that may be at risk for social issues or risks to be present. These production activities are also referred to as unit processes.	A unit process considered threatening regarding social well-being
Social impacts	UNEP (2020) defines social impacts as the consequences that pressures, whether positive or negative, cause on social endpoints of areas of protection (AoP). This implies that social impacts are only assessed through consequential, Impact Pathway S-LCIA.	The AoP in S-LCA is simply 'Social or Human well-being' and thus related with well-being of stakeholders, which is measured by social endpoints determining the damage levels to the AoP (UNEP, 2020).
Social performance	Social performance refers to the practices, principles, and outcomes of a business' relationship with stakeholders in terms of deliberate actions and unintended externalities, measured against a standard of social value (UNEP, 2020).	
Social risks	Social risks are understood as the level of probability of adverse social effects on stakeholders that occur through a certain intervention or activity, including the consequence of such an intervention. The extent of a risk can be measured at indicator level, and social risks can be seen as indications for potential social impacts (UNEP, 2020).	
Stakeholder category / group	A cluster of stakeholders that due to their similar relationship towards the product system are expected to have similar interests (UNEP, 2020).	Workers, local community, value chain actors, consumers, society, children (UNEP, 2020)
Tool	Although in literature often interchangeably referred to as LCA or S-LCA and software for LCA calculations, here it refers to the latter. LCA and S-LCA are referred to as a methods, using a tool like OpenLCA for LCA modelling and calculations.	
Unit process	Smallest part of a product system for data collection (Guinée et al., 2002). A social activity can be associated each unit process.	
Qualitative indicator	Nominative indicators of the social issue expressed in wording (UNEP, 2020).	Text describing measures of mitigating stress
Quantitative indicator	Description of the social issue expressed in numbers	Number of weekly working hours, number of accidents

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1. Introduction

The textile industry is rapidly growing due to factors such as the increasing global population, rising purchasing power in emerging nations, and the expansion of fast fashion (Sadowski et al., 2019). On average, consumers now have twice the as much clothing as compared to 15 years ago, which is only kept for only a short amount of time, and not always properly discarded of (van Dulmen et al., 2023), in line with the concept of fast fashion. Caro and Martínez-De-Albéniz (2014, p. 7) define fast fashion as "*a business model that combines three elements: (a) quick response; (b) frequent assortment changes; and (c) fashionable designs at affordable prices*". Fast fashion includes the delocalization of textile production to countries mostly located in South-East Asia, thereby boosting the local economy, but its production practices also frequently lead to negative environmental and social aspects (Luján-Ornelas et al., 2020). Fast fashion is seen as low-cost clothing established through current luxury fashion trends (Joy et al., 2012), and produced by the ready-made garment (RMG) branch of the textile industry. RGMs can be understood as mass-produced finished textile garments. Global production volumes increase to meet demand in fast fashion, but consumer prices are expected to remain at low-cost. In the search for lowest production costs, fashion companies have outsourced most of their production processes to developing countries (Joy et al., 2012), taking advantage of weak environmental awareness and laxer environmental and social regulations in these developing nations (Shen, 2014). This has led to a largely unsustainable local RMG industry, as visualized in Figure 1.

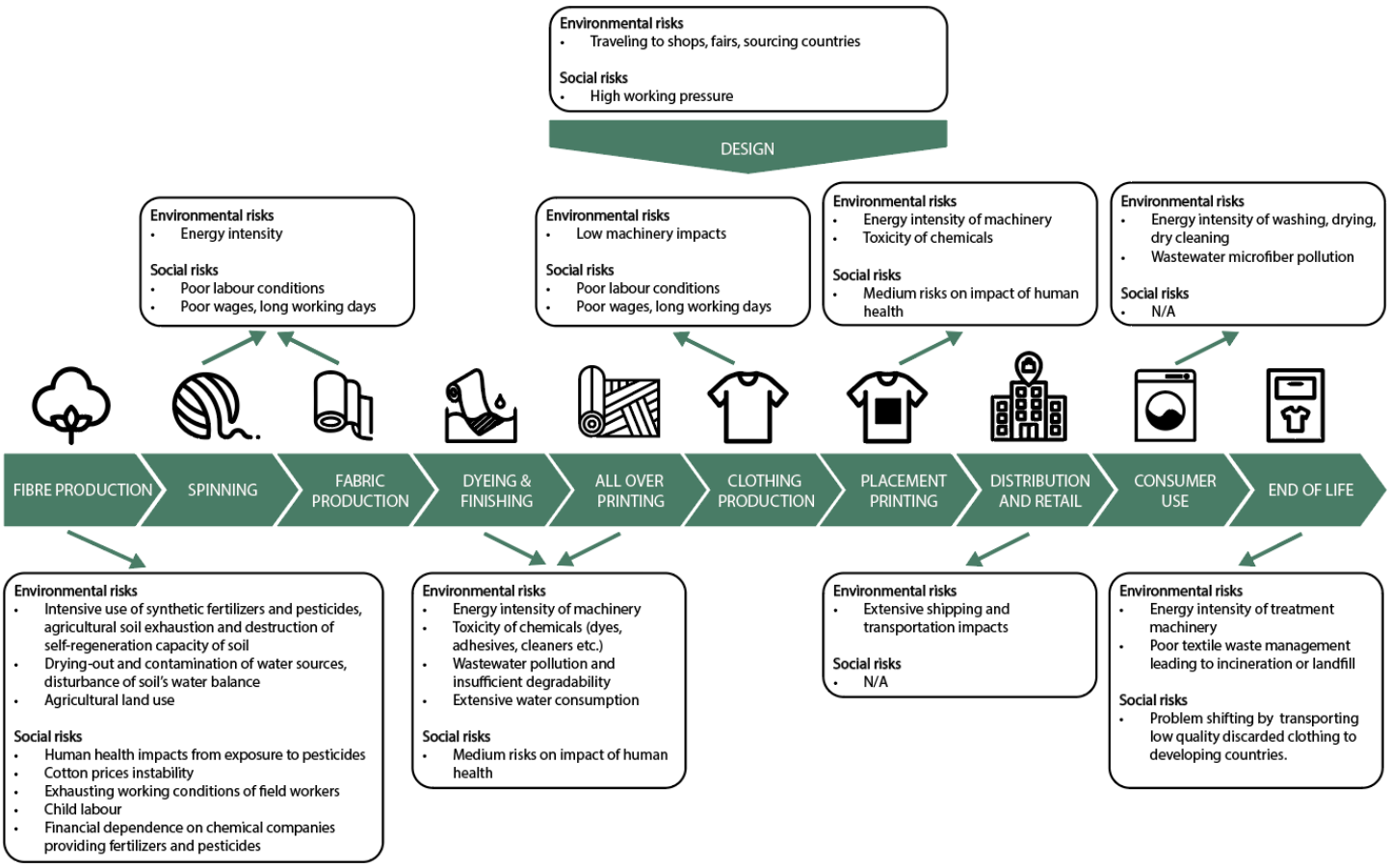


Figure 1. Overview of environmental and social risks in the RMG industry value chain. Own image, based on information adapted from Karthik & Gopalakrishnan (2014), Vassilenko et al. (2021) and MVO Nederland (2022) .

Having employed over 300 million people along its supply chain, the global fashion industry generates 1.3 trillion USD yearly (Luján-Ornelas et al., 2020). For the producing countries in the textile sector like Bangladesh, India and China, this industry is very influential to their national economies, but comes with very poor working conditions, labor rights and low wages for garment workers (Lenzo et al., 2017; Wick, 2009). A key player in this regard are the textile and fashion brands—involved as the designer as well as retailer in the product system—, as buyers of products produced in circumstances under prevailing social risks.

In the case of Bangladesh—after China and Vietnam the country with most exports of textile products (Moazzem et al., 2021)—the textile industry is of particular importance to the country's economic contribution as well as the provision of employment (Khan et al., 2020). Its 2019 statistics show that the sector contributes 9% to its gross domestic product (GDP), takes a 40% share of the country's manufacturing industry, a 7% share in national employment, and accounts for around 85% of the country's exports (Moazzem et al., 2021), reaching a value of US$ 34.13 billion of total export earnings (Khan et al., 2020). It offers employment to predominantly women coming from rural backgrounds (Rahim, 2017; Wick, 2009). While contributing to women empowerment—by providing jobs also with a great focus on women—, gender equality goals, and lifting millions of workers out of poverty, the industry also faces social issues and workplace risks.

Prevalent social issues in the textile and RMG industry include excessive working hours, low safety standards, child labor, low worker wages, gender discrimination, and lack of job security (Zamani et al., 2018), to name a few. In 2013, 1134 garment factory workers died in Dhaka, Bangladesh, in the collapse of the Rana Plaza garment factory. Disasters like these and scandals that have made it to the media, together with several awareness campaigns, have helped raising awareness of social issues in the fashion industry regarding working conditions (Macchion et al., 2018; Shen, 2014). Over the past decades growing trend is seen in companies placing more focus on the sustainability aspect of their products—including products in the fashion industry—as consumers are more frequently questioning where, how, and by whom their purchases are produced and sourced (Benoit-Norris et al., 2012; Maister et al., 2020; Shen, 2014). Due to its outsourcing of supply chain activities, consumers have increasingly been detached to the context in which the clothes they wear are made. Meanwhile, organizations and companies worldwide are increasingly subjected to both social and political pressures, to reduce negative social issues in the fashion industry (Zamani et al., 2018). These can be achieved through incorporating principles of sustainable development in the production of their fashion item—e.g., due diligence principles (OECD, 2018).

1.1. Life Cycle Sustainability Assessment

Assessing the sustainability of a product system in the textile industry holistically can be done by taking a life cycle thinking (LCT) approach (Mazzi, 2020). LCT is a comprehensive approach that takes a life cycle perspective considering the totality of a product system (Arcese et al., 2017; Mazzi, 2020): going beyond a traditional focus on production by including environmental, economic and social impacts of a product (UNEP, 2020; UNEP/SETAC, 2009). By considering broader implications on the

environmental, economic, as well as social pillar allows for addressing trade-offs between these pillars. This holistic perspective can provide insights regarding decision-making for driving change in line with sustainable development (Mazzi, 2020). In this thesis, sustainable development is understood as defined by Brundtland (1987) as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*." (p.292). It implies the development of three mutually reinforcing pillars of sustainability: environmental, social and economic (Brundtland, 1987). As social and environmental impacts can be overlooked unintentionally due to the complexity of production and consumption on a global level (Benoit-Norris et al., 2012), this emphasizes that LCT can bring powerful insights for decision making purposes.

Life Cycle Sustainability Assessment (LCSA) is an assessment framework suitable for including all three pillars of sustainable development, evaluating issues regarding sustainability from a triple bottom line perspective (Klöpffer, 2008), also known as the three pillar interpretation of sustainability. For good decision making in terms of LCT, methods under LCSA can assess the sustainability of a product and compare this to alternatives and allow making informed choices regarding more sustainable ways of production, including environmental, economic, and social considerations (Mazzi, 2020). LCSA evaluates sustainability from three life cycle techniques: Environmental Life Cycle Assessment (E-LCA), Life Cycle Costing (LCC) and Social Life Cycle Assessment (S-LCA) (Arcese et al., 2017; Klöpffer, 2008; UNEP, 2020). Hereby, LCSA is a life cycle based framework comprehensively evaluating the sustainability of future scenarios, including all three pillars of sustainability, broadening the level of analysis from the traditional product level to sector or economy level, and going beyond only technological relations (Guinée, 2016). In practice, methodological development of the three methods within LCSA however still differs greatly (Pollok et al., 2021).

1.2. A short background on S-LCA — barriers identified

Sustainability comprises of environmental, social, and economic aspects, and trade-offs between these different pillars are ubiquitous. The multidimensional nature of sustainable development in a product context calls for identification of impacts arising from different life cycle stages of a product, across these three pillars. The most widely applied method of LCSA is E-LCA (Mazzi, 2020), or just LCA, where a product's environmental impacts throughout its life cycle are assessed. E-LCA has been evolving rapidly over the past decades (Guinée, 2016) as an internationally standardized environmental assessment method. LCC focuses on direct and indirect costs and benefits from the economic activities related to the product and is generally more applied over S-LCA (Oai Li & Kruijssen, 2010). The social pillar of sustainable development is seen as the 'weaker' pillar (Lehtonen, 2004), both in terms of methodology and level of attention compared to the environmental and economic pillar. All three life cycle techniques—i.e., E-LCA, S-LCA and LCC—are important assessment techniques of sustainability, where E-LCA is by far the most developed. This is due to the fact that sustainable development was formerly thought of as primarily an environmental issue, concerning the incorporation of environmental considerations into economic decision-making (Lehtonen, 2004), leaving out the attention on the social dimension. S-LCA is the least developed and youngest method of the three (Pollok et al., 2021), and the different development paths between the

methods are showing different maturity and data availability levels, presented in Figure 2. This overview by Valdivia et al. (2021) shows the development of the method on the x-axis, in terms of methodological issues of the impact assessment, interpretation of results, availability of report records, and the user-friendliness of the method.

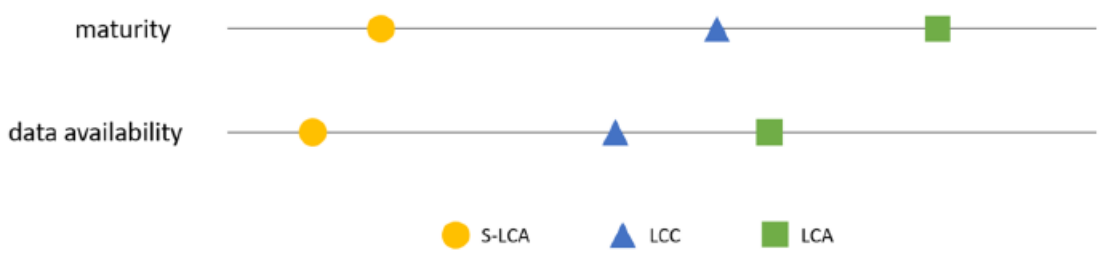


Figure 2. S-LCA, LCC and E-LCA and their development methods in terms of maturity and data availability. From Valdivia et al. (2021).

S-LCA is defined as an assessment technique aiming to assess social and socio-economic aspects of products or organizations as the negative and positive impacts along their life cycle, encompassing all life cycle stages (Mazzi, 2020; UNEP, 2020). It is a method that has been developed to evaluate potential or real socio-economic risks or impacts that affect stakeholders that are involved along a product or system's entire life cycle. Being aware of these impacts is important to be able to raise awareness about social issues in the supply chain, such as unpaid wages, child labor, and safety issues. Thereby, an S-LCA can assess the extent of an organization's or product's risks and impacts and how and where improvements can be made (UNEP, 2020).

Currently, two main S-LCA guidelines are developed (Mesa Alvarez & Ligthart, 2021): the United Nations Environmental Programme (UNEP) Guidelines (UNEP, 2020) and the Product Social Impact Assessment (PSIA) Handbook (Goedkoop et al., 2020). There are however still methodological difficulties and barriers related to S-LCA, which has limited its widespread adoption (Arcese et al., 2017; Klöpffer, 2008; Mazzi, 2020; Pollok et al., 2021; Toboso-Chavero et al., 2021; Valdivia et al., 2021). These difficulties are related to the complex nature of social issues, data availability and thereby adopting a life cycle perspective, and only working with limited usable and non-standardized indicators for social performance (Mesa Alvarez & Ligthart, 2021; Traverso, Finkbeiner, et al., 2012; UNEP, 2020). Due to the methodological challenges, S-LCA studies differ greatly in their consistency, transparency, reliability, and comparability (Pollok et al., 2021). The main barriers identified from the literature review are presented below.

1.2.1. Standardization

The lack of standardization of the method together with the complexity of social issues leads to S-LCA results often being uncertain and lacking transparency (Pollok et al., 2021). Interpreting S-LCA results also seems to be a challenge, as there is thus no standardized way of doing this step. A standardized S-LCA procedure as a methodological consensus is of help to decision-makers to compare and understand social value of companies and enable well-informed decision making (Pollok et al., 2021). Currently, however, ISO standardization is under development (ISO, n.d.), based on a proposal initiated by authors involved in both the UNEP and PSIA Guidelines and Handbook (PRé

Sustainability, n.d.). This standardization will not necessarily lead to a methodological consensus, but can provide a harmonized framework, glossary and guidance.

1.2.2. S-LCA and SDGs

In 2015 the United Nations 2030 Agenda for Sustainable Development, including 169 targets over 17 Sustainable Development Goals (SDGs) was adopted (United Nations, 2015). Whereas SDGs cover many aspects of social sustainability, S-LCA studies are currently rarely connected to SDGs (Herrera Almanza & Corona, 2020; Pollok et al., 2021). Making this connection—between S-LCA studies and SDGs—could however make S-LCA more applicable in a broader field for measuring a company's contribution to sustainable development in line with SDGs. Integrating SDGs at the S-LCA indicator level might provide a standard for how individuals and corporations should assess their performance in terms of SDG attainment (Pollok et al., 2021).

The UNEP Guidelines do visualize the different impact subcategories related to each SDG but do not go deeper than only this visual link, as presented in Figure 3. This shows that 14 of the 17 SDGs concern social aspects, having relevant connections with the S-LCA framework of UNEP (2020). Most relevantly S-LCA can support SDG 12 on Responsible Consumption and Production.



Figure 3. UNEP S-LCA subcategories linked to SDGs, adapted from UNEP (2020).

1.2.3. Applying an LCA structure to social phenomena

Whereas the UNEP Guidelines follow the ISO 14040/44 structure of LCA, and the PSIA Handbook roughly follows some similar phases, S-LCA research is not always in line with this (Pollok et al., 2021).

While ISO 14044 presents a functional unit (FU) as providing a reference to the scaling of input and output data for a specific product or service, (a FU can for example be 'the production of 1 T-shirt'), this becomes a complex issue in S-LCA as the social impacts rely on social flows and phenomena. Social aspects are not always quantifiable and are not directly linked to the function delivered by a specific product (Wu et al., 2014), making connecting social impacts to the FU by scaling the impacts to this specific unit difficult (Pollok et al., 2021; Wu et al., 2014). To link social flows to the reference flow and FU, S-LCA uses an 'activity variable' based on worker-hours. This variable addresses the contribution of processes in a life cycle to a final life cycle result, in terms of hours worked to produce a certain amount of output (UNEP, 2020), and will be further discussed in section 3.6. An issue arises as the amount of worker-hours only applies directly to certain 'worker' indicators, but is applied to indicators related to other stakeholder categories in S-LCA as well. Also, cut-off criteria can be defined with great flexibility in S-LCA following the Guidelines. This leads to a variety of including and excluding processes, life cycle stages and stakeholders in practice (Pollok et al., 2021). S-LCA results, however, are very sensitive to cut-off criteria (Maister et al., 2020). When no uniformity in these criteria is established, it leads to the issue of being unable to fairly interpret S-LCA results amongst different studies.

1.2.4. S-LCA on process or organizational level

Zamagni et al. (2011) have criticized the focus of S-LCA on process-based approaches considering product S-LCA, arguing that S-LCA should place greater emphasis on the organizational aspects during a product's life cycle. They contend that organizational behavior has much greater effect on stakeholders than the function delivered by the specific product or the technical processes behind it. The 2020 revised UNEP Guidelines do acknowledge a difference between product and organizational assessment as compared to the first version of the Guidelines (UNEP/SETAC, 2009). However, this assessment method aims for the identification of social impacts from an organization as a whole, and its associated activities (UNEP, 2020). Thus, the proposed Social-Organizational S-LCA in the Guidelines is an assessment method for assessing a certain organization on its social performance. Zamagni et al. (2011), however, suggest assessing a certain product system in terms of organizations involved, and the Guidelines do not reflect this point of view in approaching product S-LCA from the perspective of organizations involved in the product system, rather than a specific function the product delivers—i.e., the FU approach to S-LCA.

1.2.5. Indicators

A crucial challenge identified in S-LCA is the development of appropriate indicators (Guinée, 2016). Since its development, several literature studies have addressed the implementation of S-LCA and the selection of a suitable, preferably quantitative and practical set of indicators (e.g., Dreyer et al., 2010; Jørgensen et al., 2009; Lehmann et al., 2013; Martínez-Blanco et al., 2014; Traverso, Asdrubali, et al., 2012; Traverso, Finkbeiner, et al., 2012). However, this challenge is still of presence today. Currently, there are only non-standardized quantitative indicators developed in S-LCA, which are of limited use (Toboso-Chavero et al., 2021). The UNEP Methodological Sheets present six stakeholder groups, 40 corresponding subcategories, for which per subcategory three to six exemplary indicators are given (UNEP, 2021). It can be questioned whether it might be better to propose less, and more focused indicators instead.

S-LCA Guidelines are developed in 2009 by UNEP and the Society for Environmental Toxicology and Chemistry (SETAC), but there is still a need for suitable and measurable indicators, weighting, and scoring (Oai Li & Kruijssen, 2010). The requirement of a good indicator is the allowance for translating qualitative data into quantitative indicators (Corona et al., 2017; Kühnen & Hahn, 2017). While E-LCA comes with a standardized and limited default indicator-set, in S-LCA each stakeholder may prefer its own set of indicators (Mesa Alvarez & Ligthart, 2021; Wu et al., 2014). Many academics and practitioners have attempted to develop methods for improving this divergence in approaches (e.g., Benoît et al., 2010; Quintana et al., 2013), but no academic consensus on indicator sets has been achieved. For stakeholders like policy-makers, academics and practitioners, having a unified and comprehensive set of indicators is more convenient, and would enhance the general credibility of S-LCA.

Another aspect identified by Pollok et al. (2021) is the need for different impact categories and social indicators to be recognized according to their cultural settings. Currently, S-LCA practitioners only interpret the indicators for social impacts differently depending on political, ethical, and social perspectives, thereby leaving out the cultural aspect.

1.2.6. Data availability

Data availability is a significant obstacle in performing S-LCA (Jørgensen et al., 2009). Jørgensen (2013) discusses the demanding process—in terms of time and data availability—of sourcing accurate data on social issues in different life cycle stages of products for S-LCA purposes, and that databases should be developed on social impacts related to sectors and countries. Such databases have been developed—although still in early stages of development—with the most used being the Social Hotspot Database (SHDB) and the Product Social Impact Life Assessment (PSILCA) database (Mesa Alvarez & Ligthart, 2021). Currently, the databases can be labeled as highly uncertain, as there are still significant differences within one specific sector in a country (Jørgensen, 2013). As the database assessment is seen as a 'generic' sector/country level assessment, when conducting assessments at an organization- or product level, S-LCA Guidelines (UNEP, 2020) also present ways to do a complementary 'site-specific' assessment, for which primary data of the organization or the product supply chain needs to be gathered—mostly done through surveys and interviews (Wu et al., 2014). Regarding primary data, it can be challenging to acquire this data as there is a great dependence on the participation of stakeholders (Pollok et al., 2021) in how much they can and want to provide on social issues. Social aspects are complex and dynamic of nature (Chhipi-Shrestha et al., 2015), which makes developing methods for establishing suitable indicators and enlarging data availability difficult.

1.2.7. Completeness

Arcese et al. (2017) analyzed different S-LCA case studies published between 2011 and 2015. It was shown that most of these studies only considered social impacts from a negative perspective, and most studies conducted an incomplete assessment: neither performing a cradle-to-grave analysis, nor considering all stakeholder categories from the UNEP Guidelines—due to a lack of data—(Arcese et al., 2017). As a valuable insight of their analysis, they found that due to the fact that the S-LCA framework lacks clear definitions of site specific characteristics and a detailed description of stakeholder categories. This led to difficulties in understanding choices made by authors (Arcese et al., 2017; Macombe et al., 2011), and leaving out relevant stakeholder categories (Herrera Almanza &

Corona, 2020). Also, S-LCA studies do not always provide results that are actual 'social impacts' (e.g., Martínez-Blanco et al. (2014)), but rather an index or risk indicator (Macombe et al., 2011). This is due to the fact that it is very difficult to actually assess 'social impacts', thereby stranding by the identification of e.g., a social risk or indicator instead.

A literature review by Pollok et al. (2021) showed similar outcomes as Arcese et al. (2017), accentuating the emphasis placed on mainly assessing negative impacts in studies. Most traditional economic, environmental and social assessments focus mostly on the negative aspect, although attempts are being made to better incorporate positive impacts (Croes & Vermeulen, 2021). This means that positive impacts on, for instance, job creation for the local community is underacknowledged over negative impacts like long daily working hours for these workers. S-LCA Guidelines do provide categories on positive impacts (UNEP, 2020), though a vast focus lies again on negative impacts. The PSILCA database currently only contains one positive indicator on "Contribution of the sector to economic development" (Maister et al., 2020).

1.3. Problem formulation and knowledge gap

Acknowledging the importance of LCT and LCSA, S-LCA can potentially be used as a method to assess social issues, as it is a method that attempts to consistently evaluate social issues throughout a product's life cycle (Roos et al., 2017). However, the S-LCA method is currently still in its infancy (Jørgensen, 2013; Pollok et al., 2021; Valdivia et al., 2021), as many barriers mentioned remain unsolved. As a result, a majority of efforts was directed towards using indicators and impact categories to assess social impacts. This has led to critical responses questioning whether S-LCA actually should be molded in an E-LCA like framework (Clift, 2014), as "*potentially important social indicators do not fit in the structure of LCA*" (H.A. Udo de Haes in Kloepffer, 2008, p. 95). Additionally, following E-LCA, quantitative data is needed for scaling impacts to a specific FU, while social aspects include qualitative data as well, and scaling is not always possible (Pollok et al., 2021). It can thus be concluded that S-LCA is not yet well-equipped enough to handle the barriers it currently faces.

The problem this research is focusing is two-folded. Firstly, it focuses on the trouble-causing methodological development of S-LCA, as applying an E-LCA like approach causes many methodological barriers by taking a product life-cycle perspective and scaling social (semi-)quantitative indicators to the FU. During its development, the S-LCA method has been deviating from social sciences and purely qualitative ways of doing a social impact assessment, by adapting these E-LCA structures. Secondly, as the S-LCA and E-LCA development are not aligned historically (Pollok et al., 2021; Valdivia et al., 2021), these currently exist as two adjacent research fields. Practitioners in the E-LCA field are unacquainted with the current practices and stance in the S-LCA, and possibly also the other way around.

These issues are currently reflected in a lack of in-depth understanding on:

- How S-LCA performs compared to methods for social impact assessment from the field of social sciences;

- How different methods—the mentioned 'generic' and 'site-specific' assessment, and different ways to conduct these two—within S-LCA complement each other;
- How S-LCA is performed for E-LCA practitioners and the E-LCA community, and vice versa, including an understanding of details on what these methods involve and how they can be compared.

A critical evaluation of the performance of S-LCA, comparing it to social assessment methods from the field of research in social science, together with a methodological comparison of S-LCA with E-LCA is added to the body of literature on reviews of S-LCA through this thesis.

Secondly, the textile industry is of great relevance for social sustainability studies, as there are prevailing negative social impacts affecting stakeholders in the supply chain of textile products (Köksal et al., 2017). S-LCA not being a widespread method yet (Arcese et al., 2017; Klöpffer, 2008; Mazzi, 2020; Pollok et al., 2021; Toboso-Chavero et al., 2021; Valdivia et al., 2021) causes a limited amount of peer-reviewed S-LCA studies to exist. Many social sustainability studies are presented in grey literature instead (Petti et al., 2018). Subsequently, there is a an absence of peer-reviewed case studies in the textile industry (Mesa Alvarez & Ligthart, 2021; Roos et al., 2017; Zamani et al., 2018). Most of the existing studies then again are based on social risk assessment and only include a few stakeholder categories (Herrera Almanza & Corona, 2020). A vast amount of (non S-LCA) studies on social impacts in the textile industry are presented as general social analyses in grey literature (e.g., Bhattacharjee, 2016; Morgan, 2015).

1.4. Research aim, objective and research questions

Regarding the methodological barriers S-LCA currently still faces, it is crucial to critically assess how S-LCA complies as a suitable method to assess social impacts of a product, and if it actually fits in a life cycle framework as E-LCA does. This research aims on *evaluating the usefulness and feasibility of S-LCA as a method for social impact assessment throughout a product's life cycle*. Assessing the textile sector, with its unsustainable fast fashion concept and the presence of many social issues as of today, makes the research aim twofold. As the first aim is methodological in nature by assessing the value added of S-LCA over qualitative social impact assessment methods and bringing together the E-LCA and S-LCA fields, a second aim is found in assessing the social performance of a product in the textile industry.

This study provides an assessment of a product range from a fashion brand of Dutch origin, using primary data from the retailing company and looking across different stakeholder categories. The objective of the research is to add a novel comparison to the methodological development of S-LCA, by placing S-LCA next to qualitative assessment from existing ways of social assessment from the social sciences research field. Hereafter, insights obtained through S-LCA will be compared to those obtained via a general, qualitative assessment of social impacts. Being the first of its kind in making this comparison, the research contributes to an evaluation of the current performance of S-LCA in terms of value added over purely qualitative assessment methods, and what would be needed for future developments of S-LCA as a method for social impact assessment through a product's supply chain. Value-added is analyzed by comparing usefulness of the insights obtained from the assessments,

compared to the feasibility of the different assessment methods in terms of resources required in the form of time, data needs and expertise to conduct these assessments.

By methodologically evaluating S-LCA with E-LCA, this research additionally adds to the bringing together of the academic E-LCA and S-LCA fields, for future outlook on the possibilities of a triple-bottom-line sustainability assessment. Furthermore, results of this social assessment can specifically bring insights on the social issues of a textile product from a life cycle perspective, which can be beneficial for decision making purposes regarding sustainability of the textile industry and the supply chain of the product range under study.

With this objective in mind, the research addresses the following research question:

What is the value added *in terms of usefulness and feasibility* for quantifying social impacts throughout a product's life cycle by conducting a Social Life Cycle Assessment over a purely qualitative analysis of social risks and performance, using the textile industry as a case?

This question will be answered by addressing the following sub-questions, which are answered in sections 2.4 (1), 3.8 (2), 6.4 (3), and 7.5 and 8.5 (4) respectively:

1. What are commonly used methods in social sciences for assessing social issues in product supply chains, and which would be the most pragmatic to use for this research?
2. Which S-LCA frameworks exist and would be the most pragmatic to use for this research?
3. What are the social issues along the supply chain of a textile product range under study identified from a qualitative analysis?
4. What are the social issues along the supply chain of a textile product range under study identified from a Social Life Cycle Assessment?

1.5. Societal, scientific and IE related relevance of the research

As this research brings insights to methodological aspects of S-LCA, as well as social performance in the textile industry, a societal relevance can be found as a twofold. Firstly, a societal relevance can be found in the dissemination of methodological knowledge on the performance of Social Life Cycle Assessment as a method to quantifying social impacts throughout a product's supply chain, as compared to purely qualitative social analyses. Furthermore, the research provides valuable insights into social performance of the textile industry's life cycle and supply chains. As the textile industry is of great relevance in the field of social sustainability, a societal relevance is found in the dissemination of knowledge regarding the social performance of the industry throughout a product's supply chain, as well as in the fashion industry's interest in gaining knowledge for supporting decision making on social sustainability aspects.

The early stage of development in which S-LCA currently finds itself in, makes S-LCA remaining fragmented and lacking practical application (Kühnen & Hahn, 2017). This thesis contributes to scientific LCSA research and development in the field of Industrial Ecology (IE). Further methodological insight in S-LCA will help generalize and harmonize S-LCA as a method for social

performance assessment of products, organizations and supply chains. The field of IE can be seen as the conceptual foundation for the development of approaches to LCSA. Integration of methods like environmental, economic and social life cycle assessment in business organization and regulation can measure product's and organizational sustainability performance. This thesis contributes to the development of LCSA and IE constructs, as it adds to the development of a comprehensive theoretical understanding together with a reliable method for measuring social performance. This is of scientific relevance related to the field of IE, and to the overarching construct of sustainability performance assessment.

1.6. Thesis outline

The research flow diagram in Figure 4 presents the thesis structure and its approaches to answer the sub-questions and main research question. Firstly, chapter 2 introduces and discusses commonly used approaches to qualitative social assessment, answering sub question 1. Hereafter S-LCA is introduced in chapter 3, leading to the answering of sub question 2. Chapter 4 introduces the case study, whereafter chapter 5 goes further in-depth on the identified methods for the assessment, and which steps each specific method entails. Chapter 6, 7 and 8 then present the assessments, on the qualitative social risk and performance assessment, generic S-LCA, and company-specific S-LCA respectively. These chapters answer sub questions 3 and 4. Lastly, chapter 9, 10 and 11 present the discussion—including limitations—, conclusion and recommendation chapters.

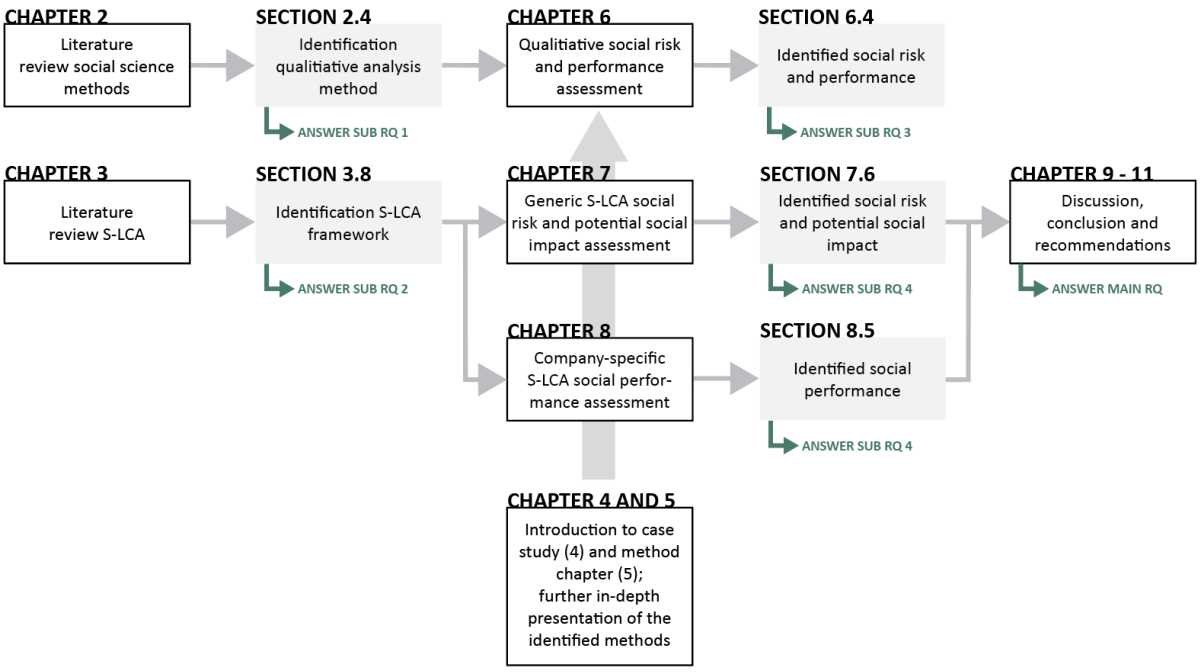


Figure 4. Research Flow Diagram.

2. Approaches to qualitative social assessment

2.1. The concept of sustainability in the corporate world

In the corporate world, sustainable development (section 1.1) was introduced by the triple bottom line in 1997 by John Elkington (Mazzi, 2020). Through this concept, businesses are encouraged to go beyond an economic focus (Avesani, 2020), including environmental and social aspects. At company-level, businesses carry responsibility in engaging to sustainability (Avesani, 2020), with increasing attention on the company's framework of sustainability plans; their Corporate Social Responsibility (CSR).

CSR is a framework reflecting sustainability performance at company level, standardized by ISO 26000 (Mancini & Sala, 2018). It refers to the activities of a company and its contributions to sustainability, on environmental, economic, and social aspects. Hereby, CSR can be seen as a as a supportive framework for companies to explore their attitude towards their business and involved stakeholders. Within the field of CSR, various types of responsibility instruments, such as guidelines, standards, and policy frameworks exist. Examples of the key instruments are the UN Global Compact (UNGC) principles (United Nations, n.d.), the Organisation for Economic Co-operation and Development (OECD) Due Diligence Guidelines (OECD, 2018), and the Global Reporting Initiative (GRI) Standards (GRI, 2021).

The UNGC presents ten principles covering aspects on human rights, labor, environment, and anti-corruption (United Nations, n.d.). Incorporating these in CSR strategies, procedures and policies, can help companies uphold and develop their corporate responsibility. The OECD Guidelines (2018) provide recommendations on responsible business conduct. It provides information on the due diligence process; an iterative process helping companies to identify, mitigate, and improve business impacts on environmental, economic, and social aspects (OECD, 2018). Lastly, GRI is an international initiative set up for promoting principles regarding social sustainability and its corporate implementation, as a disclosure framework of company's CSR strategies. It supports companies in understanding their social sustainability issues and related impacts (Mancini & Sala, 2018). Kühnen and Hahn (2017) however argue that these frameworks are centered around the disclosing of sustainability information through formal means. Hereby, it does not directly support a company regarding decision making on improving the company's social sustainability performance.

Jørgensen et al. (2009) identified needs for conducting social assessment from a company perspective. Their research showed that companies generally have developed ad hoc assessment methods, functioning okay for their own purposes, but lacking any form of streamlining. Where the OECD Guidelines, UNGC principles or the GRI Standards aim for a sort of streamlining on aspects under assessment, the ways of conducting these assessments still take a high variety of approaches. Social assessments are conducted in the form of e.g., (i) rough screenings of first-tier suppliers, (ii) assessments in compliance with business partners' Code of Conducts (CoCs)—a set of rules outlining rules, norms, and responsibilities or practices from an individual party or organization—that investigate in-house production and the upstream chain, or (iii) comparing a company's social profile with competitors via for example CSR policies and corresponding activities (Jørgensen et al., 2009). Hereby, the authors note that these assessment methods could potentially be supported by S-LCA, as currently there is a clear lack of S-LCA applied in the corporate sector.

2.2. Existing methods and frameworks on qualitative ways to assess social sustainability

Whereas literature on methods for social impacts of products is sparse, a few approaches to conduct a social assessment other than S-LCA are found in academic literature. The framework receiving the most attention in literature and in the field of social sustainability assessment is Social Impact Assessment (SIA) (Esteves et al., 2012; Rafiaani et al., 2018), and will be discussed further in section 2.2.1.

Next to SIA, different standards and principles like the UNGC principles (United Nations, n.d.), the OECD Due Diligence Guidelines (OECD, 2018), GRI Standards (GRI, 2021), ISO 2600 (International Organization for Standardization, 2010), the Social Accounting 8000 (Social Accountability International, 2023) or AccountAbility's AA100 (AccountAbility, 2023) exist. These standards and principles can provide guidance to companies on conducting their businesses in accordance with environmental, anti-corruption, and social—especially human rights and labor—standards. MVO Nederland (2020) provide a Roadmap CSR Risk Management, where the OECD Due Diligence process and the UNGP Principles for Business and Human Rights are translated in a more practical guide. Furthermore, the International Finance Corporation (IFC)—the private sector financing arm of the World Bank Group—has set eight performance standards on environmental and social sustainability (IFC, 2012). The first standard on 'Assessment and Management of Environmental and Social Risks and Impacts' presents a standard specifically for environmental and social risk and impact assessment. The second IFC Standard specifically is directed towards Labor and Working Conditions (IFC, 2012). Where the second standard focuses on labor and working conditions and therefore relates to workers, the fourth performance standard relates to community health, safety and security, thereby considers the local community. This standard on Community Health, Safety, and Security provides requirements companies need to adhere on in terms of its local community, regarding e.g., risk assessments, ecosystem services, and emergency preparedness (IFC, 2012). The other five standards involve environmental aspects, as well as social aspects on land acquisition and involuntary resettlement, indigenous people, and cultural heritage. As of less relevance for the scope of this thesis, these standards will not be further discussed.

The Roadmap by MVO Nederland (2020) is based on the UNGC principles and the OECD Due Diligence process, and these are generally adapted over the Social Accounting 8000 or AccountAbility's AA100 (AccountAbility, 2023). Furthermore, the IFC Standards provide a more hands-on overview of standards as compared to the GRI or ISO26000 Standards. Considering these might be best suited as frameworks for conducting social assessments, the SIA method, Roadmap to CSR Risk Management by MVO Nederland (2020), and the IFC Standards are discussed further below.

2.2.1. Social Impact Assessment

The development of SIA began in the early 70s along with Environmental Impact Assessment (EIA) (Becker & Vanclay, 2003; Esteves et al., 2012). There is no widely agreed definition of SIA, but it can be seen as the process of analyzing and managing both intended and unintended impacts on the human environment, caused by planned interventions, plus any social change processes that are invoked by these interventions (Becker & Vanclay, 2003). An example is the use of SIA for regulatory approval projects on resource extraction or infrastructure, where an environmental impact statement is needed, and SIA being a component of this (Esteves et al., 2012). Vanclay et al. (2015) mention the application

of SIA in many different settings but highlight its suitability on the project level of planned construction or infrastructure projects (e.g., airports, bridges, mines, pipelines, windfarms) as well as commercial agroforestry or agriculture developments, and creation of nature conservation areas. SIA is mostly used for development projects by governmental and non-profit organizations (Rainock et al., 2018). As such, it is more focused on the aspect of organizational projects instead of having a product focus.

The first Guidelines and Principles for Social Impact Assessment were published by the Interorganizational Committee for Guidelines and Principles for Social Impact Assessment (1994). This milestone document represented agreement to the core understanding and procedures of SIA in that period (Esteves et al., 2012). As a follow up, The International Handbook of Social Impact Assessment was developed and published in 2003 (Becker & Vanclay, 2003), on which the International Association for Impact Assessment (IAIA) builds further presenting the most recent SIA Guidance for Assessing and Managing the Social Impacts of Projects (Vanclay et al., 2015).

In practice, SIA still consists of different methodological forms. Guidelines on SIA can be found on state-significant projects (e.g., New South Wales Government, 2021; The Queensland Government, 2018), as well as in the mentioned documentation from scholars as the IAIA, engaged in research on SIA. SIA does not follow any standardized procedure, leading to different institutions presenting different frameworks that roughly follow the same structure but deviate on some aspect, as found in a literature review on SIA methodologies and frameworks. This review identified three main existing SIA frameworks developed by associations engaged in research on SIA: the before-mentioned Guidelines and Principles for Social Impact Assessment published by the Interorganizational Committee for Guidelines and Principles for Social Impact Assessment (1994), the Participation and Social Assessment (Rietbergen-McCracken & Narayan-Parker, 1998), and the most recent SIA Guidance for Assessing and Managing the Social Impacts of Projects (Vanclay et al., 2015).

Appendix I presents the three SIA frameworks on their phases and steps. Comparing these three, the SIA framework of the Interorganizational Committee for Guidelines and Principles for Social Impact Assessment (1994) is the only framework that provides an answer to the 'how' of investigating probable impacts of the project under study. Step 5 of the framework—as can be seen in Appendix I—, 'Projection of estimated effects' provides five ways to do so, by; (i) comparative method; (ii) populated multiplier methods; (iii) scenarios; (iv) expert testimony, (v) computer modelling; or (vi) calculation of "future forgone". After mentioning that "*The investigation of the social impacts identified during scoping is the* ***most important component****. Methods of projecting the future lie at the heart of social assessment, and much of the process of analysis is tied up in this endeavor*" (The Interorganizational Committee on Guidelines and Principles for Social Impact Assessment, 1994, p.18), it however only provides a superficial description of how to do this, as portrayed in Figure 5.

- **Comparative method** straight-line trend projects taking an existing trend and simply projecting the same rage of change into the future);
- **Population multiplier methods** (each specified increase in population implies designated multiples of some other variable, e.g. jobs, housing units);
- **Scenarios** (1) logical-imaginations based on construction of hypothetical futures through a process of mentally modeling the assumptions about the variables in question; and (2) fitted empirical-similar past cases used to analyze the present case with experts adjusting the scenario by taking into account the unique characteristics of the present case;
- **Expert testimony** (experts can be asked to present scenarios and assess their implications);
- **Computer modeling** (involving the mathematical formulation of premises and a process of quantitative weighing of variables);
- **Calculation of "future foregone"** (a number of methods have been formulated to determine what options would be given up irrevocably as a result of a plan or project, e.g., river recreation and agricultural land use after the building of a dam).

Figure 5. Presented six ways to assess the 'Projection of estimated effects', the fifth step of the SIA framework of the Interorganizational Committee for Guidelines and Principles for Social Impact Assessment (1994).

The iterative SIA framework by Rietbergen-McCracken & Narayan-Parker (1998) puts a greater focus on stakeholder identification, and involving stakeholders is a returning aspect throughout the framework. After identifying stakeholders and social factors, the analysis and assessment step follow, to which no detail is provided regarding the how. Development plans should be consulted with stakeholders, on how social measures are incorporated; how these will be carried out and monitored; how changes to the project will be addressed; and how stakeholders will continue to be involved throughout the process. The last phase on implementation and monitoring in this regard includes active stakeholder involvement (Rietbergen-McCracken & Narayan-Parker, 1998).

The SIA framework of Vanclay et al. (2015) provides a framework focusing on all project phases and puts a focus on addressing social issues early on in a project. Their framework covers a wide variety of different steps and sub-tasks, focusing on the interaction between a project and its local communities. Also in this framework, it is described what steps to take and which tasks this includes, but no clarity on how to execute this is provided.

2.2.2. Roadmap to CSR Risk Management

The Roadmap to CSR Risk Management presents eight steps to help business with their CSR Risk management (Figure 6), based on the OECD Due Diligence and the UNGP Principles for Business and Human Rights (MVO Nederland, 2020). As a first step of the framework, CSR policies and activities should be checked to see what the company's mission is, and what their CSR targets imply—also for the organization's stakeholders. A mapping of the supply chain follows, identifying all products and services purchased, produced, and exported in the product supply chain or organization's business. As a third step, CSR risks associated with the product system or organization's businesses under study are to be identified. MVO Nederland developed a CSR Risk Check tool (MVO Nederland, 2020) that generates a document on risks related to certain countries and products, specific for each process in a supply chain. When, for example, assessing a T-shirt, the tool can generate reports on CSR risks in the cotton harvesting sector of India, the production of certain dyes and cleaning chemicals needed in Pakistan, and the final garment manufacturing in China. Combining these identified sector-risks with

primary data on risks related to the characteristics of the organizations and suppliers in the supply chain, can then identify a list of CSR risks specified for a product or service of a certain organization. Step four consists of priority setting on which risks should be mitigated first. A risk assessment matrix can be used to be able to rate the risk according to its likelihood for occurrence and severity—the potential impact on the organization—, the local community, and the environment. Hereafter, action can be taken to tackle risks, and the CSR risk management should be implemented in the organizations' business processes. Following this, monitoring of the process and evaluation of policies should be done, followed by the last step on communicating with stakeholders about formulated policies and their progress. The framework enables assessments at the product, organization, and project levels.

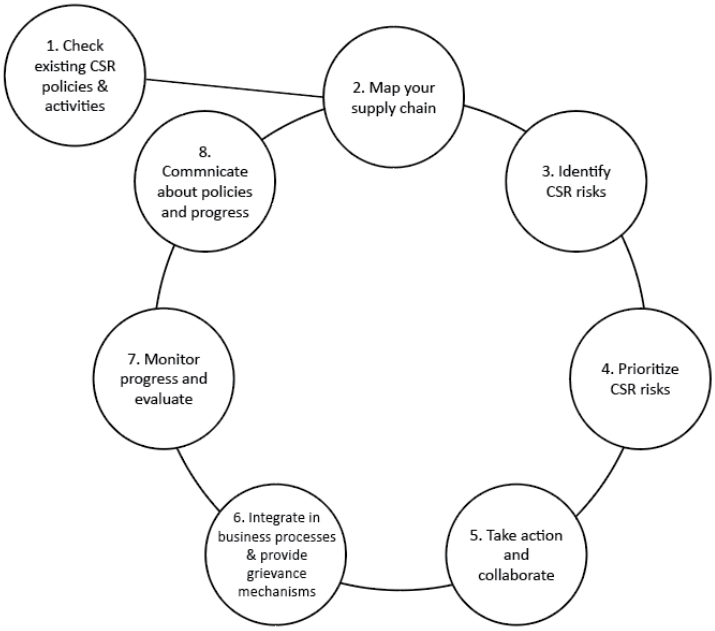


Figure 6. Eight steps of CSR Risk Management. Adapted from MVO Nederland (2020).

2.2.3. IFC Standards

The first out of eight IFC Performance Standards presents a Standard on 'Assessment and Management of Environmental and Social Risks and Impacts', as a basis for the seven following standards that present lists of requirements on labor conditions, resource efficiency, community, land resettlement, biodiversity, indigenous people, and cultural heritage. Generally, the standards provide a basis for businesses to identify risks and impacts for doing business in a sustainable way, relate to project-level activities (IFC, 2012) by providing a list of requirements per presented topic. The first performance standard stresses the importance of integrated sustainability assessment to identify environmental and social impacts, risks, and opportunities, related to a project. Furthermore, it highlights the importance of community engagement, and good CSR management of the organization throughout the life of a project. It does not, however, present a hands-on framework or method on how to conduct this sort of environmental and social risks and impact assessments. This is because the standard is targeted towards providing elements for requirements of corporate environmental and social management systems, of which identifying risks and impacts is an underlying assessment. The standard states that the identification of risks and impacts should be done in an adequate, accurate way, with objective evaluation and presentation, and should be prepared by competent professionals (IFC, 2012), thus not

providing any further guidance on how a risk and impact assessment can or should be conducted. It should be mentioned that the IFC provides many more guidance documentation, manuals and frameworks on environmental and social corporate governance. These also address social audits mostly focused on the governance performance of a certain company through complex methodology tools. As the standards provide hands-on requirements, these are addressed for this thesis, whilst other documentation will not be further discussed.

The second standard on 'Labor and Working Conditions' presents a standard that recognizes economic growth, which should be accompanied with fundamental rights for human workers (IFC, 2012). It touches upon fair treatment, equal opportunities and non-discrimination, worker-management relationships, national employment and labor laws, worker protection including vulnerable worker categories—e.g., children, supply chain workers, and migrants—, and safe and healthy working conditions, worker health, and forced labor. Per aspect the standard sets out requirements with respect to an organization's (i) direct workers, (ii) contracted workers, and (iii) supply chain workers. These requirements explicitly state clear requirements from an organization's perspective on proper social standards, thereby providing the basis for a social assessment, assessing the—extent of the—compliance to each requirement.

The fourth standard involves the local community (IFC, 2012). Due to the unavailability of data on this stakeholder category, as will further be discussed in section 5.3, this standard is not further considered in the assessment following in section 6.3—which will focus on labor conditions and thus related to the stakeholder category 'workers'. It is however an important stakeholder category that should be included in social sustainability assessments of products, a certain site, or a company.

2.3. Social sustainability studies in the textile industry

The textile industry is amongst the leading global polluting industries (Gbolarumi et al., 2021) with prevailing social issues throughout its supply chain (Zamani et al., 2018). Still, a predominant focus lies on environmental assessments over social assessments in this industry (Zamani et al., 2018). Only a few studies have investigated social issues along the life cycle of textile products (Lenzo et al., 2017), its complex supply chain structure being one of the foremost reasons for the lack of assessments (Zamani et al., 2018).

Gbolarumi et al. (2021) conducted a systematic literature review and identified peer-reviewed studies on sustainability assessment in the textile industry specifically until 2021. Out of the 24 studies identified in total, Gbolarumi et al. (2021) presents those 11 studies -with faulty referencing to the correct papers- address the social dimension. However, when looking into all those 24 studies, only nine studies adequately address the social side of sustainability (number 1 to 9 in Table 2). An additional literature review conducted in this thesis identified 6 more existing peer-reviewed studies on social sustainability in the textile industry (number 10 to 15 in Table 2). These are sourced using keywords like "textile industry" OR "fashion industry" OR "RMG industry" AND "sustainability assessment" AND "social" or "textile industry" AND "social LCA", plus snowballing from initial acquired literature. Number 10 to 15 in Table 2 present these studies.

Table 2. Sustainability studies in the textile and apparel industry, addressing social sustainability.

	Reference	Objective	Description	LC approach
1	Baskaran et al. (2012)	Assessment - organization	Discrimination, human rights, child labor, working hours, corruption, and pollution are evaluated as sustainability criteria in the Indian textile industry. 63 suppliers are evaluated and categorized on their performance, following a 'Grey approach': a mathematical method to analyze criteria using inconsistent and uncertain data.	No
2	Shen (2014)	Assessment - organization	The H&M supply chain is investigated on its sustainability. The paper only qualitatively investigates H&M, mostly on environmental aspects. No clear framework or approach is used, therefore no robust assessment is done.	No
3	Roos et al. (2016)	Assessment - sector	A sector-based assessment of the Swedish apparel sector is conducted on environmental (LCA) and social aspects (S-LCA). Hotspots are identified and interventions portray different environmental impact reduction possibilities. Interventions related to social sustainability were not yet found to be measurable. The social assessment therefore only included a risk identification on social indicators related to workers only.	Yes
4	Lenzo et al. (2017)	Assessment-product	The study follows the UNEP S-LCA Guidelines, analyzing cradle-to-gate social impacts of a textile product made in Italy. It applies a generic sector assessment with SHDB, together with a product-specific assessment. Workers and Local Communities are included as stakeholder categories.	Yes
6	Zamani et al. (2018)	Assessment - sector	The study follows the UNEP S-LCA Guidelines, analyzing sector-level impacts using the SHDB. The clothing industry for Swedish consumption is assessed with impact categories based on consumer priorities.	Yes
7	Pande & Kumar Adil (2019)	Framework	A framework as an assessment tool for sustainable practices of manufacturing organizations is proposed, centered around the triple bottom line. However, it only goes as far as presenting a compendious framework and a list of potential sustainable practices as a guideline.	No
8	Guarnieri & Trojan (2019)	Model	A multi-criteria -including social, environmental, and economic criteria- model is proposed to support decision making on supplier selection of outsourcing activities in the textile industry.	No
9	Tseng et al. (2019)	Assessment - sector	Corporate sustainability is addressed from economic, environmental, and social perspective. A valid hierarchical framework for assessing corporate sustainability in the textile industry of Taiwan is performed. This is done by integrating the 'decision-making trial and evaluation laboratory method', 'exploratory factor analysis' and the 'fuzzy synthetic method'.	No
10	Herrera Almanza and Corona (2020)	Assessment - sector	S-LCA is applied to the textile industry, to understand the social performance of a textile product and investigate the contributions to SDGs. The study links S-LCA indicators with the SDG framework	Yes
11	Luján-Ornelas et al. (2020)	Analysis - sector	A literature review is conducted on the transition towards sustainable production and consumption of textile products, through different life cycle stages. Findings are that transparency and traceability in product supply chains are fundamental in the transition of the industry.	Yes
12	(Hirokawa & Ihara, 2022)	Assessment - product	The supply chain of a T-shirt is studied through S-LCA, quantifying 'labor problems' in monetary terms from a consumer perspective using Willingness to Pay, deviating from the UNEP Guidelines and LCA structure.	Yes
13	Mahiat et al. (2022)	Assessment - sector	The study focuses on the handloom industry in Bangladesh, assessing environmental and social impacts, the latter through S-LCA following the UNEP Guidelines. However, the method is not presented transparently.	Yes
14	Muñoz-Torres et al. (2023)	Assessment - sector	The study presents an S-LCA on the global textile sector, assessing social risks of the textile industry through use of the SHDB and comparing these outcomes to a literature review.	Yes
15	Carlson and Bitsch (2018)	Analysis — sector	A case study on the Bangladeshi RMG industry, using qualitative analysis and the Institutional Analysis and Development framework addresses the sector from an institutional perspective.	No

2.4. Key findings

The first sub-question on what commonly used methods in social sciences for assessing social risks in product supply chains are, and which would be the most pragmatic to use for this research can be answered.

Starting with SIA as the most commonly used method for assessment of social impacts (Esteves et al., 2012; Rafiaani et al., 2018; Vanclay et al., 2015), some issues are found. The three SIA methodologies discussed do not go in-depth on providing a method on how to execute a SIA in practice: they do not provide a clear framework, which are project-oriented only. Only the Guidelines and Principles for Social Impact Assessment by the Interorganizational Committee for Guidelines and Principles for Social Impact Assessment (1994) provide some information on how to assess social impacts, but also stay on a superficial level. Therefore, SIA is not found to be a suitable method for this study. Some important take-aways however can be highlighted. All three methodologies stretch the importance of stakeholder identification and involvement. Furthermore, it is important to analyze the project under study and understand social factors or issues. Likely social effects of the project can be predicted, whereafter the project should be implemented, and mitigation and monitoring should take place. When translating this to a product-perspective, elements like stakeholder identification, proper product analysis of the supply chain, and identifying social factors associated with the product, plus understanding social effects throughout a product's life cycle can be found as important aspects to take into consideration when evaluating social impacts associated with a specific product.

Methods for social impact assessment provide a focus on projects, instead of products. Whereas S-LCA principles are implemented in the UNEP Guidelines (2020) and PSIA Handbook (2020)—introduced in section 3.2 and 3.3—, no hands-on methods for assessing social risks in product supply chains specifically are found. This reflects the uniqueness of S-LCA amongst social sustainability assessment methods regarding its life cycle approach related to products or services (Benoît et al., 2010). The investigated SIA frameworks focus on planned interventions and assessing possible impacts this can cause, rather than providing a framework for assessing social impacts from a product's perspective.

The Roadmap to CSR Risk Management (MVO Nederland, 2020) provides a hands-on framework on CSR risk management. As this research aims to identify social risks related to the life cycle of a certain product range in the textile industry, the steps one to four provide a relevant framework for assessing the product system. However, the framework will not be suitable for covering a full life cycle, e.g., including the retailing in Europe and end-of-life phase of the product under study.

Lastly, Performance Standard 2 of the IFC Standards provides hands-on requirements on social aspects, related to labor and working conditions for an organizations direct, contracted, and supply chain workers. This Standard provides a good basis for a social assessment of the business activities of a certain organization in the form of a requirements list, thereby being organization-oriented instead of having a product focus per se. The organizations involved in the product system under study can be evaluated following the IFC Standards. Where the IFC Standards provide standards, it does not provide an implementation framework of these standards. The Roadmap to CSR Risk Management, therefore,

is the only proper implementation of any standards—in this case OEDC and UNGC Principles—on corporate social responsibility.

In the textile industry, currently there are many different methodologies used for assessing social sustainability (Gbolarumi et al., 2021), as also is identified in the literature review of section 2.3. Together with the relevance of assessing social risks and performance in the textile industry as presented in chapter 1, addressing this thesis towards the textile industry is found to be of great relevance to focus on.

3. Introduction to Social Life Cycle Assessment

3.1. History of S-LCA

The historical development of S-LCA goes hand-in-hand with the development of the Life Cycle Sustainability Assessment (LCSA) concept. A life cycle approach was firstly introduced by Projektgruppe Okologische Wirtschaft (1987), proposing the inclusion of environmental, economic, and social aspect when considering sustainability (Guinée, 2016). Klöpffer (2003) mentions S-LCA in 2003, arguing holistic sustainability assessment should be combining LCA with LCC and S-LCA. At this time, only O'Brien et al. (1996) had proposed a method to combine LCA with S-LCA. In 1996 the first framework on the integration of social impacts with environmental impact assessment was published. It described an attempt for combining S-LCA with E-LCA as 'Social and Environmental Life Cycle Assessment' (SELCA), on the purpose of quantifying sustainability more holistically (O'Brien et al., 1996). The method suggested by O'Brien et al. (1996) had not advanced significantly until the Life Cycle Initiative of UNEP/SETAC started discussions on how to practically integrate social aspects in LCA in 2002 (Benoît et al., 2010; Oai Li & Kruijssen, 2010). Although academics did propose a framework for social impact assessment in LCA (e.g., (Benoît et al., 2007; Dreyer et al., 2006; Norris, 2006)), S-LCA methodologies have only concretely been under development since 2009. This is the moment when UNEP/SETAC published the first S-LCA Guidelines (UNEP/SETAC, 2009), of which an updated version was published in 2020 by UNEP (UNEP, 2020).

These Guidelines originated from the UNEP/SETAC task force in 2004, concerning five objectives: (i) converting the environmental-focused LCA into a triple bottom line sustainability assessment method, (ii) establishing a framework to include socio-economic benefits into LCA, (iii) determining implications for life cycle inventory analysis, (iv) determining implications for Life Cycle Impact Assessment (LCIA), and (v) providing an international forum for sharing knowledge and experiences regarding the integration of social aspects in LCA (Benoît et al., 2010). Many ideas concerning sustainability assessment integration came about from then on (Oai Li & Kruijssen, 2010), with the UNEP/SETAC Guidelines on integrating social aspects in an LCA-like framework as a significant milestone in S-LCA development. In 2014, the Roundtable for Product Social Metrics additionally developed the Handbook for Product Social Impact Assessment (PSIA), of which the latest version was updated in 2020 (Goedkoop et al., 2020). Under the scenario of usefulness of the UNEP Guidelines in the industry context, this Handbook is developed as a more practical and business-oriented guideline, as proposed by multinational companies within different industry fields (Pollok et al., 2021). It is developed based on the UNEP/SETAC 2009 version of the Guidelines, together with other guidelines at the corporate level such as the Global Reporting Initiative (GRI), with the aim of broader involvement of the industry itself for creating indicators. The approach proposed in the PSIA Handbook, however, is referred to as 'product social footprint' instead of S-LCA—although taking a life cycle perspective. This is due to the fact that the Handbook does not prescribe full alignment with the ISO 14040/44 standard for LCA (Goedkoop et al., 2020), to allow more methodological flexibility for practitioners.

The launching of the UN Sustainable Development Goals (SDGs) in 2015, and the development of the Guiding Principles on Business and Human Rights (United Nations, 2011) have highlighted the importance of researching negative and positive social impacts of supply chains (UNEP, 2020), by

applying S-LCA-like methods that help to understand and reflect upon these. As of today, S-LCA is seen as a method that can provide support for decision making on improving social impacts related to a product or service, throughout the life cycle of this product using LCT. The life cycle approach of S-LCA makes the method more holistic than SIA methods (Jørgensen, 2013). S-LCA is still quite young, therefore assessing social aspects is currently both still been done purely qualitative—mostly without a clear methodology—, or through developed guidelines as mentioned above (Mesa Alvarez & Ligthart, 2021). The UNEP Guidelines and the Handbook for Product Social Impact Assessment (PSIA) have been the two most applied and known S-LCA guidelines so far (Mesa Alvarez & Ligthart, 2021), and are discussed below. Currently an ISO standard—based on a proposal submitted by authors of both the UNEP Guidelines as the PSIA Handbook—of S-LCA is under development (ISO, n.d.; PRé Sustainability, n.d.).

3.2. The UNEP S-LCA Guidelines

The UNEP Guidelines (2020) follow a methodology that is based on the commonly known Life Cycle Assessment (LCA) on environmental impacts (E-LCA). The S-LCA framework, however, takes a stakeholder approach considering potential social impacts on different stakeholder categories (UNEP, 2020), as social sustainability calls for identification and managing of impacts a certain product, service, or organization has on people.

The Guidelines are complemented by Methodological Sheets (UNEP, 2021), that present each stakeholder group and corresponding impact subcategories. The sheets present impact subcategories (hereafter referred to as subcategories) linked to a specific stakeholder group (Figure 7). These socially significant themes are formulated as those that might affect stakeholders, whether positive or negative, during the life cycle of a product or service. To assess these subcategories, several indicators can be used, depending on the study's context. The Guidelines present example indicators, describing how impacts of these subcategories can be assessed, as a basis for gathering relevant data (UNEP, 2020). For example, the percentage of working children below 15 years old, or records of names and ages or birth dates can be indicators used to assess the subcategory 'child labor' (UNEP, 2021). The first official version of Methodological Sheets were published in 2013, consisting of 31 sheets, covering 5 stakeholder groups. Introduced in the latest version of the Methodological Sheets is the 6th stakeholder group of children, as this group represents the future generation and thereby is a category that can measure wellbeing and guaranteeing welfare comparing the present to the future generation (UNEP, 2021). Subcategories can be further grouped logically in groups of impact categories, e.g., 'Human Rights', 'Working conditions' or 'Health and Safety' (UNEP, 2020). However, the Guidelines do not present a practical exhaustive list of impact categories, therefore here these will not be discussed in more depth.

Stakeholder categories	Worker	Local community	Value chain actors (not including consumers)	Consumer	Society	Children
Subcategories	1. Freedom of association and collective barganing 2. Child labor 3. Fair salary 4. Working hours 5. Forced labor 6. Equal opportunities / discrimination 7. Health and safety 8. Social benefits / social security 9. Employment relationship 10. Sexual harassment 11. Smallholders including farmers	1. Access to material resources 2. Access to immaterial resources 3. Delocalization and migration 4. Cultural heritage 5. Safe and healthy living conditions 6. Respect of indigenous rights 7. Community engagement 8. Local employment 9. Secure living conditions	1. Fair competition 2. Promoting social responsibility 3. Supplier relationships 4. Respect of intellectual property rights 5. Wealth distribution	1. Health and safety 2. Feedback mechanism 3. Consumer privacy 4. Transparency 5. End-of-life responsibility	1. Public commitments to sustainability issues 2. Contribution to economic development 3. Prevention and mitigation of armed conflicts 4. Technology development 5. Corruption 6. Ethical treatment of animals 7. Poverty alleviation	1. Education provided in the local community 2. Health issues for children as consumers 3. Children concerns regarding marketing practices

Figure 7. Stakeholder categories and subcategories in the UNEP 2020 Guidelines

The Guidelines present S-LCA as following the four phases of E-LCA, based on the ISO14040 standard. These phases include (i) setting the study's goal and scope (Goal and Scope), (ii) data collection (Inventory Analysis), (iii) assessment of the risk and potential impacts (Impact Assessment), and (iv) the interpretation of results (Interpretation). Figure 8 shows the S-LCA decision tree illustrating main decisions that need to be taken per phase in the S-LCA. Each phase and what is exactly included is introduced in the following sections.

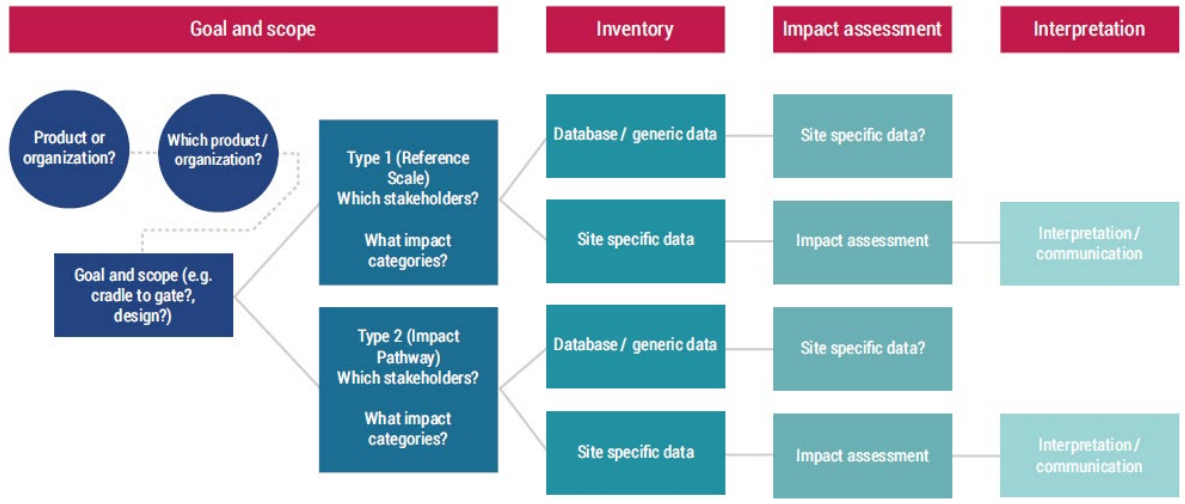


Figure 8. S-LCA decision tree, adopted from UNEP 2020 Guidelines for S-LCA (UNEP, 2020)

What becomes clear of this figure is that in S-LCA two impact assessment approaches exist, corresponding with the aim of the assessment. These are the Reference Scale approach (or Type I/ Reference Scale S-LCIA) and the Impact Pathway approach (or Type II/ Impact Pathway S-LCIA). The Reference Scale approach is relevant for assessing a system on its social performance or social risk,

whereas the Impact Pathway approach is relevant for assessing potential social impacts in a product system, aiming on predicting consequences arising from a certain activity in the product system (UNEP, 2020). An activity here is referred to as a 'social activity' associated with a certain 'unit process' (UNEP, 2020). A 'unit process' here is a certain production process (e.g., yarn production), whereby the 'activity' is the associated social process (i.e., the activity of spinning cotton fibers into cotton yarn). The two impact assessment approaches—as well as different impact assessment methods corresponding to these approaches—will be explained in further detail below and are further discussed in section 3.2.3.

- Reference Scale S-LCIA (RS S-LCIA) "*assesses the social performance or risks of activities of organizations in the product system (e.g., the practices implemented to manage social impacts)*" (UNEP, 2020, p 28). Through the method indicators are assessed on a reference scale, using specific reference points. Social risks can be general indicators for potential social impact, by scaling these social risks to a certain (UNEP, 2020).
- Impact Pathway S-LCIA (IP S-LCIA) on its turn "*assesses potential or actual social impacts by using causal or correlation/regression-based directional relationships between the product system/organizations' activities and the resulting potential social impacts*" (UNEP, 2020, p 28). Through this approach, potential or actual social impacts can be assessed, depending on whether the assessment is based on observed data or not. A focus lies on consequences of activities that have a possible long-term implication along an impact pathway, where IP S-LCIA classifies indicators with impact categories at midpoint and endpoint level (UNEP, 2020). In S-LCA-terms 'midpoints' cover characterization of impacts midway the cause-effect chain (midpoint) of a social issue, whereas 'endpoint impacts' are impacts at the end of this chain, i.e., on the level of the 'human well-being' area of protection (AoP) in S-LCA.

Furthermore, the assessment can be done on different levels of resolution: a 'generic assessment' or 'site-specific assessment' (Figure 8). To understand what is actually assessed through these different S-LCA approaches, a few core concepts are of importance to be defined. Here, the concepts as defined by UNEP (2020) are discussed. Section 2.4 presents how these concepts are defined and addressed further in this thesis.

- **Social impacts** are defined as "*consequences of positive or negative pressures on social endpoints of AoP*" (p 134). This implies that social impacts, whether potential or actual, are assessed through IP S-LCA as they are assessed at endpoint indicator level (impacts at the end of the cause-effect chain and thus at the level of social consequences from a certain effect). Hereby, the UNEP Guidelines are not consistent in defining **social impacts**, in line with ***potential*** and ***actual*** **social impacts**. The Guidelines mention that S-LCA mainly is focusing on assessing ***potential*** **social impacts**, defined as "*the likely presence of a social impact, resulting from the activities/behaviors of organizations linked to the life cycle of the product or service and from the use of the product itself*" (UNEP, 2020, p. 24) and that potential social impacts are "*often based on more than one (inventory) indicator (e.g., a **social risk**) and can contain aspects of causal relations, when they are calculated against the background of the Impact Pathway (IP) approach*". In contrast, ***actual*** **social impacts** are defined as positive or negative consequences arising from causal relationships between aspects related to human well-being, and a certain activity. These impacts can thus be defined as

changes affecting stakeholders, as a result of a certain activity (UNEP, 2020). It is important to mention that there can only be spoken about *actual* social impacts, when verified and observed primary data coming directly from stakeholders is used. The definitions of social impacts as being measured at endpoint indicator level, is inconsistent with mentioning that potential social impacts can—but do not have to—be calculated via Impact Pathway approaches, and can also be evaluated through the assessment of **social risks**. As related to a specific product system, social impacts are through site-specific data.

- **Social risks** on its turn are the topics where probability can be found on adverse social effects on stakeholders, through activities of an organization (UNEP, 2020). It assesses the product system on a lower resolution country/sector level. Thus by a generic assessment. The extent of a risk—mostly on country, sector, or company level—can be measured, e.g., low/medium/high risk. Social risks are indications for potential social impacts (UNEP, 2020).
- A **social hotspot** is a process (unit process) in the life cycle of a product where there is a high likelihood for social issues or social risks to appear. These hotspots can cause threats to social well-being (UNEP, 2020).
- Lastly, **social performance** refers to the performance of a certain organization in terms of principles, practices, and outcomes of business relationships and activities, measured against a certain standard. Social performance generally is measured at indicator level (UNEP, 2020), using site- or company-specific data. It measures the performance of the organizations involved in the product system, thereby taking a company-specific perspective over a product perspective.

From a perspective of data, social performance is thus measured with company-specific data, whereas social risks are measured with generic sector/country level—thus lower resolution—data. Having both social performance and social risk assessments can be beneficial, as the additional social risk assessment can contextualize the social performance assessment on company level (UNEP, 2020).

In the following sections, the four phases of an S-LCA study, and what each phase entails are explained.

3.2.1. Goal and Scope definition

Following the ISO14040 framework, firstly the goal and scope of the study need to be defined. The goal definition specifies what the goal of the study is in terms of intended use, target audience, what the study aims to assess, on which topic, and which stakeholders are affected (UNEP, 2020). A goal of an S-LCA study can, for example, be to identify social hotspots of a certain product or examine potential social improvement options along a product's life cycle. Ideally, it specifies whether the goal of the study is based on attributional or consequential thinking.

The scope definition then clarifies the project under study and the methodological framework of the research. The following elements should be included and defined in the scope definition (Mancini et al., 2018; UNEP, 2020):

- The function, functional unit (based on the function), and reference flow of the product or service under study;

- Definition of the product system, and defining the parts of the product system that are included in the assessment (identifying system boundaries and presenting cut-off criteria);
- Which stakeholders, and subcategories (Figure 7) are applicable to the product system;
- Type of impact assessment approach (RS S-LCA or IP S-LCA);
- Choosing the variables determining the importance of different activities in the product system (activity variables, explained in section 3.6);
- Data collection strategies and data quality requirements;
- Limitations of data access.

The UNEP Guidelines present S-LCA as a study where the functional unit (FU) and reference flow are used, to identify the object of the study and determine the product system (UNEP, 2020). However, if the inventory is based on semi-quantitative and qualitative data—as is the case for many social aspects—the impacts will rarely be related to FU of the product (Hosseinijou et al., 2014). An example of a purely qualitative indicator is a policy textually describing measures taken to manage labor conditions. The qualitative nature of these social aspects leads to the inability to aggregate these to a specific FU. The UNEP Guidelines do acknowledge this issue, as "*Given that some potential social impacts do not depend on the physical flows and the nature of unit processes but more on the behavior of the companies and stakeholders involved in the life cycle under analysis, some practitioners do not provide results that have been scaled to the functional unit*." (UNEP, 2020, p 46). As an example, they discuss the assessment of forced labor, which cannot be scaled to e.g., a number of T-shirts that are part of a product system. When the scaling to the FU cannot be performed due to lack of data or other reasons like using qualitative or semi-quantitative data, or because these impacts might not scale linearly, reasons for non-scaling should be explicitly specified and discussed (UNEP, 2020). It is thus identified that linearly linking qualitative social aspects to a FU is not possible, only for semi-quantitative or quantitative indicators this is the case. This can be e.g., rate of fatal accidents or a gender wage gap value. In this regard some practitioners even have expressed favor of a non-FU-based S-LCA approach (Petti et al., 2018).

After defining the function, functional unit and the reference flow, the product system can be defined. This is a system of interconnected unit processes in the life cycle of a product by material, energy, product, waste, or service flows that can provide one or more defined functions (Guinée et al., 2002). These unit processes can be associated with so-called social 'activities' in S-LCA terms: e.g., the unit process of yarn manufacturing, can be associated with the social activity of workers harvesting cotton and spinning this into yarn. An 'activity' is thus still an economic activity, but explicitly refers to the human aspect of this. The product system, including its system boundaries can be presented in the form of a flow chart, including all inputs and outputs, and specify geographical location and companies or factories involved in the system (UNEP, 2020). Criteria used to define cut-offs should be clearly presented in the scope definition, with the aim of transparently presenting system boundaries and reasons for excluding certain processes or flows (UNEP, 2020).

After clearly defining the product system and which processes to include and exclude, an important step in the Goal and Scope is the identification of stakeholders involved in this product system, and which subcategories are of relevance to assess. This is of importance, as it can be difficult to collect data

specifically related to companies or factories involved in the product system (UNEP, 2020). Therefore, critically identifying which subcategories should be assessed provides a focus on relevant categories to gather data on. When gathering site-specific data is found to be very challenging, generic data can be used to complement this data for background processes in the supply chain (UNEP, 2020). Ultimately, in a 'complete' S-LCA, all relevant stakeholders and subcategories should be considered and included.

The choosing of an impact assessment approach (RS S-LCIA or IP S-LCIA) comes with a few decisions that need to be taken in the Goal and Scope phase (Figure 9). When choosing either one of the two, stakeholders and the subcategories under assessment should be selected. Furthermore, when choosing RS S-LCIA, reference scales used for the impact assessment need to be formulated, as a prerequisite for the Impact Assessment phase. When using IP S-LCIA, the same needs to be done for the choice of a characterization model, and type of impact pathway used. If applicable, as a last step the weighting method should be determined.

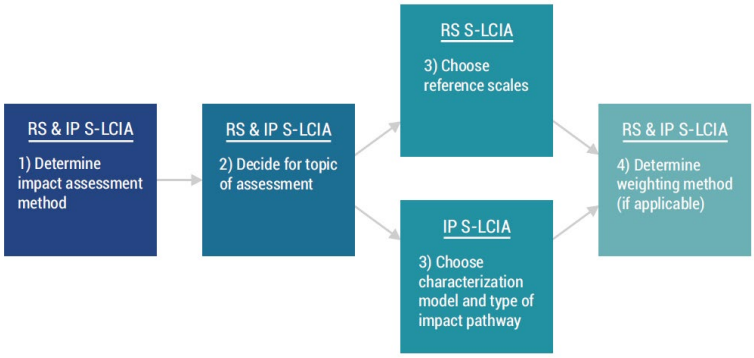


Figure 9. Steps in Goal and Scope regarding choice of IA approach. Image from UNEP (2020).

3.2.2. *Inventory Analysis*

Certain data on social issues is needed to be able to describe social risks, performance or impacts within a certain product system. Same as E-LCA, S-LCA is taking a life cycle perspective, meaning data should be collected across the life cycle of a product (UNEP, 2020), for assessing potential or actual social impacts, risks, or organizational performance along a product's supply chain—the latter is not addressed in the Guidelines and further discussed in section 5.2.1. When taking the example of the T-shirt, this means that data should be gathered on topics as working conditions of the people in the producing stage, together with their wage, working hours, and potential safety hazards that can happen at the factory. Also in the packaging and shipping sector, and in the cotton harvesting, knitting, dyeing, and shipping sector similar data on social issues as e.g., working conditions should be gathered. Additionally, the local community surrounding the factories should be considered where data should be collected on living conditions, local employment, and such. The collected data should be in some way quantitatively relatable to the FU, particularly when conducing an S-LCA using generic social risk databases such as the SHDB or PSILCA social database. Appendix V shows examples of what these indicators could be through the PSILCA database.

The Guidelines in theory explicitly steer towards the scaling to a specific FU. A way to do this is via the so-called 'activity variable' as a measure of the process activity related to process output (UNEP, 2020). This is a variable that reflects the share of a given activity, associated with each unit process. In S-LCA

terms an 'activity' refers to the social activity (e.g., workers that work on the spinning of yarn) associated with a certain unit process (i.e., yarn production). 'Activities' are in this regard always associated with 'human activities', where humans and thereby a social context are involved. The activity variable is a measure of the process activity related to the process output (UNEP, 2020). In the terminology of 'activity' a difference can be identified between S-LCA and E-LCA, where in E-LCA terms an 'activity' refers to a certain process (Guinée et al., 2002). Section 3.6 describes how activity variables are used for scaling these social flows to reference flows and the FU.

Furthermore, section 5.2.1 presents one of these social databases for FU-based S-LCA and discusses the units of the different indicators used in the database. It is thus important to note that even some fully quantitative indicators—e.g., the rate of fatal accidents at a workplace—are not directly quantitively relatable to a certain FU, but need this variable of worker-hours to quantitively relate it to a FU (see section 1.2.3). An example of such an indicator is the 'gender wage gap', reflecting the difference between male and female median wages divided by the higher median wage and expressed in percentage. To relate a sectorial gender wage gap of e.g., 20% to a specific reference flow, the worker-hours variable is used, representing the amount of hours worked under a certain level of social risk (e.g., high risk for a large gender wage gap within the studied country, sector, organization or activity) to produce a certain amount of product output. Criticism is expressed on this variable, as in this case is reflected: a gender wage gap has no direct link with the worker-hours spent in a certain unit process, but this activity variable is still applied.

Where available, primary data available by a specific company should be gathered or retrieved via interviews with different stakeholders. Secondary data sources can be consulted, through a literature review or using S-LCA databases. The life cycle inventory then builds up to an inventory of all physical processes and flows in the product system under study and the connected social flows to all these processes.

During the inventory, data related to all unit processes of the product system within the system boundaries is collected. The data collection depends heavily on the choice of impact assessment approach. The Inventory Analysis phase consists of a few steps (UNEP, 2020), if applicable considering being in line with what is specified in the Goal and Scope;

- Identification of data to prioritize collection on—i.e., stakeholder groups, subcategories, or specific unit processes;
- Collecting data for stakeholders and subcategories;
- Collecting data for the RS S-LCIA or IP S-LCIA;
- Collecting primary (company/site-specific) and secondary (generic) data for unit processes and—if applicable—related activity variables;
- Collecting data for scoring and/or weighting.

Firstly, prioritization of certain activities in a product system on their relative importance can guide the data collection process and the choice of subcategories. The Guidelines suggest three ways to do so. A first approach can be a literature review on identifying key social issues that should be included in the assessment. Secondly, the activity variable can be used to identify the most 'intensive' unit process—

i.e., the unit process where most of the labor in terms of hours in the product system happens—to identify unit processes of importance to put focus on in the assessment. Lastly, hotspots—a unit process linked to an activity where a social issue (as an impact) or a social risk is likely to occur—throughout the life cycle can be identified. This can be done through a generic assessment by using social databases (PSILCA or SHDB). This assessment then provide a country/sector level assessment based on national statistics (Maister et al., 2020), as a basis for a site- or company-specific assessment. This assessment requires a proper mapping of the product system, as part of the Goal and Scope, and building the model in LCA software with the use of a social database.

For the site-specific assessment, data should be collected on site, company and product level, on relevant stakeholder groups and subcategories for RS S-LCIA or impact categories for IP S-LCIA.

An important note that should be addressed regarding the Inventory Analysis phase of as a basis for RS S-LCIA is its difference with E-LCA. In E-LCA clear distinctions take shape between the Inventory Analysis and the Impact Assessment phase; various impact assessment models can be linked to the life cycle inventory from e.g., LCI databases like ecoinvent, where these are developed separately. In S-LCA, however, a less clear division can be identified for a database S-LCA. This is due to the nature of the social flows, which are represented by a number of worker-hours that are performed under certain social conditions—situated in a certain unit process. These social conditions have a nature (e.g., children in employment) as well as a certain magnitude (e.g., high or low and good (opportunity) or bad (risk)). The latter aspect—the classification of the magnitude—happens through the reference scales, which are set through certain impact assessment models. During the inventory, the flows are already classified on their magnitude, and through characterization in the Impact Assessment phase, all these different flow contributions and corresponding worker-hours values are aggregated in terms of medium risk hours (see section 3.6). These social flows are comparable to environmental flows in E-LCA, whereby in S-LCA the magnitude of the conditions are thus already evaluated in the inventory stage through the specific impact assessment model and established reference scales.

The social databases (SHDB or PSILCA) have in their framework a set of pre-determined reference scales in terms of risk levels corresponding to each impact subcategory (UNEP, 2020). These reference scales are ordinal scales, comprising of a few levels that correspond to a certain performance reference point (PRP) (UNEP, 2020). Reference points can be targets or standards or industry best practices, for example (Pollok et al., 2021). Table 3 provides an example of an inventory table with performance reference points (PRPs) as presented in the PSICLA database for the subcategory children in employment. These PRPs are thus the values that separate the different risk levels and are the points that distinguish the different reference scales: in the below example thus 2.5, 5, 10, and 20. The PRPs and corresponding risk level assignment of the indicators is based on labor laws, international conventions and standards, export opinion and developer experience and evaluation (Maister et al., 2020).

Table 3. Risk assessment for impact subcategory children in employment, adapted from PSILCA.

Children in employment (as a % of total employment), male/female/total	
Indicator value (reflecting the PRPs)	**Corresponding risk level (reference scale)**
0	No risk
0 < 2.5	Very low risk
≥ 2.5 < 5	Low risk
≥ 5 < 10	Medium risk
≥ 10 < 20	High risk
>20	Very high risk

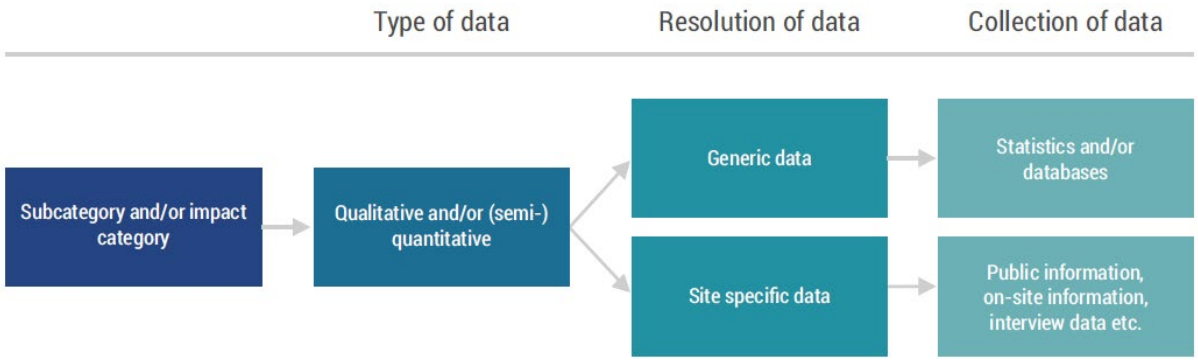


Figure 10. Data collection and its interrelations in S-LCA. From UNEP (2020).

In summary, depending on what is defined in the Goal and Scope, S-LCA can include both a generic and a site-specific (or company-specific) assessment, or an assessment using a mix of both site-specific as generic data. The difference between the first two assessments lies in the resolution of the data used, as visualized in Figure 10. For both the generic and the site-specific assessment, also depending on the Goal and Scope definitions, data can be collected for an Impact Pathway or Reference Scale assessment. When a RS S-LCIA approach is chosen, the reference scales are already established in the Inventory Analysis phase, where the magnitude of each social flow is evaluated on its risk level. For each stakeholder category and subcategory, data can be collected on the level of a social flow, corresponding with the subcategory. The social databases provide data on indicator level, whereas for primary data collection the Methodological Sheets (UNEP, 2021) can be used, that present example indicators per stakeholder subcategory. A difference in the level of resolution of different data types is presented below:

- **Company data**: data derived from a specific company, but not allocated to a certain production site. It can be collected through e.g., interviews, surveys, audit results;
- **Site-specific data**: data collected for a unit process (mostly production activities), occurring at a specific location in a specific organization and facility. Also collected through e.g., interviews, surveys, audit results;
- **Generic data (country/sector level)**: data from social databases, statistics, or literature review. It is not collected for a specific process, thus is not considered primary data.

3.2.3. Impact Assessment

The UNEP Guidelines present two types of Impact Assessment approaches—or characterization models—to calculate, understand and evaluate the significance and magnitude of *potential social impacts*

throughout the life cycle of a product (UNEP, 2020). These potential social impacts are defined as likely consequences of negative or positive pressures on social endpoints (Arcese et al., 2017), resulting from activities or behaviors of organizations in the product system (UNEP, 2020). Where some methods solely focus on the evaluation of social risks, these social risks are understood in the Guidelines as "*general indicators for potential social impacts*" (UNEP, 2020, p 80). However, looking into different methods to conduct RS-LCIA or IP-LCIA, it can become clear that not in every case 'potential social impacts' actually are assessed, and it is not clear what is exactly understood by a 'general indicator for potential social impacts'. The RS S-LCIA approach is used when the aim of the study is assessing social performance or social risk, and the IP S-LCIA approach fits for assessing social impacts through characterizing the cause-effect chain (UNEP, 2020).

Reference Scale S-LCIA (RS S-LCIA) encompasses the establishing of certain reference scales in the Inventory Analysis phase, by which the data collected on relevant stakeholder groups and subcategories can be assessed in the Impact Assessment. Using this approach can describe a product system in terms of social performance or social risk. The qualitative data can, with the help of these reference scales and PRPs be translated to semi-quantitative data. This can be done through methods like scoring methods, checklist methods, and database methods as presented by Chhipi-Shrestha et al. (2015) and Pollok et al. (2021). Firstly, using checklist methods can only identify the presence of an impact, but does not address its magnitude. Secondly, using a scoring method is most commonly done, by categorizing semi-quantitative data in different scoring values. Both the checklist and scoring method is using site- or company-specific data, where social performance is assessed through. Thirdly, database methods use databases like SHDB and PSILCA and categorize social risk in low, medium, high, or very high risk, on the level of country, sector or stakeholder (Pollok et al., 2021), as presented above in Table 3. This method however lacks inclusion of positive impacts as only for one indicator (contribution of the sector to economic development) 'opportunities' are addressed instead of 'risks'.

When using the latter database method, S-LCA takes a form most closely to E-LCA. During the Impact Assessment phase of this S-LCA approach, the risk assessed social flows—during the Inventory Analysis phase—are characterized by applying the activity variable with a certain weighting method and aggregating inventory results expressed through medium risk hours (see section 3.6). Another approach in the Impact Assessment phase is the risk-assessment through the direct value of the social flow (see Table 3)—done through the so-called direct quantification method introduced in section 3.6.

Impact Pathway S-LCIA (IP S-LCIA) is very underrepresented in existing S-LCA studies so far (Chhipi-Shrestha et al., 2015; Pollok et al., 2021). This type of assessment portrays causal relations, explaining resulting potential impacts of changes in the life cycle of a specific product and links these to the Areas of Protection (AoP) 'human well-being'. This can be done with or without midpoint aggregation and is a LCIA approach. Pathways for causal links require quantitative cause-effect modelling, thereby it requires quantitative data that is highly unavailable in social sciences. This is because causal relations of social impacts are not known, or do not allow quantifiability, as well as the nature of human interaction and thereby uncertainty of behavioral impact (Pollok et al., 2021). For both the empirical method and the E-LCI database method presented under IP S-LCIA these challenges are faced, as only

very few actual 'social impacts' can be assessed in a purely quantitative way by a generic method (Pollok et al., 2021).

Figure 11 provides an overview of the two S-LCIA approaches and their different methods. Additionally, it shows what actually is assessed by this method. As both RS S-LCA and IP S-LCA do not follow a common standard, it should be mentioned that procedures followed by practitioners vary greatly within both RS S-LCA and IP S-LCA studies (Pollok et al., 2021). Any form of S-LCA includes qualitative and/or semi-quantitative data, therefore it is important to notice that none of these different methods are a form of purely quantitative S-LCA due to the qualitative and dynamic nature of social phenomena. The UNEP Guidelines, however, only discuss S-LCA as comprising of these database methods.

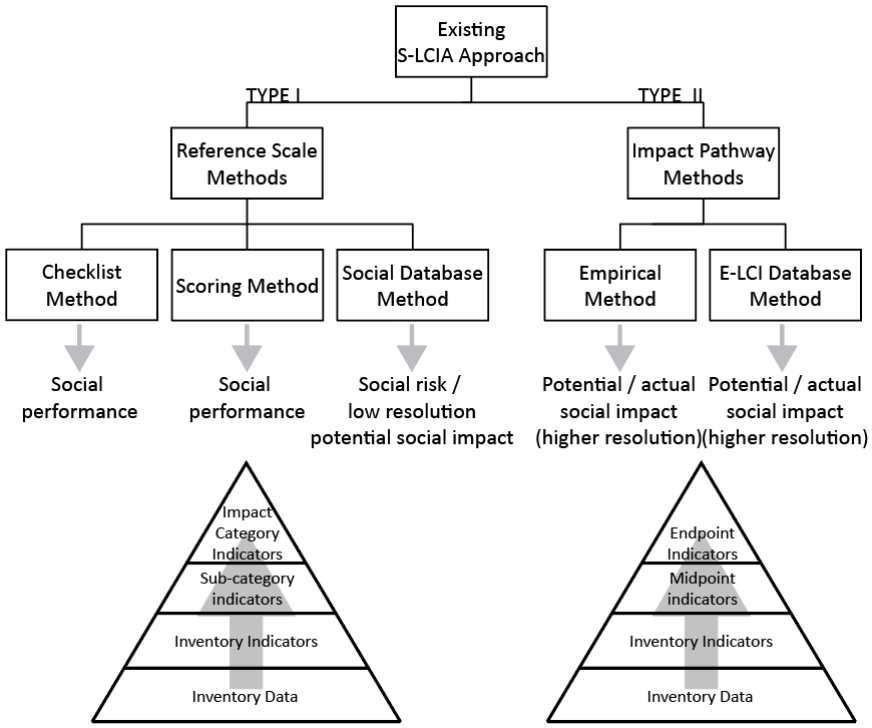


Figure 11. S-LCIA approaches and their different methods, and assessment level. Adapted from information from Pollok et al. (2021) and Chhipi-Shestha (2014).

- The RS S-LCIA checklist method can only provide information on certain performance indicators per subcategory (e.g., the organization has a policy allowing freedom of association and collective bargaining; yes or no). Providing enough checks per subcategory indicator can then provide an overview of the social performance of a certain organization;
- The RS S-LCIA scoring method allows for an assessment of organizational social performance, as through categorizing data of a company in scoring values (e.g., A to D with A for a good performance and D for a bad performance) only allows for acquiring insights on the company's performance, not on risks or impacts related to a product;
- The RS S-LCIA social database method allows for a social risk assessment through the direct quantification method, or the assessment of potential social impacts through the use of an activity variable—i.e., worker-hours. Through the use of this variable, the social risks are scaled to a FU leading to these being referred to as potential social impact. All inventory flows are

normalized per FU. For the direct quantification method, overall results for different indicators is normalized by the total amount of products in the life cycle. For both assessment, lower resolution database data is used, possibly complemented with company- or site-specific data;

- Impact Pathway methods allow for assessment at endpoint level, making an assessment of potential or actual social impacts possible. However, it requires quantitative cause-effect modelling, thereby quantitative data that is highly unavailable in social sciences, making it an unfeasible and underrepresented Impact Assessment approach in S-LCA (Pollok et al., 2021).

3.2.4. Interpretation

As a last phase of an S-LCA, the Interpretation reviews the first three phases and interprets S-LCA results. This phase consists of a completeness check, consistency check, uncertainty, sensitivity and data quality check, materiality assessment, plus conclusions, limitations, and recommendations (UNEP, 2020).

The completeness check reviews if all relevant issues presented in the Goal and Scope are adequately addressed in the Inventory and Impact Assessment. It also highlights questions still unsolved and why missing information still pertains. The consistency check evaluates if the methods applied, and data used, are in line with the Goal and Scope and applied consistently throughout the study. Uncertainty analysis can address the uncertainty of scoring factors and subcategory indicator aggregation into stakeholder type. Sensitivity analysis can then be used to verify assumptions made under different conditions. Some issues that are relevant to apply a sensitivity analysis on are e.g., the choice of the activity variable, aggregation and weighting criteria, allocation method, and data assumptions. The materiality principle aims to identify significant social performances or risks, whereby 'significance' is related to the concept of materiality in S-LCA. Materiality assessment can be supported by a contribution analysis (UNEP, 2020). It is important to keep in mind that in E-LCA terms, this step is generally referred to as 'contribution analysis' instead of 'materiality assessment'. However, the term 'materiality assessment' can take more forms than contribution analysis in S-LCA. When having assessed the social performance of a company, instead of social risks related to a product system, this step can involve comparing the assessment results to a benchmark and thereby providing insights into significant issues. The term is also used in the UNEP Guidelines as a way to, in the Goal and Scope phase of an S-LCA, identify relevant categories that should be part of the assessment.

Especially the sensitivity analysis and contribution analysis aspect of the materiality assessment are of importance to address the (i) robustness of the S-LCA results, as well as (ii) to identify social hotspots.

For reaching useful conclusions, addressing data quality is fundamental to ensure or discuss reliability validity, and objectivity of findings. These three aspects are defined by (UNEP, 2020) as the following:

- **Reliability**: the extent of producing reliable and consistent results;
- **Validity**: the extent to which the indicators are measuring an intended concept;
- **Objectivity**: the extent to which the practitioner or data source is separated from the object of investigation and does not include bias.

The UNEP Guidelines and the PSILCA documentation present the same pedigree matrix regarding this, to give the data collected a certain data quality score (Figure 12). It is recommended to do this during data collection, to properly document the quality of the data directly, and ensuring the acquired information meets the required quality criteria (UNEP, 2020).

Score / Indicator	1	2	3	4	5
Reliability of the source(s)	Statistical study, or verified data from primary data collection from several sources	Verified data from primary data collection from one single source or non-verified data from primary sources, or data from recognized secondary sources	Non-verified data partly based on assumptions or data from non-recognized sources	Qualified estimate (e.g. by expert)	Non-qualified estimate or unknown origin
Completeness conformance	Complete data for country-specific sector/ country	Representative selection of country-specific sector / country	Non-representative selection, low bias	Non-representative selection, unknown bias	Single data point / completeness unknown
Temporal conformance	Less than 1 year of difference to the time period of the dataset	Less than 2 years of difference to the time period of the dataset	Less than 3 years of difference to the time period of the dataset	Less than 5 years of difference to the time period of the dataset	Age of data unknown or data with more than 5 years of difference to the time period of the dataset
Geographical conformance	Data from same geography (country)	Country with similar conditions or average of countries with slightly different conditions	Average of countries with different conditions, geography under study included, with large share, or country with slightly different conditions	Average of countries with different conditions, geography under study included, with small share, or not included	Data from unknown or distinctly different regions
Further technical conformance	Data from same technology (sector)	Data from similar sector, e.g. within the same sector hierarchy, or average of sectors with similar technology	Data from slightly different sector, or average of different sectors, sector under study included, with large share	Average of different sectors, sector under study included, with small share, or not included	Data with unknown technology / sector or from distinctly different sector

Figure 12. Data quality pedigree matrix. From Maister et al. (2020) and UNEP (2020).

3.3. The PSIA S-LCA Handbook

Other than the UNEP Guidelines, the second most known guideline for S-LCA is the PSIA Handbook. This Handbook describes a S-LCA methodology on assessing social impacts related to four stakeholder categories: workers, local communities, small-scale entrepreneurs, and users (Goedkoop et al., 2020). The Handbook is based on the first version of the UNEP/SETAC Guidelines of 2009, together with initiatives at corporate level like GRI, aiming on being a more business-oriented and practical guideline (Pollok et al., 2021).

Within the different stakeholder groups, so called 'social topics' are presented, comparable with the 'impact categories' in the UNEP Guidelines. Different performance indicators are the underlying markers of performance of these social topics, that can further be assessed following an impact assessment method by categorizing these on a minus two to plus two scale. Figure 13 presents this relationship between stakeholder categories, social topics, performance indicators and impact assessment method. The Handbook presents a framework consisting of 7 phases, which are shortly addressed hereafter, and presented in Figure 14.

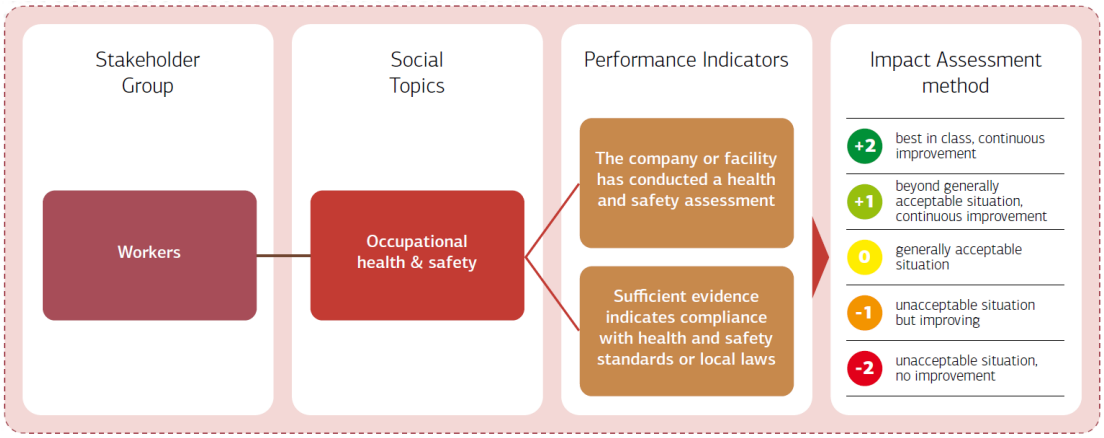


Figure 13. Key elements of the PSIA methodology. From Goedkoop et al. (2020).

The PSIA Handbook presents three steps to take as part of the first 'Preparation phase'. Firstly, the context should be understood and defined to get a grasp of the requirements of the study. Furthermore, a materiality assessment—interpreted as the identification of relevant social topics that should be under focus of the S-LCA— can be conducted to identify the stakeholder groups and social topics that are of most interest to the study. Lastly, a preparation of the data collection process per stakeholder category should be executed (Goedkoop et al., 2020).

The second phase is the Goal and Scope, where several steps can be followed. Here, the goal is defined, by stating the intended application, intended audience, reasons for carrying out the study, and a description of the context where the product or service is used. The scope includes the definition of the product system, the identification of the functional unit and system boundaries, a discussion of allocation procedures when multi-functionality or recycling processes are part of the product system—and social indicators are linearly relatable to FUs—, a consideration of adding steps with potential positive impacts, and when necessary, the materiality assessment is updated on the selection of social topics.

As an optional phase, Circular Economy (CE) analysis can be conducted. This phase includes a definition of different CE strategies, when this is applicable to the product system—when it includes a recycling loop—of the product or service under study.

The next phase is called the 'Hotspot identification'. In this phase, a shortlist of value-chain actors that may have significant negative or positive impacts are identified. Per social topic, a shortlist should be made on supply-chain actors that might have significant impacts. These can flow into identified hotspots for further impact assessment, and when no further assessment is planned on certain aspects, it here provides an overview of risks in the supply chain.

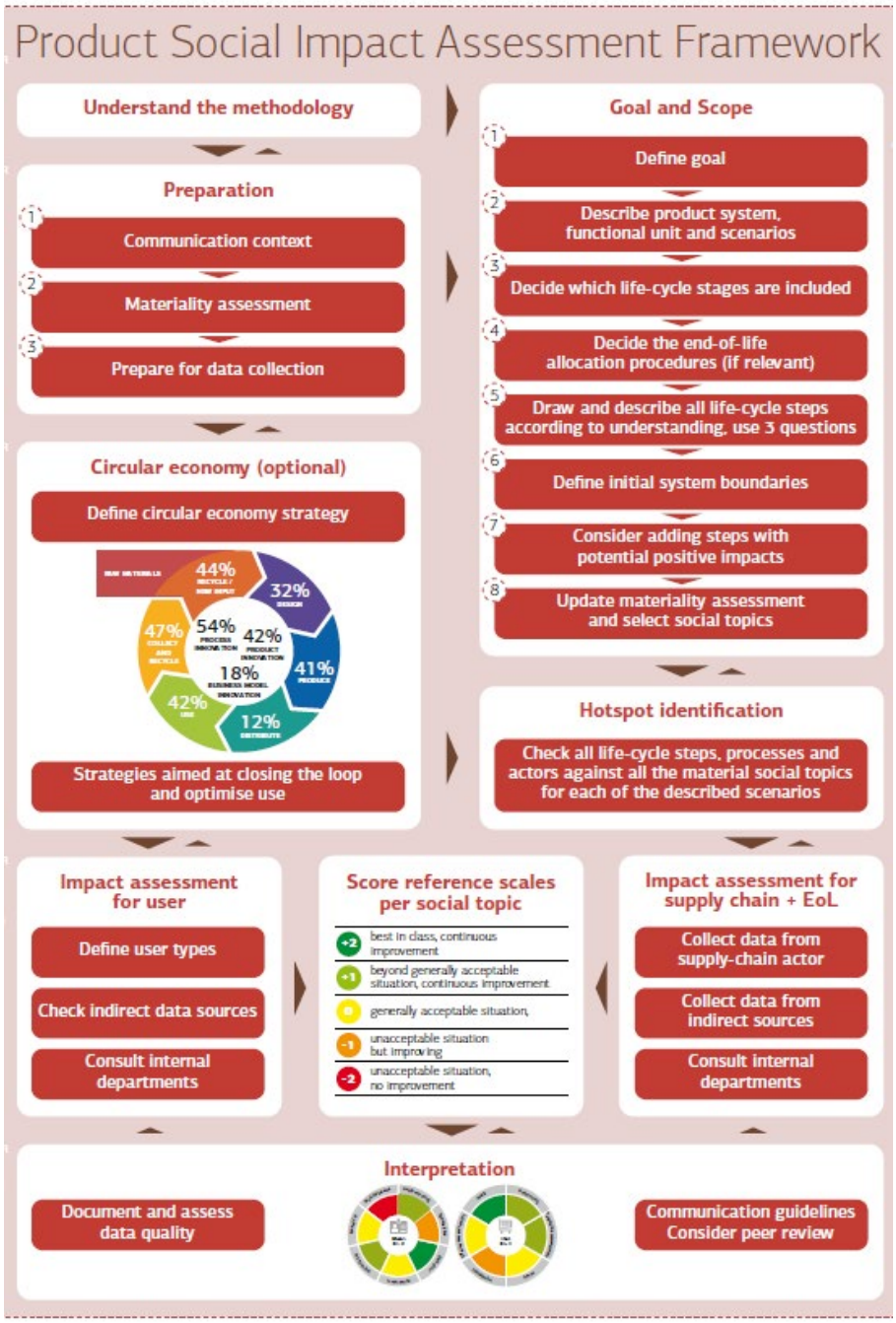


Figure 14. Product Social Impact Assessment (PSIA) Framework, presented in the PSIA Handbook (Goedkoop et al., 2020).

After the hotspot identification, two assessment phases follow: assessing social impacts on stakeholders and assessing social impacts on users. Firstly, the 5th phase on assessing social impacts on stakeholders includes the assessment of social impacts for workers, small-scale entrepreneurs and local communities. This is done by collecting primary data directly from supply-chain actors in the form of questionnaires, or indirectly via other data sources. Via reference scales, similar as RS S-LCIA in the UNEP Guidelines, a scoring is assigned per social topic, from minus two (unacceptable situations with no improvement) to plus two (best in class, continuous improvement). The 6th phase conducts the same assessment but then on users. The PSIA Handbook makes a distinction between the assessment of both groups, as for the first assessment likely will be executed in collaboration with, or by purchasing specialists, whereas for the assessment of the users product development experts likely will be involved.

The 7th and last phase, the Interpretation, interprets the results, together with a data quality assessment, documentation, and clear reporting. If found necessary, Goal and Scope, hotspot identification and Impact Assessment can be refined iteratively.

3.4. Comparison and critical notes between the two current developed frameworks

A few differences between these UNEP Guidelines and PSIA Handbook are identified and presented in Table 4. Regarding the phases involved in the process of S-LCA, the UNEP Guidelines are based on the ISO 14040/44 following the four corresponding phases. The PSIA Handbook follows roughly the same, but three more phases are added to these, as also shown in Table 4 and discussed in the above section 3.3. Firstly, a preparation phase includes the planning for material and data to be used and needs for data collection. Secondly, a phase related for Circular Economy can be included when the case specifically is linked to this aspect. Another added aspect is the separation of the impact assessment in 2 groups: users, and the remaining stakeholders, namely workers, local community and small scale entrepreneurs. Lastly, instead of an inventory phase the PSIA Handbook proposes a specific hotspot identification step (Mesa Alvarez & Ligthart, 2021). Where the UNEP Guidelines cover 6 stakeholder groups; workers, local community, value chain actors, consumers, society, and children (UNEP, 2020), the PSIA guideline does not cover the latter two (Goedkoop et al., 2020), and focuses on small scale entrepreneurs specifically instead of value chain actors.

Impact Assessment in S-LCA is a highly discussed topic (Mesa Alvarez & Ligthart, 2021), as it does not follow a standardized method. Both the UNEP and PSIA guidelines follow different approaches. Following the UNEP Guidelines, there are two impact assessment approaches or characterization models: the Reference Scale Approach (Type I) and the Impact Pathway Approach (Type II). The Reference Scale Approach describes a product system focusing on its social performance or risk, using performance reference points (PRP), based on international standards for minimum levels (Mesa Alvarez & Ligthart, 2021; UNEP, 2020), through which it assesses inventory data. The Impact Pathway Approach predicts the consequences of the product system, using causal relationships between activities in the product system and resulting potential social impacts (UNEP, 2020). These potential impacts are measured by cause-effect relations between indicators and so-called Areas of Protection (AoP), in S-LCA formulated as 'human well-being' (Goedkoop et al., 2020; Pollok et al., 2021; UNEP, 2020). In the case of PSIA, impacts are assessed through a five-point ordinal scale between minus two and plus two with assessment on performance indicators and reference scales, adopting the Type I impact assessment approach.

Table 4. Differences between UNEP and PSIA S-LCA methods. Highlighted in bold significant differences between the two.

Aspect	**UNEP Guidelines** (UNEP, 2020)	**PSIA Handbook** (Goedkoop et al., 2020)
Phases	Goal and Scope Inventory (LCI) Impact Assessment (LCIA) Interpretation	**Preparation phase** Goal and Scope **Circular Economy and social impacts** **Hotspot identification** Assessing social impact **on stakeholders** Assessing social impact **on users** Interpretation
Stakeholders included	Workers (including smallholders) Local Communities Value chain actors Consumers **Society** **Children**	Workers Local Communities **Small scale entrepreneurs** (value chain actors) Users (Consumers)
Impact categories **Bold is highlighted the different ones**	*Workers* Freedom of association and collective bargaining Child labor **Fair salary** **Working hours** Forced labor Equal opportunities/discrimination Health & safety **Social benefits/social security** **Employment relationship** **Sexual harassment** **Smallholders including farmers** *Local communities* Access to material resources Access to immaterial resources **Delocalization and migration** **Cultural heritage** Safe & healthy living conditions **Respect of indigenous rights** Community engagement **Local employment** **Secure living conditions** ***Value chain actors*** Fair competition Promoting social responsibility Supplier relationships Respect or intellectual property rights Wealth distribution *Consumers* Health & safety **Feedback mechanism** **Consumer privacy** **Transparency** **End-of-life responsibility** *Society* **Public commitments to sustainability issues** **Contribution to economic development** **Prevention and mitigation of armed conflicts**	*Workers* Occupational health & safety **Remuneration** Child labor Forced labor Discrimination Freedom of association and collective bargaining **Work-life balance** *Local communities* Health & safety Access to material and immaterial resources Community engagement **Skill development** Contribution to economic development ***Small scale entrepreneurs*** Meeting basic needs Access to services and inputs Women's empowerment Child labor Health & safety Land rights Fair trading relationships *Users* Health & safety **Responsible communication** **Privacy** **Affordability** **Accessibility** **Effectiveness and comfort**

(continued)

	Technology development **Corruption** **Ethical treatment of animals** **Poverty alleviation** *Children* **Education provided in the local community** **Health issues for children as consumers** **Children concerns regarding marketing practices**	
Impact assessment	Type I: Reference Scale S-LCIA, for assessing social performance or social risk Type II: Impact Pathway S-LCIA for assessing social impacts through cause-effect chain characterization	5-point scale method from -2 to +2, for assessing performance indicators

3.5. S-LCA Databases

The two developed S-LCA databases for Reference Scale S-LCIA (RS S-LCIA) are the Social Hotspot Database (SHDB) and the Product Social Impact Life Cycle Assessment (PSILCA) database (Pollok et al., 2021). These databases have been developed for providing transparent and comprehensive global information for the assessment of social risks of products over their life cycle (Maister et al., 2020) and are still in early development (Mesa Alvarez & Ligthart, 2021). Assessments using such a database therefore are conducted with lower resolution data on country/sector level. The SHDB has been applied mostly so far in scientific research, as it has become a useful database for generic S-LCA (Ramos Huarachi et al., 2020). It is developed by New Earth in 2009, and its data is based on the Global Trade Analysis Project (GTAP) Input-Output model (Benoit-Norris et al., 2012; Mancini et al., 2018). The assessment is useful for prioritizing company or site-specific data collection activities, and provide perspective on company/site-specific results (Benoit-Norris et al., 2012). The PSILCA database was developed and is maintained by GreenDelta GmbH, in compliance with the UNEP/SETAC Guidelines, and provides data on social risks on country and sector level (Maister et al., 2020). It provides social indicators for stakeholders and impact subcategories as presented in Figure 7, based on the UNEP Guidelines. For example, stakeholder group workers, subcategory 'Fair salary' can be assessed using the following indicators found in the PSILCA database: Living wage, per month; Minimum wage, per month; and Sector average wage, per month (Mancini et al., 2018).

Both SHDB and PSILCA are based on three aspects: an economic Input-Output model, the worker-hours activity variable and a database on social aspects (Indrane, 2019). A few differences between the databases can be found. The Input-Output models between SHDB and PSILCA differ: SHDB is based on the Global Trade Analysis Project (GTAP), and PSILCA uses the Eora multi-regional input-output model (MRIO) database (Maister et al., 2020). Also, different methodologies are applied for calculating the worker-hours model. Lastly, some differences can be found in methodologies used for assigning risk levels (Indrane, 2019).

3.6. The use of an activity variable in S-LCA

The activity variable (briefly introduced in section 3.2.2) is a useful aspect of S-LCA introduced to reflect the share of a given activity associated with each unit process (Ciroth, 2020). The variable is introduced by Norris (2006) as quantitative value of 'worker-hours' or 'value-added'. The latter concept relates to how much value—or profit—a process creates (UNEP, 2020). Currently, however, 'worker-hours' is the only activity variable properly used in S-LCA and adapted in the PSILCA and SHDB social databases, as better suiting indicators for other stakeholder categories then workers are still being assessed (Maister et al., 2020).

As mentioned in section 3.2.2, the activity variable reflects the time spent by workers to produce a certain amount of output (reference flow) of a specific unit process. Whereas only directly reflecting social flows related to 'workers', in practice this variable is used for calculation of all types of indicators in S-LCA with common LCA software. It can thus be reasoned that no direct link to this variable is found for social flows not related to the stakeholder category 'workers', for example, the country's illiteracy rate. The scaling of this specific illiteracy rate to a certain product system and FU causes issues as it does not have any causality with the specific product system and the function of the product. Although not properly sufficient, no improved approach for this specific activity variable is developed yet (Ciroth, 2020). The discussed important limitation should thus be kept in mind in terms of the interpretability of S-LCA results.

Through the activity variable, a risk-assessed social inventory flow (see section 3.2.2) can be multiplied with the characterization factor of the corresponding risk-level of the risk assessed flow and allow for impact assessment calculations. The activity variable is added as a quantitative value to calculate a risk-assessed indicator over the life cycle of a product system (Ciroth, 2020).The PSILCA database includes a 'Social Impacts Weighting method' as impact assessment method. This method describes the exponential relationship between characterization factors for certain risk levels of indicators (Maister et al., 2020). A step by step calculation of this Impact Assessment phase in the PSILCA database is presented hereafter.

Firstly, in the Inventory Analysis phase the different social flows are risk-classified (see section 3.2.2 and Table 3) per unit process. The inventory results (Table 5) then present the total life cycle inventory of the specific subcategory—in the example 'children in employment, total'—in terms of duration per risk-assessed class. Note that this indicator does have a link with the 'worker-hour' activity variable as it reflects the amount of hours worked by children throughout the product system. Here, 'duration' as the unit reflects the amount of worker-hours spent throughout the total product system under different risk conditions—i.e., a specific unit process in the system can be located under 'low risk' conditions on child labor, whereas a background process can have 'very high risk' conditions on this category. 'Duration' thus refers to the life cycle inventory results, whereas worker-hours is the corresponding unit process related unit.

Table 5. Example of PSILCA inventory results for subcategory 'children in employment, total'.

Impact subcategory	Unit	Amount
Children in employment, total; very high risk	Duration	0.000065
Children in employment, total; high risk	Duration	0.000061
Children in employment, total; medium risk	Duration	0.04
Children in employment, total; low risk	Duration	0.0007
Children in employment, total; very low risk	Duration	0.006

For each indicator, in the Impact Assessment phase the data is then expressed at the medium risk level using characterization factors. Table 6 shows these characterization factors for the impact assessment method corresponding with each risk level. As is shown, also opportunity levels are considered in this method. Currently, only one indicator in PSILCA, 'Contribution of the sector to economic development', assesses an opportunity level instead of a risk level (Maister et al., 2020), thereby being the only indicator taking a 'positive' opportunity perspective over 'negative' risks.

Table 6. Characterization factors for corresponding risk and opportunity levels for the Social Impacts Weighting method in PSILCA.

Risk level	Factor	Opportunity level	Factor
Very low risk	0.01		
Low risk	0.1	Low opportunity	0.1
Medium risk	1	Medium opportunity	1
High risk	10	High opportunity	10
Very high risk	100		
No risk / no opportunity	0	No data	0.1

Through the use of these characterization factors, the Social Impact Weighting method is able to generate results as potential social impacts. This is done through multiplying the characterization factor of the risk-assessed flow belonging to a certain unit process with the total amount of hours worked for producing the output of a certain product system—i.e., FU—(Maister et al., 2020). Results are expressed in relation to the medium risk level with a 'medium (med) risk hour' as the unit. In the above example, the 0.000065 very high risk hours thus reflects a 0.00065 * 100 = 0.065 med risk hour. This value reflects the number of worker hours in the product system, characterized by a certain social risk, whereby higher values correspond to higher risks, i.e., leading to a more negative potential social impact.

In PSILCA, the total impact assessment results are calculated through the following equation applied to each unit process:

$$C_I = w \cdot s \cdot R$$

This equation reflects;

C = contribution of each unit process to the specific indicator;

I = the type of social indicator, e.g., 'children in employment, total';

w = amount of worker-hours spent per unit of output of the specific process;

s = scaling factor for the process, calculated by inverting the technology matrix and multiplying by the demand factor—as in E-LCA.

R = characterization factor to express flow contributions in terms of 'med risk hours' and thus allow aggregation.

Using an activity variable as worker-hours does come with some implications. First and foremost, the already discussed implication of no direct link with worker-hours and indicators related to e.g., society as the illiteracy rate causes incorrect results. Furthermore, by only being able to show indicator results in terms of a risk class, the worker-hour method hides the 'actual' indicator results. Furthermore, the assessment results of 'med risk hours' is a true 'bottleneck in communication' (Ciroth, 2020). Therefore, GreenDelta dove into the development of a method going beyond the 'worker hours' activity variable in 2020, applied to the PSILCA database.

They present a method to directly quantify social indicators in S-LCA (Ciroth, 2020). Through this method, the direct quantification of the social indicators is used for calculations, instead of a risk-classified indicator. 'Children in employment, total' will be used as an example illustrating the difference between the two methods and their indicator value differences.

When conducting the S-LCA based on the worker-hour assessment method for an illustrative unit process X, the social conditions under which this process takes place can be a 'very low risk' for employment of children. This risk-assessed social flow of the unit process is expressed in terms of worker-hours, presenting e.g., 0.1 hour of labor is executed under a 'very low risk' of child labor.

Modelling the same flow but then via the direct quantification method, implies using the 'raw value' of the social flow. This means that the flow is not risk-assessed, but the social condition is expressed through its direct 'raw' value (also see Appendix V for these units): there is a risk of 2% of all children ages 7-14 being employed (corresponding with a 'very low risk', see Table 3). Thus, for the life cycle inventory calculations this social indicator value is expressed as the average % of total children in employment across the product system, instead of different risk-assessed flows and 'duration' values (as shown in Table 5). As the unit of the indicators ('worker-hours' versus '%') differs, it is not possible to combine these method: through the PSILCA database version 3 two separate databases are provided through which the two different assessments can be conducted.

To deal with the aggregation of results across processes in the life cycle, the direct quantification method includes a normalization of the calculation results based on the idea that every process contributes a certain amount of its product (in monetary value) to the overall (life cycle) costs incurred by the product system to deliver the functional unit, thereby also contributing social impacts. The percentage contribution (cost of product required/cost incurred by full product system) is multiplied

by the social indicator, e.g., 10% illiteracy. Adding up the weighted contributions gives an idea of the "average" conditions of illiteracy present in the entire product system when delivering the functional unit. A python script provided by GreenDelta allows for execution of this method in LCA software. Through this script, firstly inventory results are calculated and normalizes these by total amount of products in the life cycle. In the direct quantification method, no characterization step is involved, and the calculation is left at inventory level, not allowing for any contribution analyses. As generally indicator values are assessed as risks, they cannot be termed as 'social impacts' due to not being a causal impact of a certain product consumption.

For the Impact Assessment phase, differences between the two methods arise. Whereas the worker-hours assessment allows for impact assessment through the 'Social Impact Weighting method' in PSILCA, it can conduct the impact assessment and expresses the different impact categories in terms of 'med risk hour'. As the direct quantification method only stays at inventory level, the impact assessment phase should be executed manually, through classifying the inventory results in terms of their risk-class. This can be done by manually assigning risk-classes to the final inventory results (see Table 3), e.g., a 2% 'children in employment, total' corresponds with a 'very low risk' on child labor throughout the product system.

A few issues that arise should be mentioned and kept in mind, as identified by Ciroth (2020) and UNEP (2020):

- For the direct quantification, the normalized inventory results show the social indicator value per social indicator as an average—not allowing for identifying and flagging parts of the supply chain where extreme values occur, which would be a key objective of the S-LCA exercise (Ciroth, 2020);
- Indicator values are linked in an indistinct manner to the output of a certain process (Ciroth, 2020), as a 'life expectancy at birth' value of 75 years does not necessarily link to the output of a process of e.g., transportation and retail of a garment. By working with social databases as PSILCA or SHDB, the data used is on a country and sector level. For interpretation of social indicators and linking these to the output of the product system, a useful way is to use performance reference points (PRPs) to classify each social indicator to a certain risk-level (Ciroth, 2020). This can be done by using the risk assessment characterization factors in the PSILCA documentation (Maister et al., 2020) to weigh the risks (Table 6), as characterization is not applied in the direct calculation;
- It can be hard to collect the company or site-specific data needed to calculate the worker-hour variable (UNEP, 2020). Hypotheses and estimates are necessary, for which the SHDB or PSILCA databases can be used. However, this leads to the value carrying uncertainty;
- Worker-hours does not always provide relevant information regarding the importance of a unit process in a system (UNEP, 2020). As an example, a certain process can contribute to a small share in terms of worker-hours throughout the system, but be very impactful in a specific regard, e.g., displacing local community for the expansion of cotton fields in a certain region.

3.7. How S-LCA has been adopted so far

The two mentioned S-LCA frameworks, the UNEP Guidelines and the PSIA Handbook, differ from each other on methodological aspects, as well as their general adoption in S-LCA studies. Mesa Alvares and Ligthart (2021) analyzed 76 S-LCA case studies conducted between 2009 and 2020. It was found that 76% of these studies followed the UNEP Guidelines and the Type I assessment, 4% PSIA and 19% used other methods or were conducted without a clear methodology (Mesa Alvarez & Ligthart, 2021). This shows the auspiciousness of the UNEP Guidelines as a method, as it is the most developed framework for S-LCA purposes (Kühnen & Hahn, 2017), and by far the most applied S-LCA framework in published literature. It should however be mentioned that as there are still many ongoing barriers in the S-LCA methodology, these are still present under the UNEP Guidelines. However, there seems to be a great reliance on the UNEP Guidelines and the procedures presented in these Guidelines. This leads to S-LCA practitioners 'blindly' following these guidelines, and not challenging key aspects of methodological barriers in S-LCA. Pollok et al. (2021) found this reflected in S-LCA studies that generally only very limitedly include a critical methodological reflection. The Guidelines leave a lot of room for practitioners to define which stakeholders and subcategories to include, where to put the system boundaries, and which impact assessment method to use. Hereby, for the example of RS S-LCIA, the establishing of reference scales is up for the practitioner to choose, leading to a great variety of different approaches in S-LCA studies, and missing relevant explanations of choices taken during the process (Pollok et al., 2021).

3.8. Key findings

This chapter surveyed existing S-LCA frameworks, and it can be identified which would be the most pragmatic to use for this research, answering sub-question two. Two main guidelines on S-LCA are identified and presented; the UNEP Guidelines (UNEP, 2020) and the PSIA Handbook (Goedkoop et al., 2020). From these, the UNEP Guidelines generally are more adapted by S-LCA practitioners. Considering the focus of the PSIA Handbook on small scale entrepreneurs, and the general adoption of the UNEP Guidelines, the latter were found to be fitting for the purpose of this study and the fashion brand with its globalized business practices. Both the PSILCA and SHDB social databases are aligned with these Guidelines (Maister et al., 2020), providing an extra argument for adapting these.

Through S-LCA still being in its infancy, however, the terms social risks, performance, and impacts are used interchangeably in S-LCA studies (Macombe et al., 2011). This is most likely resulting from the Guidelines leaving room for interpretation by the reader and practitioner on what is actually assessed through which methods (as presented in section 3.2). The Guidelines do not present a very clear definition on when exactly potential social impacts are assessed over social risks, and refers to the concepts of social impacts, social risks and social performance inconsistently throughout the document. In practice, this leads to variability in what is studied by S-LCA practitioners, through practitioners' understanding of 'social impacts' (Chhipi-Shrestha et al., 2015; Macombe et al., 2011). Therefore, it is of importance to clearly define the concepts and identify which of these three are exactly addressed in which type of S-LCA and S-LCIA.

- Depending on the method used within, social risks, as well as social performance and potential social impacts are assessed through RS S-LCIA.
- According to the UNEP Guidelines (2020), using a social database with an activity variable, assesses **potential social impacts**. This is because the risk assessed flows from the social risk database are quantitatively related to the product system as the activity variable "*reflects the share of a given activity associated with each unit process*" (UNEP/SETAC, 2009). This RS S-LCIA approach can estimate the likely magnitude and significance of potential social impacts further down the line, without establishing a link between the production activity and longer-term impacts (UNEP, 2020). It links to the notion that social risks are *indications for potential social impacts*, and that S-LCA *mainly assesses potential social impacts* UNEP (2020). Therefore, this kind of S-LCA is generally the most adapted.
- Through the direct quantification method developed by Ciroth (2020), a more direct access to indicator values is provided, overcoming the use of an activity variable. As to not being a causal impact of a certain product consumption, the assessment results can only be seen as **social risks**.
- Company- or site-specific assessments assess a company' or site's **social performance** through RS S-LCIA which is measured at inventory indicator level. Where social risks can be associated with a certain product system, social performance can be associated with the organizations involved in the product system;
- **Potential and actual social impacts** are assessed through IP S-LCIA, where these impacts are assessed at endpoint indicator level and IP S-LCIA allows for characterizing potential and actual social impacts (UNEP, 2020). A difference is found when comparing to E-LCA, where no distinction is made between potential and actual impacts. Here, all impacts are conventionally considered potential, as in this context it relates to the modelling and normalization of results (UNEP, 2020). In S-LCA terms, actual social impacts are referred to as impacts assessed with verified and observed primary data available (UNEP, 2020). This IP S-LCIA approach requires pathways for causal links, which on its turn require quantitative cause-effect modelling with highly unavailable quantitative data. Expressed through being a very underrepresented impact assessment approach in S-LCA studies (Pollok et al., 2021), it can thus be concluded that IP S-LCIA currently is an unfeasible method for the assessment of product social impacts.

The UNEP Guidelines (2020)—though presenting an extensive glossary at the end of the document—are not explicitly clear in terminology used, especially comparing it with terminology generally used in E-LCA, as will be further discussed in chapter 9. Furthermore, within S-LCA, one has to deal with the RS S-LCIA and IP S-LCIA approaches, as well as the possibility to conduct assessments on a generic as well as site- or company-specific level. Within this chapter, it is aimed to explain the different core concepts of what can be under assessment through S-LCA—potential and actual social impacts, social risks, as well as social performance. The great variability of methods and aspects under assessment make the S-LCA method presented through the Guidelines generally a comprehensive, yet therefore not immediately a clear method for social impact, risk, or performance assessment.

The below illustration (Figure 15) aims to clarify the position of social performance, risk, and impact and their linkages through causality—and how the different concepts are understood in this thesis. A certain company or product provides a context for social performance of a company involved in the product system. The level of social performance can cause a certain effect when sectorial social risks occur. For example, through bad policies and therefore bad performance of a certain company with regards to healthy working conditions, the workers are exposed to the sector-level social risk where a high risk of violation of safety standards is identified. This causes the effect of workers' exposure to unhealthy working conditions, leading to potential or actual social impacts in the form of change in health status of the individual.

In line with what is presented in Figure 15, the four concepts are in summary defined as follows:

- Social performance: Practices, principles, and outcomes of a business' relationship with stakeholders in terms of deliberate actions and unintended externalities, measured against a standard of social value (UNEP, 2020).
- Social risk: The level of probability of adverse social effects on stakeholders that occur through a certain intervention or activity, including the consequence of such an intervention. Social risks can be seen as indications for potential social impacts (UNEP, 2020).
- Potential social impact: The likely presence of a social impact, originating from activities and behaviors of organizations linked to the product system UNEP (2020), as well as the presence of a social risk.
- Actual social impact: Changes that affect stakeholders as a result of an activity, based on observed data UNEP (2020).

In this context, an activity is a 'social' or 'human' activity associated with a certain unit process (e.g., the human activity of spinning cotton fibers into cotton yarn).

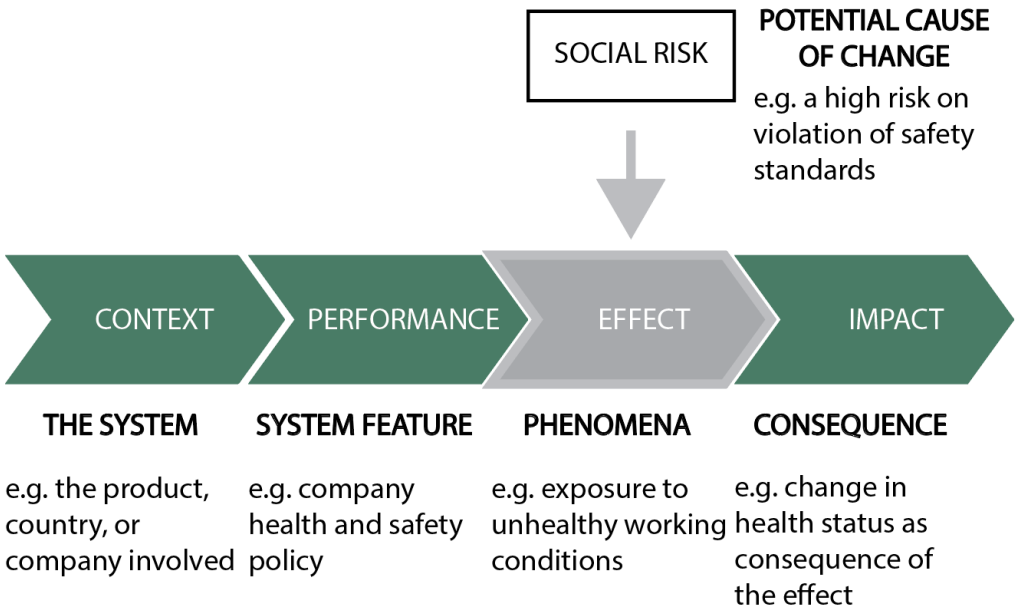


Figure 15. Differences in social performance, social risk, and social impact through causal link display. Own image.

4. The case study – an introduction

4.1. The product range under study

The RMG industry is a branch of the textile industry, focusing on textile-based clothing in the garment industry. In this thesis the textile industry is investigated, with a specific focus on the RMG industry—an industry in literature also referred to as' fashion-' or 'apparel industry', used intertwined with 'textile industry'. The textile product under study is a product range of a global fashion brand of Dutch origin. The product range is commercialized by this brand which is mostly operating in Europe and of which the headquarters are based in Germany. Primary data is acquired and used for the mapping of the product system and data—mostly in the form of policies—is used to assess the social performance of organizations in the supply chain.

The product range (Figure 16) is an apparel range that is Cradle to Cradle® (C2C) Gold Certified in 2021 (C2C-Centre, 2021). These garments are produced in Bangladesh, mainly consisting of cotton sourced from India. It is certified under the C2C® Certification version 3.1. For this certification process, the product range is assessed on environmental aspects of material health and reutilization, renewable energy and carbon management and water stewardship (Cradle to Cradle Products Innovation Institute, 2020). Additionally, it includes a non-elaborate assessment on 'social fairness', only touching upon some material-specific audits on e.g., responsible sourcing (Cradle to Cradle Products Innovation Institute, 2020). The renewed C2C® Certified Product Standard (version 4.0) is in effect since July 2021 and does include a more extensive assessment on social fairness, addressing aspects on the assessment of social risks and opportunities, as well as human rights policies and transparency and stakeholder engagement, to name a few (Cradle to Cradle Products Innovation Institute, 2021).

The product range includes different kinds of apparel, namely T-shirts and trousers, varying from children's to men's size, therefore the assessment will address social issues of an average product from this product range, taking the average weight of the products and averaging all ingredient inputs. This means that no conclusions can be drawn on a specific T-shirt of this product range, as the different products will not be assessed individually, due to the data provided showing all ingredients for the total product range, and not being aggregated per clothing item or size.

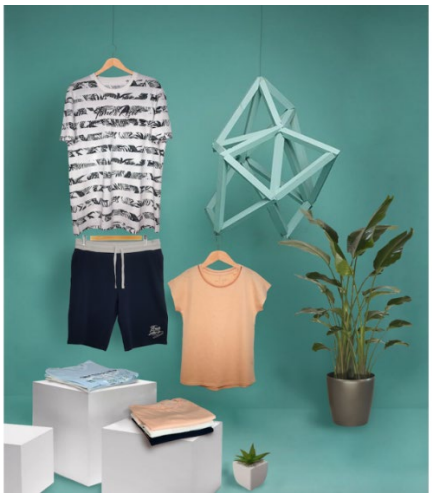


Figure 16. C2C® certified apparel product range under study. Produced in Bangladesh for a European fashion brand. Image from C2C-Centre (2021).

4.2. The product system

To get an understanding of production activities and stakeholders involved in the supply chain, the Bill of Materials (BoM) was provided and used to analyze where each material input is sourced from, and the quantity in which it occurs in the product (see Appendix A). The commissioning party for the social assessment of this product range is the fashion brand itself, whereas data was provided by the C2C® Certifying company Eco Intelligent Growth S.L., if not stated differently. The garment range is produced by the Tier 1 manufacturer in Bangladesh and over 90% of the material input for these garments is cotton, sourced from a Tier 2 supplier in India (Figure 17). As these organizations, together with the fashion brand, are the main organizations involved in the supply chain, these are introduced in the following sections. Due to confidentiality reasons, the three organizations are referred to as 'fashion brand, 'Tier 1 manufacturer' and 'Tier 2 yarn supplier'. Please find a more detailed visual mapping of the product system in Appendix II, which is providing more information on material and energy inflows and outflows to the system, as a basis for the in chapter 7 presented S-LCA.

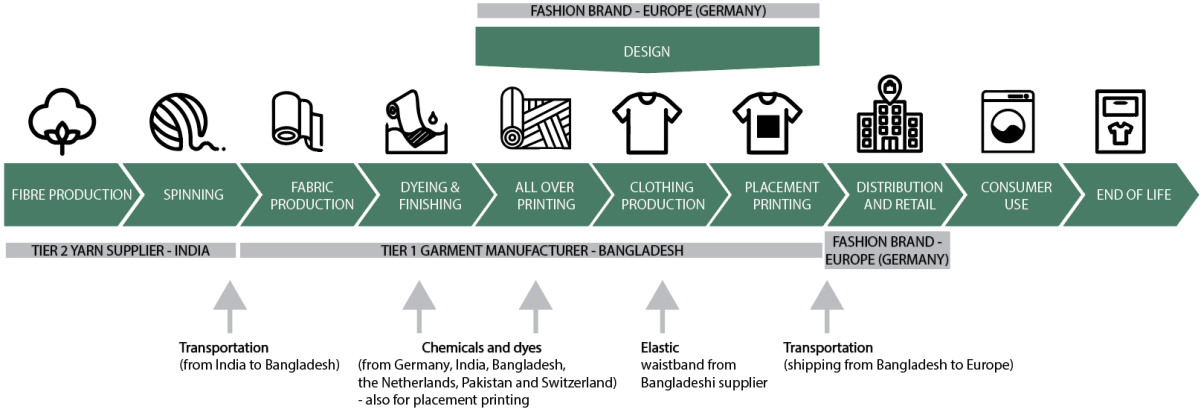


Figure 17. Supply chain mapping on sectors involved and country of origin. Own image. Tier 1 is a direct supplier of the product, whereas Tier 2 suppliers are suppliers for the Tier 1 supplier.

The Tier 1 manufacturer is a vertically integrated company, having different garment production facilities close to each other: four facilities are involved in the production process of the garments. At the main location, after knitting, dyeing, washing and printing, the production from textiles to the garment takes place. Also, this is the facility where the last step on quality review and storage takes place, before shipment to Europe. Next to the organic cotton and viscose yarn from the Tier 2 yarn supplier in India, other material inputs consist of dyes, plus auxiliary, printing, and process chemicals. Most of these chemicals are sourced from suppliers in Germany, and a few in India, Bangladesh, The Netherlands, Pakistan and Switzerland. However, due to the small percentual contribution of these chemicals, the Tier 1 manufacturer in Bangladesh and the Tier 2 yarn supplier in India are prioritized as organizations to be assessed on their social performance—as well as the fashion brand itself. Where the transportation and logistics additionally take a big share in the product system, this is left out of scope due to data unavailability and the scope of this thesis.

The different facilities of the Tier 1 manufacturer are included in different steps of the production process. The first facility of the Tier 1 manufacturer involved in the production of the product range receives the yarn and knits this into fabric. Hereafter, the fabric is dyed and washed. The second facility then prints textures on the fabric. At the main facility, these fabrics are turned into garments, after

which the last facility adds placement printing to some of the garments. Lastly, the product is returned to the main facility where a final check takes place.

The BoM only provides data for a cradle-to-gate scope, and no specific data is available for the downstream processes of shipping, distribution and retail, use, and end-of-life phase of this product range. Therefore, assumptions are made for the mapping of these downstream phases in the generic S-LCA, presented in section 7.1.

4.3. The fashion brand — commissioning company

For reasons of confidentiality, the name of the fashion brand is not named here. Sources used for this information are listed in Appendix III.

The fashion brand of the product range is known as a globally operating fashion brand, having its origin in the Netherlands and being mostly present in the European market. This party is directly involved in the design-phase of the product system, as well as the distribution and retailing phases. Furthermore, as it is the commissioning party of the product, it is indirectly involved and responsible of the social impacts behind the garments' product chain, thus involved throughout all phases in the product system. The brand has a sustainability strategy projected towards 2028, as a guiding framework providing sustainability goals on a global scale. With its sustainability reporting, the fashion brand adheres to Global Reporting Initiative (GRI) Standards, UN Sustainable Development Goals (SDGs), OECD Due Diligence Guidelines, and the UN Global Compact (UNGC) principles. Through this sustainability report, their CSR performance is publicly communicated.

The fashion brand is keen to work towards adopting C2C® Certified standards, aiming on continuing their growth with C2C® certified products. This line of products is designed with disassembly in mind, meaning it is manufactured for recycling, reuse, and remaking. In line with this circular mindset their take-back system is launched, allowing customers to bring in their worn clothes, shoes, and other textiles. This program is set up so that customers that return used apparel receive a 10% discount voucher for their next purchase of the fashion brand. It thus incentivizes the customer to return used fashion items, but also buy new ones in return.

Concerning social sustainability, the brand has developed a social stewardship program with the goal of increasing supply chain transparency, safe and fair working conditions of workers in the supply chain, and ensuring 75% of workers throughout the supply chain are covered by a successful wellbeing program—which currently scores a 10%. This reflects the brand's focus on their supply chain practices, also expressed in the form of many supplier-related policies available on their website.

In their sustainability report, the fashion brand shows that 50.9% of its products are produced in Bangladesh, followed by China and Turkey with a 12.4 and 9.5% respectively. For all its Tier 1 suppliers, the fashion brand applies an own developed rating methodology, rating the suppliers from A to E—A being the best and D or E being rated as a factory that requires immediate improvement for continuing collaboration with the fashion brand. The numbers presented in the sustainability report show that only a 2.4% of factories in Bangladesh are ranked A, compared to a 76.3% of all sourcing factories in

Bangladesh scoring a D/E rating. What is behind this rating is not presented. As the fashion brand has partnerships with around 310 operating factories in Bangladesh (Mapped in Bangladesh, 2022), this corresponds to around 5-10 factories being A-ranked, compared to over 230 factories D/E. Transparently showing these numbers, together with its different programs on worker wellbeing, gender equity and improving purchasing practices show the fashion brands' goals to drive change in the industry. Key priorities highlighted in the sustainability report are (i) female empowerment, (ii) purchasing practices, (iii) elevating worker voices, (iv) easier access to the fashion brands' grievance mechanisms, (v) supporting supplier responsibility, and (vi) adequate wages for supply chain workers. As the fashion brand has great responsibility in this regard, it is the party held responsible for supply chain practices and plays a key role in ensuring these targets.

4.4. Tier 1 Manufacturer

For reasons of confidentiality, the name of the Tier 1 manufacturer is not named here. Sources used for this information are listed in Appendix III.

The garment producing party is located in Dhaka, Bangladesh. This manufacturer is a company involving all-round business processes on apparels, textiles, textile printing, washing, garment accessories, as well as packaging, ceramics, pharmaceuticals, dredging and ICT. Their sustainability view—presented in their sustainability report—is focused around five pillars; people, process, product, community and environment. With these pillars they aim for a holistic approach regarding both environmental as well as social sustainability. The people pillar focuses on responsibility towards employees, whereas the community pillar provides a focus on livelihood of employees surrounding the factories and the development of the local community. An extensive overview of their policies and initiatives with regard to their 'People' pillar is presented in Appendix IV.

4.5. Tier 2 Yarn supplier

For reasons of confidentiality, the name of the Tier 2 yarn supplier is not named here. Sources used for this information are listed in Appendix III.

As mentioned, over 90% of the material input is sourced from an organic cotton yarn supplier in India. This party focuses on 'eco-friendly and environmentally responsible textile' as presented through their website. The company is a cotton yarn manufacturer with two plants in the proximity of Indore, India. Their mission is to provide high quality goods, ensuring minimum impact on both environment and society. Both this Tier 2 supplier as well as the Tier 1 manufacturer are nominated by the fashion brand as suppliers of the C2C® Certified product range. As these two parties are C2C® Gold suppliers they are complying to the C2C® Gold Certified requirements and regulations. Monitoring of this compliance happens through the fashion brand as the responsible party.

No direct policies or reporting of the Tier 2 yarn supplier is available—i.e., there is no information available about these policies and reports in terms of their content as well as existence. Therefore, any policies or statements regarding sustainability and CSR practices cannot be discussed further.

5. Assessment method

The research aims on *evaluating the usefulness and feasibility of S-LCA as a method for social impact assessment throughout a product's life cycle*. This evaluation is done by comparing S-LCA with purely qualitative ways of assessing social impacts of a textile product. Hereby, the social performance of the prioritized companies involved in product range and social risks and potential social impacts associated with the product system are assessed using three different methods, of which one consists of two sub-methods. These methods involve a qualitative assessment, as well as three approaches to S-LCA, as presented in the following sections. Through placing S-LCA next to a purely qualitative assessment, these different methods are compared and the value-added of S-LCA is evaluated. This evaluation is done in terms of usefulness of the insights obtained from the assessments, compared to the feasibility of the different assessment methods in terms of resources required in the form of time, data needs and expertise to conduct these assessments.

The outcomes of the different assessments have answered sub questions 3 and 4. Through the evaluation of methodological barriers of S-LCA after conducting the assessment, the feasibility of S-LCA compared to E-LCA is evaluated, answering the last sub question. Figure 18 shows a representation of these different methods applied in this research—the qualitative assessment and different sub-methods the S-LCA consists of—further presented in the following sections. Hereby, the study takes an exploratory form by exploring the performance of S-LCA as a method for social impact assessment.

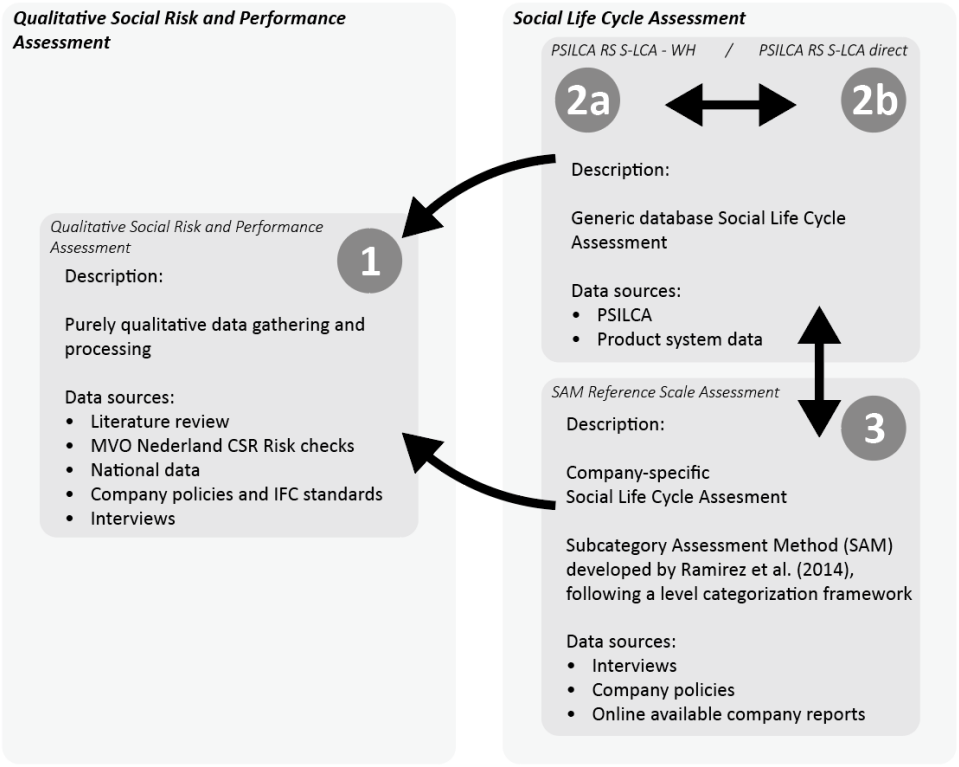


Figure 18. Overview of different methods used to assess the social performance of the product range under study. The arrows represent comparisons that will be made between the different methods, to critically evaluate the S-LCA method.

5.1. Procedure for conducting the Qualitative Social Risk and Performance Assessment

For the qualitative social risk assessment (number 1 in Figure 18) the following three steps are taken, further addressed in chapter 6. Firstly, a short literature review was used as a starting point to get a general understanding about social issues in the Bangladeshi textile and RMG industry. Keywords as 'social issues textile industry' or 'RMG industry' and 'Bangladesh' were used to search for literature in Google Scholar, followed by literature snowballing.

Secondly, a benchmark assessment to identify social risks was conducted following the Roadmap to CSR Risk Management (MVO Nederland, 2020). These risks are identified for the prioritized stakeholders in the product system, namely the Tier 1 manufacturer in Bangladesh and the Tier 2 yarn supplier in India.

Hereafter, the IFC Performance Standard 2 was used as a list of requirements on labor and working conditions within organizations, and regarding their value chain workers. Here, following a checklist method, the fashion brand is assessed on its social performance regarding labor and working conditions for their direct workers and value chain workers. The Tier 1 manufacturers' performance is assessed regarding direct workers, as there are no further supply chain workers involved in the product system. The Tier 2 yarn supplier was not included in this assessment as there are no direct data or policy documents from this party provided. Indirectly, the party is assessed through the supply chain workers requirements of the fashion brand's assessment.

5.2. Procedure for conducting the Social Life Cycle Assessment

Through following the UNEP Guidelines (2020), this S-LCA study is following the four phases of the ISO 14040 series; (i) Goal and Scope; (ii) Inventory; (iii) Impact assessment; and (iv) Interpretation. The study was conducted in three-fold, i.e., using three different impact assessment methods. Firstly, a generic assessment was conducted using the PSILCA social database, to identify social risks and potential social impacts, measured at country/sector level. The methods being introduced in section 3.6, this generic assessment on its turn was also performed in two ways (2a/2b in Figure 18); by (2a) using an activity variable (in this case worker-hours) and (2b) via the direct quantification of social risks presented by Ciroth (2020), as a workaround around the unintuitive activity variable. Having conducted both these assessments allowed for a comparison between the two and the evaluation of the value-added of the direct quantification as compared to the worker-hour assessment. This generic database S-LCA provided a hotspot analysis on the social risks—through the direct quantification method—and potential social impacts specific to the product system of the product range under study, through the worker-hours assessment.

As the product system of the product range under study includes involvement of different organizations, but not necessarily is focused on a specific site, the generic assessment was complemented with a company-specific S-LCA assessment (3 in Figure 18). This is an S-LCA only using 'site-specific' data—as how the concept is presented through the UNEP Guidelines. From here on, this is worded as 'company-specific', to be better fitting to this study. Both the generic as company-specific assessment methodologies were at its basis adapted from the UNEP Guidelines. However, the

Guidelines leave room for interpretation regarding the impact assessment methodology. This is e.g., on the establishing of reference scales. For this, the PSILCA or SHDB can be used, that have their own reference scales available through the database.

Different practitioners have developed their own impact assessment methods that, for example, allow for the assessment of social performance of companies through the development of company-performance reference scales (e.g., Ramirez et al., 2014; Wang et al., 2016). This reflects the fact that the Impact Assessment phase in S-LCA is very fragmented. Many different impact assessment methods are developed, and this 'company-based' assessment is widely accepted, as it can be argued that social impacts rather are related to the behavior of a company over the function delivered by a certain product (Wu et al., 2014). In this regard, the method of Ramirez et al. (2014) has been adapted by various practitioners, (Lenzo et al., 2017). This Subcategory Assessment Method (SAM) methodological framework from Ramirez et al. (2014) was used for the company-specific assessment, complementary to the generic PSILCA assessment. SAM provides an in-depth assessment on a company-specific level, rather than a country and sector level. Through the SAM assessment, firstly the social performance of involved organizations is identified. Hereafter, the product social performance is assessed through multiplying the assessment outcomes of the individual organizations with their share of worker-hours in the product system, thereby also using the activity variable approach for scaling performance to a specific product system. However, as this method scales the performance of organizations proportionally to their involvement in the product supply chain, it does not scale to a certain FU—but rather the product system. This method is further presented in section 5.2.1. For both the generic as company-specific assessment, RS S-LCIA is thus seemed a fitting approach, in line with the goal and scope of the study, and further discussed in section chapters 7 and 8. The Guidelines present the different phases and steps that should be taken for the RS S-LCIA approach, presented in Figure 19.

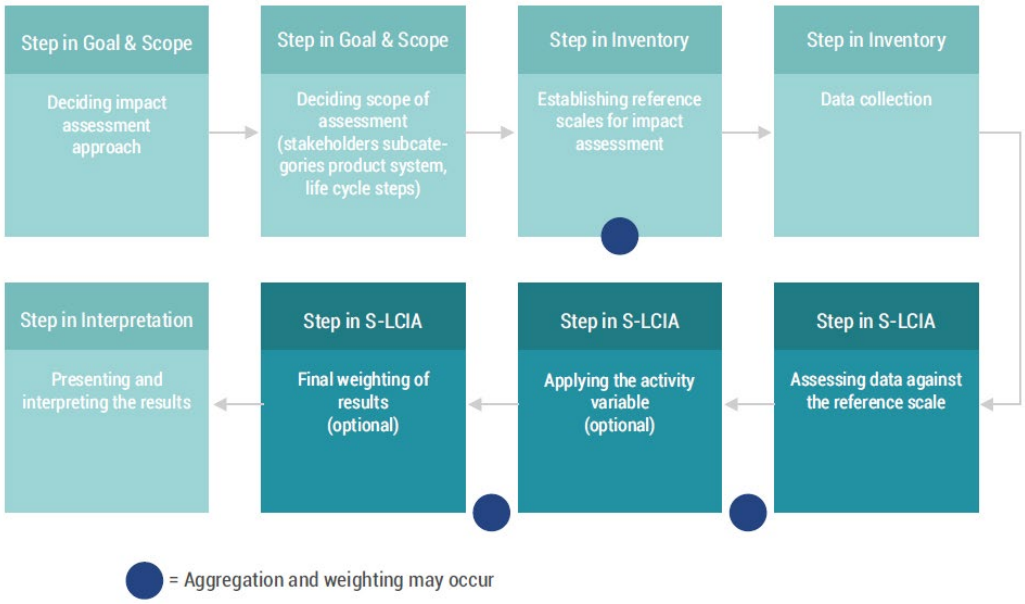


Figure 19. Steps related to the RS S-LCIA approach. From UNEP (2020).

Applying several forms of S-LCA in this study—social risk assessment through the direct quantification method in PSILCA, potential social impact assessment through the PSILCA worker-hour method, and social performance through the SAM S-LCA characterization model—allows for evaluation of different

elements used for these different assessment. For example, the value-added of using an activity variable compared to the direct quantification method can be identified, as well as what conducting a company-specific assessment complements to a generic assessment. A further focus in this evaluation lies on what value the different S-LCA assessments bring as compared to the purely qualitative assessment on answering the main research question.

5.2.1. The PSILCA social database

The PSILCA database (Maister et al., 2020) was used for conducting the generic S-LCA. As the database is based on the Eora MRIO database to cover the global economy, it contains data for 20 stakeholder subcategories (Appendix V), largely in line with the subcategories presented in the UNEP Guidelines, and presented in Figure 7. This database is however based on the 2009 version of the UNEP/SETAC Guidelines (Maister et al., 2020), as it is developed in June 2020. Therefore, some stakeholder groups and subcategories presented in the 2020 UNEP Guidelines are not yet available through PSILCA.

Table 7 aims to present the alignment between PSILCA and the 2020 UNEP Guidelines in terms of subcategories included. Consumers and children are two stakeholder categories not available through PSILCA in general, therefore not included in Table 7.

Table 7. Overview of alignment of subcategories in the UNEP Guidelines and PSILCA database.

Stakeholder categories	**Worker**	**Local community**	**Value chain actors (not including consumers)**	**Society**
Corresponding subcategories	- Freedom of association and collective bargaining - Child labor - Fair salary - Working hours - Forced labor - Equal opportunities/ discrimination - Health and safety - Social benefits/ social security	- Access to material resources - Safe and healthy living conditions - Local employment - Migration - Respect of indigenous rights	- Fair competition - Promoting social responsibility -	- Contribution to economic development
UNEP subcategories not available through PSILCA	- Employment relationship - Sexual harassment - Smallholders including farmers	- Access to immaterial resources - Cultural heritage - Community engagement - Secure living conditions	- Respect of intellectual property rights - Wealth distribution - Supplier relationships	- Public commitments to sustainability issues - Prevention and mitigation of armed conflicts - Technology development - Corruption - Ethical treatment of animals - Poverty alleviation
PSILCA subcategories not presented in UNEP Guidelines		- Environmental footprints - GHG footprints	- Corruption	- Health and safety

To assess these subcategories, PSILCA in total covers 74 qualitative and semi-quantitative social indicators, covering 189 countries and around 15 000 country-specific sectors (Maister et al., 2020). Appendix V provides an overview table of the stakeholder groups and subcategories adapted from in the PSILCA database, with their corresponding indicators and units of measurement. What can be seen is that the database includes a few subcategories that are not presented in the UNEP Guidelines. These are related to environmental footprints and GHG footprint (local community), corruption (which is assessed under 'value chain actors' instead of 'society'), and health and safety (in PSILCA addressed under 'society' instead of 'local community'). The latter two are thus assigned different stakeholder groups but in principle align with the UNEP Guidelines. The subcategories 'environmental footprint' and 'GHG footprint' however are added in the last version of the PSILCA database (version 3). The environmental footprint reflects the 'embodied agricultural-', 'forest- ' and 'water footprint', plus the 'number of threatened species' related to the specific sector. GHG footprint reflects the embodied CO2 and CO2-eq footprint of the sector. Of course these environmental and GHG footprints corresponding to a certain sector have in some way a social impact on the local community. However, these categories better present environmental impacts over social impacts. In the PSILCA documentation (Maister et al., 2020) these newly added indicators are only briefly presented without any further elaboration on why it is considered to include these in a social database.

Data sources for the database are official statistical agencies (e.g., ILOSTAT, WHO, World Bank, and other qualified sources as ICTWSS and World Factbook) (di Noi et al., 2020). These risk classes are defined based on international standards, local laws, international conventions and PSILCA expert opinions (Maister et al., 2020). When there is missing data, a 'low risk' factor is assigned (Maister et al., 2020). As the PSILCA database is based upon the Eora MRIO database, it uses monetary flows to link processes (Maister et al., 2020).

Since recently, a direct quantification method (as introduced in section 3.6) is developed and available through the PSILCA 'raw value' database provided in the 'professional' and 'developer' version of the database. This method allows for an assessment of social risks as a workaround of the activity-variable. However, the same level of resolution in data—namely country and sector level—is used for this assessment and the worker-hour assessment.

5.2.2. Subcategory Assessment Method

As mentioned, the UNEP Guidelines only provide some information on how reference scales and corresponding PRPs can be set up, e.g., by norms, practices, or a socio-economic context (UNEP, 2020). Some suggestions are proposed by UNEP (2020), but some criticism is outed as not all subcategories are included, or the methods are not objective in the assessment (Ramirez et al., 2014). Therefore, Ramirez et al. (2014) developed the Subcategory Assessment Method (SAM) as a characterization model to evaluate subcategories in the Social Life Cycle Impact Assessment (S-LCIA) phase. This method takes an organizational approach and assesses the social performance of a certain product, by scaling the social performance of different organizations involved to their contribution in the product system in terms of worker-hours.

SAM is developed as a method evaluating the social performance of organizations that are responsible for processes in the product system consistently including all subcategories. Hereby, it presents levels per subcategory aligned with the 2009 version of the UNEP/SETAC Guidelines (UNEP/SETAC, 2009), and the method thus is corresponding with the first version of the Methodological Sheets. To assess the social performance of an organization, per subcategory the method assigns an A to D score (Figure 20)—A being the best score, D the worst. This RS S-LCIA approach thus assigns reference scales to each level using PRPs. The most decisive PRP however is presented by Ramirez et al. (2014) as a Basic Requirement (BR) providing the baseline of an organization's performance. When an organization complies to the BR, they get assigned a level B. These BR reference points are mostly defined based on International Labour Organization (ILO) conventions (Ramirez et al., 2014). Showing proactive behavior on top of complying to the BR—by promoting BR practices along the company's value chain—leads to an A scoring. Level C and D are assigned when the organization does not comply to the BR, and are differentiated through requirements in the subcategory context. This scoring method will be thoroughly addressed in section 8.3. The scoring model introduced by Ramirez et al. (2014) goes hand-in-hand with the data collection process in the form of a questionnaire, which later on is presented in the supplementary material of Petti et al. (2016).

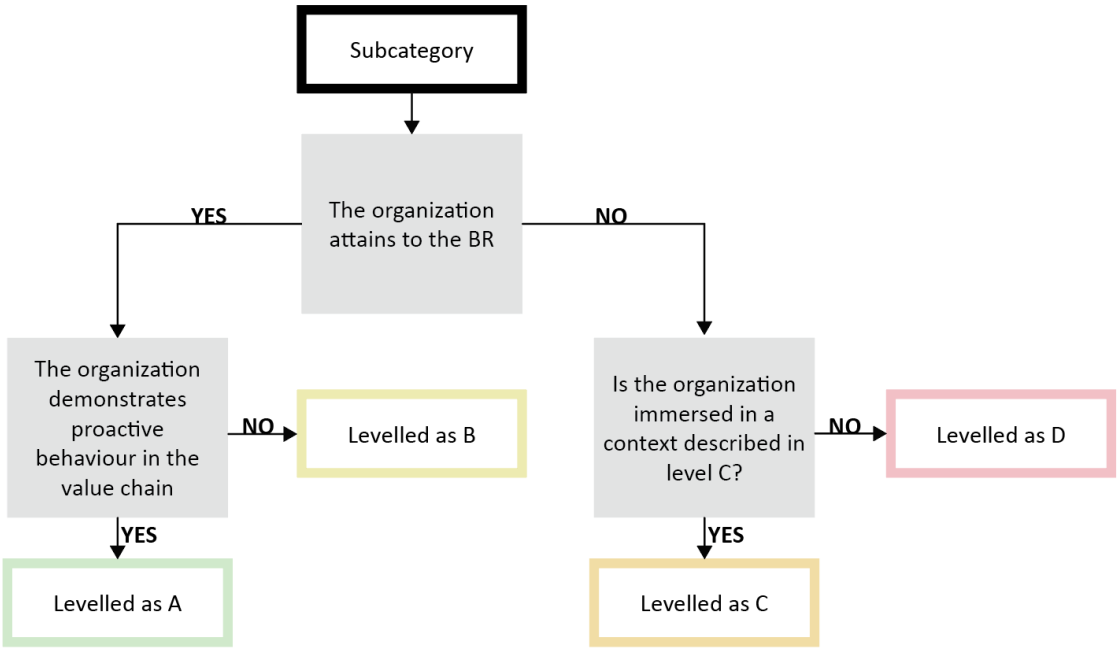


Figure 20. SAM evaluation steps. Adapted from Ramirez et al. (2014).

A difference between level C and D, as shown in Figure 20, is the context in which the organization is immersed. To give a few examples, this 'context' is referred to as e.g., if the country in which the organization is located has a high or low workers' rights score (see (International Trade Union Confederation, 2022)), or if the weekly working hours of workers in the organization are higher than the average in the specific country. Per subcategory this 'context' thus refers to a subcategory-specific context, and further specification can be found in Appendix F.

Through the scoring method, SAM is able to transform qualitative data to a semi-quantitative framework. Hence, it can analyze social performance and behavior of an organization involved in a

certain product system, thus being able to assess organization's performance along the life cycle of a certain product. It can highlight best and worst processes and related organizations in this regard—on the level of the stakeholder subcategory. After this step, the performance of organizations can be aggregated per stakeholder category, and present the social performance of a certain product over its life cycle.

The SAM is further developed by Petti et al. (2016) through adding the step on scaling the percentage of hours worked in each different organization in the supply chain. This way, the different company-specific outcomes can be aggregated per stakeholder category and subcategory, to assess each subcategory in terms of social performance of companies involved in the product system, therefore scaling the performance of each company to its contribution in terms of hours worked to produce a certain output. This means that this step allows for a scaling to percentual contribution, but not directly to a certain FU. Since dealing with performance data, the product performance is not expressed in relation to the FU, but to the general product system and therefore also for one single product.

SAM is based on the 2009 UNEP/SETAC Guidelines and corresponding first version of the Methodological Sheets. Therefore, it was needed to address the assessment of consistency with the Methodological Sheets of 2021 (UNEP, 2021). The BRs formulated by Ramirez et al. (2014) were analyzed for any inconsistencies with the definition of the subcategory, the aim of the assessment, as well as the indicator examples given in the Methodological Sheets. This analysis showed that only the subcategories 'Freedom of Association and Collective Bargaining' and 'Equal opportunities/ discrimination' showed minor misalignments. With regard to Freedom of Association and Collective Bargaining, the Methodological Sheets mention that the assessment aims on identifying whether workers can form associations themselves, can organize unions, engage in collective bargaining and have the right to strike. The BR of Ramirez et al. (2014) only addresses whether there are employees member of a union. This however does not yet cover if the employees actually have the right to strike or not. Regarding 'Equal opportunities/ discrimination', there is another shortcoming in the defining of classifying the organization as C or D. The BR does include discrimination based on gender inequality, race, color, religion, political opinion, national extraction, or social origin. For the classification of an organization as C or D, however, the Global Gender Gap Index 2022 score is taken, meaning this only addresses gender inequality.

In the case of 'Fair salary', the BR is changed to including that the lowest salary is equal to or higher than the minimum wage in the sector and country, and that this is also a wage that can be considered a living wage. The latter aspect was not covered by the BR, but the importance of salary covering a living wage is an important aspect to include in the requirement.

Further subcategories show alignment between the Methodological Sheets and the BR and scoring framework of Ramirez et al. (2014). Therefore, the discussed small inconsistencies have been adjusted to show alignment according to discussed above (see Appendix F) and were qualitatively evaluated in the Interpretation phase.

5.3. Primary data gathering

The C2C® Gold certification process of the specific product range has been established with the help from a consultant company, Eco Intelligent Growth. This third party has been able to provide the primary data of the product range; the Bill of Materials (BoM), social documents of the Bangladesh manufacturer (policies, living wage calculations, Code of Conduct), and contact details of the two main parties involved in the value chain: the fashion brand in Europe and the garment manufacturer in Bangladesh. Where no contact was established with the cotton supplier in India, this party is included in the assessment as it is an important Tier in the supply chain.

Hereby, primary data was gathered and used in threefold;

- **Qualitative social risk and performance assessment**: Company policies are provided through Eco Intelligent Growth for the Tier 1 manufacturer, as well as through publicly available reporting of the fashion brand. Additional information from the questionnaires for the company-specific SAM (see Appendix B) is used when considered relevant. This data mostly consists of worker-related policies on labor and working conditions. Therefore, the local community stakeholder category is not covered to the extent of being able to include an assessment on compliance to IFC Standard 4 (IFC, 2012);
- **Generic S-LCA assessment**: The provided BoM includes the data needed for the modelling of the product system in OpenLCA and linking this to sector-level processes in PSILCA. OpenLCA is used as LCA software, for practical reasons of license availability and the PSILCA database only being available through OpenLCA and SimaPro. For the worker-hour assessment, additional information on the number of hours worked to produce the output corresponding with the reference flow of the unit process is required. As there is no direct contact with the Tier 2 yarn supplier or any upstream (chemical) suppliers, the worker-hour values were taken directly from the PSILCA database. With regard to the Tier 1 manufacturer, insufficient information is provided for deriving a worker-hour value. Therefore, also for this unit process the generic PSILCA value is taken;
- **Company-specific SAM**: Company policies are used for sourcing information needed to answer the questions corresponding to the method. Further questionnaires were set up and primary data is gathered from the Tier 1 manufacturer, as well as from an independent external auditor party on social compliance auditor in Bangladesh—providing a 3rd party perspective to the Tier 1 organization. As a result of time constraints and no contact details, the Tier 2 yarn supplier is not directly contacted. Information on the performance of this company is acquired through the fashion brand. The questions were set up based on the questionnaire presented in the supplementary material of Petti et al. (2016). These questions are developed as questionnaires for the data collection of S-LCA for all stakeholders and related subcategories (Petti et al., 2016), along a product's life cycle, and based on the methodological sheets of 2013 (UNEP/SETAC, 2013). In this study, questions are adjusted to the product and organizations involved, limited to the prioritized subcategories (as will be presented later in section 8.1.3), and additional questions adapted from Grönkvist (2019). These questionnaires, adapted in this thesis, can be found in Appendix B. Where needed the questionnaire is complemented with

some additional questions on relevant background context information. Complementary interviews are conducted as a follow-up on the answers in the questionnaire. Many upstream suppliers (Tier 3) are also involved in the product system—such as the chemical providing companies—but as priority is given on the fashion brand, Tier 1 manufacturer and Tier 2 yarn supplier, an analysis of the social performance of these Tier 3 companies is left out of scope for the company-specific SAM. As the generic assessment consists of a model of the product system linked to certain social database sectors, these social risks following from the chemical sectors of the respective countries are included in this assessment.

Data needs for the different assessments can be summarized as follows:

Data needs for the qualitative assessment:

- Data on the involved companies in terms of their performance characteristics, in line with the requirements listed in IFC Standard 2

Data needs for the generic S-LCA assessment:

- Data on physical material and energy flows (flowchart);
- Data on the social flows from PSILCA;
- Data for the calculation of the worker-hours activity variable.

Data needs for the company-specific S-LCA assessment:

- Data on physical material and energy flows (flowchart) and suppliers involved;
- Company performance data on assigning certain reference scales through SAM;
- Data for the calculation of the worker-hours activity variable.

Questionnaires were thus sent to the Tier 1 manufacturer, a the independent external auditor on compliance of companies in Bangladesh to CoC of buyers (in this case the fashion brand), as well as the fashion brand. The fashion brand received two questionnaires: a questionnaire regarding the performance of the company itself, as well as their requirements and monitoring of tier suppliers, and a questionnaire specified to the Tier 2 yarn supplier involved in the product system. In the form of a structured questionnaire, the interviews were conducted as semi-structured follow-ups on the questionnaires. The interviews took place online, for about 20-30 minutes each, and were recorded—which is only used through confidential means by analyzing the interviews afterwards. Each party has been participating to its extent, whereas only the fashion brand has not filled in the questionnaire on the internal performance of the organization. Reasons for this were mentioned to be time constraints of the responsible person with regard to each social topic. Instead, the company referred to their online available reports, which have been used as a data source instead. The questionnaires as presented above including company-responses can be found in Appendix B.

As a next step, the acquired data is analyzed through the different S-LCA assessment methods presented. These assessment results should be evaluated on reliability, validity, and objectivity, for reaching useful conclusions. Therefore, the data is analyzed through the data pedigree matrix presented earlier in Figure 12.

5.4. Critical notes and limitations

Following the presented methods, a few critical notes should be highlighted. First of all, in line with the step of identifying data to be prioritized for collection during the Inventory Analysis phase in S-LCA (UNEP, 2020), a choice has been made on focusing on certain stakeholders and subcategories for the SAM—as will be presented in section 8.1.3. As this is a necessary approach to take in terms of feasibility, it does exclude subcategories that are of less relevance, but including these might lead to insightful findings. Whereas the PSILCA database does include social flows over 20 subcategories under 4 stakeholder categories, more subcategories are covered in this assessment. The difference in subcategories assessed between the generic PSILCA and company-specific SAM does allow for an evaluation whether the outcomes of the generic assessment show different hotspots as compared to the prioritized subcategories for the SAM.

Next to the focus on certain subcategories for the SAM, as mentioned also not all companies involved in the product system can be assessed. Therefore, it is chosen to focus on the fashion brand, Tier 1 manufacturer and Tier 2 yarn supplier—excluding Tier 3 suppliers and companies involved in the transportation phases.

Furthermore, the questionnaires and interviews are only addressed from the point of view of the management, both from the fashion brand as the Tier 1 manufacturer their perspectives. This means that there have not been any direct responses from workers themselves, leaving out their perspective. Only in the case of the Tier 1 manufacturer the independent external auditor party has been providing this 3rd party perspective to the assessment.

Lastly, it is noticed that there is a language barrier of English proficiency, leading to the Tier 1 manufacturer providing inconsistent information during the interview, the answering of the questionnaire and further email correspondence. This issue is further addressed in chapter 8.

Regarding the qualitative social risk and performance assessment, a reasonable choice has been made to focus on the Roadmap to CSR Management and the IFC Standards, over assessing directly through the GRI and OECD frameworks or the ILO Conventions. These three are indirectly included through the Roadmap, as well as the ILO Conventions that provide the basis of the SAM assessment. Directly assessing a company through these named frameworks, however, could potentially provide relevant insights. Even more initiatives exist in this regard, providing tools and frameworks to qualitatively assess a company, sector, or specific site (e.g., the Fairtrade Textile Programme and Textile Standard (Fairtrade International, 2016), or the tool for integrating children's rights by UNICEF (2020).

Through the Roadmap to CSR Risk Management, only the Tier 1 manufacturer and the Tier 2 yarn supplier are assessed, due to practical reasons as time constraints. However, also including e.g., the assessment of the chemical and transportation sector would allow for a more holistic life-cycle perspective.

6. Qualitative Social Risk and Performance Assessment

This chapter presents the qualitative assessment of social risks throughout the product system of the product range introduced in section 4.1, and the social performance of the prioritized involved companies. Section 6.2 provides the assessment following the Roadmap to CSR Risk Management (MVO Nederland, 2020) on assessing the social risks on sector level, after which section 6.3 assesses the social performance of the three companies—namely the fashion brand, Tier 1 manufacturer and the Tier 2 yarn supplier—through a checklist assessment of alignment with IFC Performance Standard 2.

6.1. Social risks in the Bangladeshi RMG and Indian cotton industry

The textile industry is of relevance to social sustainability, as its complex supply chain principle is affecting many stakeholders with severe negative social impacts (Köksal et al., 2017; Luján-Ornelas et al., 2020). Different life cycle stages of textile products all come with their social issues. Firstly, concerning the production of fibers, the cotton cultivation industry is on the top of the 2022 list of goods produced by child labor (ILAB, 2022). Furthermore, for the production of textile around 15 000 chemicals are used, potentially harmful for workers, the local environment and end consumers (Luján-Ornelas et al., 2020). Also, issues on labor conditions, wages, workers' rights and equal opportunities arise throughout the textile and clothing supply chain (Lenzo et al., 2017; Luján-Ornelas et al., 2020).

The process of manufacturing the garment product range under study—from knitting of yarn to shipping—all takes place in Bangladesh under the Tier 1 manufacturer's responsibility. Specifically in Bangladesh these issues are also identified. These include e.g., the declining of workers' wages in the last decade—causing many textile workers for global production to earn less than a living wage—, and poor regulation of overtime (factories in Bangladesh have an average overtime of 28 hours per week, exceeding the legal maximum of 12 hours per week) (Asif, 2017). Also, the Bangladeshi RMG industry is an industry where child labor, repression against trade unions, gender discrimination, and sexual harassment are frequently occurring (Herrera Almanza & Corona, 2020). Also, due to the extensive—and not always safe—use of chemicals and machinery in the production of textile products, the health and safety of garment workers is put at risk (Asif, 2017; Luján-Ornelas et al., 2020). Lastly, as the Tier 2 yarn production—including the cotton cultivation—takes place in India, this industry is amongst the top of prevailing global industries with regard to child- and forced labor (ILAB, 2022).

6.2. The Roadmap to CSR Risk Management

As a first step of the Roadmap to CSR Risk Management (MVO Nederland, 2020) existing CSR policies should be gathered. This is to get an idea about the organizations and their CSR mission, vision, and targets, and how these are translated into activities. This step of the framework has—to the extent information was available—been addressed in section 4.3, 4.4, and 4.5. This shows that the fashion brand has a great focus on supply chain activities, while it can be seen as the responsible stakeholder in this regard. Appendix IV—as introduced in section 4.4—presents an overview of all social initiatives and policies presented in the Sustainability report of the Tier 1 manufacturer. No direct information or

documentation was available for the Tier 2 yarn supplier. This is due to this party not having any public information available online, as well as the consulting company Eco Intelligent Growth not having direct contact with this party and therefore not having provided with any documentation.

Secondly, the mapping of the supply chain should take place. This was done using the provided BoM, including information of all upstream suppliers. Figure 17 (see section 4.1) shows a simplified mapping of the supply chain, showing all organizations and products involved including sourcing country. As the CSR Risk Check tool provides a risk analysis on country and sector level (MVO Nederland, n.d.), the information in the figure is suitable for the assessment purposes, as it maps the supply chain in terms of products purchased, produced, and exported. As visualized in Figure 17, the BoM provides information on material ingredients and their supplier details, thus providing information on the producing country. How and by which parties the transportation takes place is however not provided.

The third step of the Roadmap presents the identification of CSR risks for each sector and corresponding producing country. For this step, MVO Nederland has developed a Corporate Social Responsibility (CSR) Risk Check Tool, commissioned by the Dutch Ministry of Foreign Affairs. It uses the latest external sources on CSR risks, and both the risks and advices are formulated in line with the OECD Guidelines and UN Guiding Principles on Business and Human Rights (MVO Nederland, 2022a). The tool develops reports of different sectors in different countries, summarizing all CSR risks on both environmental and social aspects. With regard to the specific product system, the following products and sectors are identified to be of relevance:

- Tier 2 yarn production: 'Cotton textile fibers' in India and 'Textile yarn and fabrics' in India;
- Tier 1 garment manufacturing: 'Clothes of knitted or crocheted textile fabric (except swimwear or coated apparel)' in Bangladesh;
- Transport to Europe: 'Transport & logistics', in Bangladesh, India, The Netherlands and Germany—because the shipping is assumed to go via Calcutta (India) to Rotterdam (The Netherlands), to retail stores in Europe. Most retail stores of the fashion brand are located in Germany (Appendix VI), for which the last transportation step to Germany is assumed;
- 'Other organic chemicals' from the chemical producing countries.

The CSR Risk Tool is used for assessing the prioritized processes on cotton cultivation and yarn spinning in India, as well as the garment manufacturing in Bangladesh. This is because there is no primary data available on the transportation system, and the 'Transport & logistics' and 'Other organic chemicals' sectors contain a highly aggregated presentation of risks. Results are presented hereafter.

6.2.1. Results — Sector-level identified CSR Risks

The below tables present the CSR Risks generated through the CSR Risk Tool of the sectors related to the garment industry of Bangladesh and cotton cultivation and yarn industry of India. The CSR Risk Reports on 'Clothes of knitted or crocheted textile fabric (except swimwear or coated apparel)' of Bangladesh (Table 8) presents social risks with a focus on the Tier 1 garment workers. These identified risks thus apply to the corresponding stakeholder category of 'Workers' in S-LCA. A similar focus on workers is found in the CSR Risk report for the Tier 2 reports of 'Cotton textile fibers' and 'Textile yarn and fabrics' in India, of which the identified social risks are presented in Table 9 and Table 10.

Table 8. Social risks in the 'Clothes of knitted or crotched textile fabric' sector in Bangladesh. Adapted from the CSR Risk Check by MVO Nederland (2022a).

Category	Module	Specified risk
Fair business practices	Market distortion & competition	- Global textile brands are continuously asking for low purchase prices and short manufacturing times. This is coupled with the risk of **poor forecasting, poor payment terms and unfair penalties**.
Human rights & ethics	Consumer interests & product safety	- Personal data is not always used in a secure way.
Labor rights	Freedom of association	- The right to freedom of association is **frequently violated** in the textile industry. - Workers might be **dissuaded from participating in strikes**, or **unfairly punished** for doing so; - Over 11600 workers lost their jobs after protests by garment workers in December 2018/January 2019, demanding an increase in minimum wage. Many were still prosecuted, and workers were pressured to plead guilty to the damage the factories suffered from, promising not demanding higher wages anymore; - **Belonging to a trade union can get a worker fired**, intended to destroy trade unions in the sector; - Rights to freedom of peaceful assembly and association are **restricted**; - The country is in the top 10 most dangerous countries worldwide for workers, where workers have **no guarantee for workers' rights**; - There is **high violation against human rights defenders**.
	Labor conditions	- Workers are forced to work **long hours under bad conditions**. Mid-level managers mistreating workers is common. Workers often have no contract and are not guaranteed to keep their job; - **Workers do not know their rights** and thus cannot claim any compensation for abuse of rights; - Many garment workers are employed in local factories supplying foreign brands through larger factories or agents. This **indirect sourcing** leads to little oversight and a **high vulnerability of workers** to safety or labor right issues; - Due to demands of foreign brands for short lead times, last-minute changes, poor production planning, late arrival of inputs, political unrest or lack of capacity, **factories may undertake hidden subcontracting**. This leads to difficulties in controlling working circumstances; - The impact of COVID-19 on garment workers is significant. Garment workers are **more vulnerable to forced labor and exploitation** and make longer hours. Salaries are lower and some facilities not available anymore; - A third of garment workers in Bangladesh **works over 60 hours a week**.
	Child labor	- **Child labor most likely occurs** in garment and textile production in Bangladesh; - Bangladesh scores **poorly** regarding regulation of child labor and decent work for young workers; - Generally, child labor is still existing in Bangladesh, even **in worst forms like forced labor** in brick and dried fish production.
	Discrimination & gender	- Women work in 90% of the garment industry and may be at risk of **discrimination at work.** Men occupy technical and managerial positions, while **women work low-skilled and low-paid**; - Women are experiencing **sexual intimidation, violence, and discrimination**; - Gender-based violence and harassment has increased during the COVID-19 pandemic. Economic harm affected women greatly.
	Wage & renumeration	- The garment industry is known for **excessive overtime, poor conditions and low wages**. In many cases legal minimum wages are not paid, leading to people living below national poverty levels; - Workers do not earn enough for proper meals. Additionally, **one out of three workers is separated from their children**, with 80% of these cases due to a lack of enough income; - COVID-19 has shown garment workers' wages to go down. Garment workers that were union members were fired, decreasing worker's ability to fight for better payment.
	Health & safety at work	- **Working conditions are unsafe**, and many workers cannot afford any medical treatment related to sickness or injury at work; - The 2018 'Accord on Fire and Building Safety', designed to make garment factories safe workplaces, was signed by 183 international brands. Only a few brands supported factory repairs, as it is the brand's responsibility to facilitate funding for building improvement. Therefore, this remains a problem in many factories; - Women in the garment factories have problems with urinary tract infections, caused by **not being allowed to go to the toilet** during working hours; - There are **no sufficient penalties for violations on safety & rights compliance**.

Table 9. Social risks related to 'Cotton textile fibers' production in India. Adapted from the CSR Risk Check by MVO Nederland (2022b).

Category	Module	Specified risk
Fair business practices	Market distortion & competition	The cotton growing region in India has the nickname '**suicide belt**'. Here, farmers are in great debt, as they have to buy expensive seeds and fertilizers and pesticides. However, the price farmers obtain from harvesting is very disappointing. The **farmers are in such debt**, even after borrowing money from family and being ashamed of their debt-status—leading to **high suicide rates**.
	Community impact	**Pollution caused by dyeing** puts over a million people at risk, as they get exposed to pollution in terms of contaminated water, containing pollutants like chromium, cadmium and lead. These lead to cardiovascular **diseases for adults and developmental and neurological damage for children**.
	Consumer interest and product safety	In India, **pesticides classified as "very hazardous" to human health** are used for the production of cotton, soy and maize.
Labor rights	Freedom of association	India scores a **five on a 1-5 scale** (5 being the **worst countries worldwide to work in**) for freedom of association and workers' rights in 2022 still. Human rights defenders are affected by violations.
	Labor conditions	- **Workers are oppressed**, applied by humiliating disciplinary measures. Apparel factories put high pressure on their workers; - Generally in India workers' social security measures are **barely implemented** in informal sectors.
	Forced labor & human trafficking	- In Southern India the "Sumangali System" is common, where girls get a contract for 3 years with low wages and most of the money they only receive after finishing the three years. Conditions are harsh and unhealthy, and girls **live in hostels with barely any contact outside of work**.
	Child labor	- The **worst forms of child labor likely occur**. For the spinning of cotton thread and yarn, and in the production of products like carpets, footwear, and bags, children are exploited; - Especially **children between 8 and 17 years old** are **likely working** in the production of garments in India; - The Fair Wear foundation reports that 14 million children are working in India, making India likely the **country with highest number of working children worldwide**; - In the production of thread and yarn children are performing very **dangerous tasks.**
	Discrimination & gender	- Female workers in the cotton industry in India face **sexual harassment and rape**, as strong indicators show; - Risks are specified for garment factories, where **violence against women at the workplace** occurs frequently, gender wage inequality is a prevalent issue, and female hygiene facilities are lacking; - There is a **40-50% pay gap between men and women**.
	Wage & renumeration	- Reasons are there to believe that concerning minimum wages in the cottonseed industry, legal **norms are not followed**; - Generally, the garment industry in Southeast Asia is a **low wage, excessive overtime and poor working conditions** industry.
	Health & safety at work	- Over 20 cotton farmers died in 2017, in the central Indian district of Yavatmal, due to poisoning of pesticides used on their own land. Several 100 farmers from the 800 farmers that had acute poisoning after spraying these pesticides, went temporarily blind; - **Working conditions of small farmers do not meet safety standards**. Agriculture is a risky sector regarding health and safety, and is classified one of the three most dangerous regarding (non-) fatal accidents, and occupational diseases. There is a high risk of infection by parasite diseases, and coming from the exposure to chemicals.

Table 10. CSR Risks related to 'Textile yarn' production in India. Adapted from the CSR Risk Check by MVO Nederland (2022c).

Category	Module	Specified risk
Fair business practices	Market distortion & competition	Global textile brands are continuously asking for low purchase prices and short manufacturing times. This is coupled with the risk of **poor forecasting, poor payment terms and unfair penalties**.
Labor rights	Freedom of association	- The process of forming and registering of trade unions in the clothing- and textile industry in India faces several restrictions and obstacles, as prejudice against trade-unions is prevalent widely. Furthermore, **threats and violence against union members, striking workers and labor activities is common practice**; - Generally, India scores a **five on a 1-5 scale** (5 being the amongst the worst countries worldwide to work in) for freedom of association and workers' rights in 2022 still. Human rights defenders are affected by violations.
	Labor conditions	- In the South of India, the **working conditions in the spinning industry are hard. 60+ hours working weeks and no possibility to refuse overtime and obliged night shifts are ordinary**. Workers are oppressed, applied by **humiliating disciplinary measures**. Apparel factories pressure their workers. The same conditions apply to **homeworkers that are 'invisibly' employed** in the clothing and textile industry; - Generally, in India, there are barely any social security measures implemented for workers in informal sectors.
	Forced labor & human trafficking	In Southern India the "Sumangali System" is common, where girls get a contract for 3 years with low wages and most of the money they only receive after finishing the three years. Conditions are harsh and unhealthy, and **girls live in hostels** with barely any contact outside of work.
	Child labor	- Child labor occurs in the garment production in India. For the yarn spinning this is not specified; - The Fair Wear foundation reports that 14 million children are working in India, making India likely the country with highest number of working children worldwide.
	Discrimination & gender	Risks are specified for garment factories, **where violence against women at the workplace** occurs frequently, **gender wage inequality** is a prevalent issue, and female hygiene facilities are lacking.
	Wage & renumeration	Generally, the garment industry in Southeast Asia is a low wage, **excessive overtime and poor working conditions industry**.
	Health & safety at work	In factories, **physical conditions are poor**. Safety and hygiene aspects are insufficiently implemented, and many health problems occur.

6.2.2. Results — Supply chain organizations' characteristics

Next to this sector-level risk assessment, the characteristics of the specific companies involved in the supply chain also should be considered. This is to identify risks especially related to these organizations and to specify the assessment more on the specific supply chain studied. The Roadmap presents this step as investigating characteristics on (i) presence of management systems; (ii) reputations of the supplier; and (iii) supplier relationships.

Here, the fashion brand and Tier 1 manufacturer are addressed on these three points, discussing their coverage of different policies, as well as reputation of the organization, and relationships it has with suppliers. Due to not having any data or information available from the Tier 2 yarn supplier, this organization is left out in this step.

The fashion brand — Germany

The fashion brand has a great coverage of policies in place. All publicly available on their website, they present many different policies mostly focusing on their suppliers. These include policies with regard to working conditions in terms of e.g., working hours, adequate wages or health and safety. Policies for

direct employees and e.g., their working conditions, are not publicly available—although these are provided to employees internally. An overview of these policies is enclosed in Appendix VII.

A few initiatives exist that assess fashion brands on their sustainability performance, thereby it can provide insights to evaluating the reputation of the fashion brand compared to other brands. Appendix VIII shows an overview of the fashion brands' scoring under the Fashion Transparency Index of Fashion Revolution (Fashion Revolution, 2022), the Fashion Checker of Clean Clothes Campaign (Clean Clothes Campaign, n.d.), and its sustainability rating by Good On You (Good on You, n.d.). These findings show that the fashion brand scores higher than the average, but still is not looked upon as a well-performing brand in sustainability terms.

Through their Supplier Code of Conduct and all other supplier policies in place, the fashion brand conducts regulatory monitoring of the different suppliers on their adherence to these policies, and assessment of business practices.

Tier 1 Manufacturer — Bangladesh

The Tier 1 manufacturer has issued an extensive amount of policies, available through Appendix C. Many of these are also addressed in their publicly available sustainability report. All their policies and business practices adhere to the Bangladesh Labour Act of 2006 (CITE) and corresponding Labour Rules of 2015, showing the company's alliance with national laws. Furthermore, the company specifies that it complies to Code of Conducts of buyers at all times.

To get an understanding of the reputation of the Tier 1 manufacturer, an interview was conducted with an independent external auditor party on social compliance with buyers' CoC. In this context, buyers are the fashion brands that have running orders at a garment manufacturing company. This interview is held as a follow-up on a questionnaire (Appendix B), by means of which supporting information was acquired. This consists of information on the RMG industry in Bangladesh as well as the benchmarking of the performance of the Tier 1 manufacturer in comparison with the local RMG industry. This interview was conducted to include the independent external auditors' perspective in this assessment, as well as the company-specific SAM presented later in chapter 8. The independent external auditor was asked to provide a scoring of the Tier 1 manufacturer, from 1 (worst) to 10 (best), on its performance on social topics compared to the industry average (which corresponds with a 5 and would thus imply equal performance to the average sector). On the topics of freedom of association and collective bargaining, child labor, fair salary, working hours, equal opportunity/discrimination, health and safety, and social benefits/social security the Tier 1 manufacturer scores either a 9 or a 10 out of 10, showing its significantly good reputation as compared to the industry average. This high scoring results from the manufacturer's extensive policies, and adherence to these policies providing good working conditions for garment workers, as mentioned by the independent external auditor party auditor through the questionnaire. The auditor additionally indicated a great preference of garment workers for working for this specific manufacturer over other companies.

Next to this, a publication in a scientific journal in 2021—for which due to confidentiality reasons no reference can be provided—discusses a specific research on the sustainability performance of the Tier

1 manufacturer. This research focuses on the social pillar of their sustainability program. Appendix IX presents an overview of what is discussed here.

Regarding supplier relationships, the Tier 1 manufacturer itself also conducts supplier assessments. This is done through their own Code of Conduct for suppliers.

6.2.3. Interpretation

As the last step of the Roadmap to CSR Risk Management framework addressed in this assessment, the identified risks should be prioritized. This step is necessary for further formulation of action plans, implementation, monitoring and communication. As this thesis only aims for the identification of social risks, performance, and potential social impacts, these further steps of the Roadmap are not addressed.

Addressing the likelihood and severity of the sector-level identified risks (section 6.2.1) evaluated through the company characteristics presented in section 6.2.2, allows for an identification of risks that should be prioritized for evaluation. This prioritization is done through the risk assessment matrix presented by MVO Nederland (2020) (Figure 21). Severity is defined as how serious the identified risk is and what consequences it could lead to in terms of effects, whereas likelihood addresses the probability of the occurrence of the identified risk (MVO Nederland, 2020).

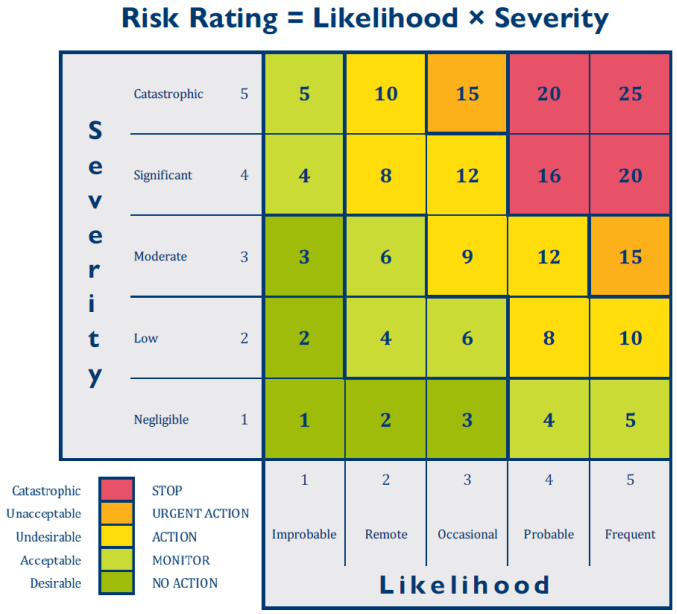


Figure 21. Risk prioritization assessment matrix. Image from MVO Nederland (2020).

The results of this evaluation are presented hereafter in Table 11. For more background on the evaluation of the severity and likelihood ranking, please refer to Appendix X. Due to not having any information or data from the Tier 2 yarn supplier, only the Tier 1 garment manufacturer was taken into consideration. Therefore, the assessment of the Tier 2 yarn supplier can only stay at the level of identification of sector-related risks, as presented earlier in Table 9 and Table 10. No evaluation of likelihood and severity of the risk for the specific Tier 2 supplier was thus addressed due to a high range of error that should be considered with not having any company-specific information related to their performance. Therefore, the assessment of these risks is left as a recommendation for further investigation of this specific Tier 2 supplier. Additionally, as the CSR Risk Tool (MVO Nederland, n.d.)

was unable to generate reports on risks regarding the design or retailing phase, this assessment and evaluation step was also not conducted for the fashion brand.

As shown in Table 11, the aspects of violation of the right of freedom of association, and the dissuasion or unfair punishment of workers participating in strikes is ranked as that action is needed—corresponding with an 'undesirable' rating. This is because even though employed at a company taking these aspects into consideration (i.e., the Tier 1 manufacturer involved in the product system under study), still publicly raising a one's voice in Bangladesh causes high risks for people in terms of brutal repression of strikes (International Trade Union Confederation, 2022). Also, with regard to excessive overtime hours, urgent action should be taken. Garment workers at the company work a standard of 12 hours of overtime—adding up to a 60 hour workweek—, explaining the corresponding 'unacceptable' label for this aspect.

There is an in-house store at the Tier 1 manufacturer that provides workers with food products at reduced price. It should be further calculated if living expenses are then covered through the wage earned by workers. The company itself provided a living wage calculation, showing that the wage of a garment worker in general terms is not considered a living wage. Here, it is assumed that the workers' partner earns more than the garment worker, to be able to provide for a 3-people family's living expenses. This is in line with urgent action that should be taken, corresponding to the 'unacceptable' label regarding the work weeks of workers at the Tier 1 manufacturing company—working extensive hours under low wages. As working for 60 hours a week is standard, it is likely this number of weekly hours occasionally gets violated. Therefore, urgent action should be taken by the manufacturer as well as fashion brand to see if and how improvement can be made. The most impactful, however, is the 'catastrophic' situation of gender discrimination against female workers who only perform low-skilled work, reflected through the ranking category 'stop'. The gender equality target of the company should be critically evaluated to see how fully equal opportunities for both male and female workers and employees can be achieved.

Other categories received the 'monitor' ranking, representing an 'acceptable' risk rating, but continuous monitoring should be done. This is conducted by means of CoC compliance by the fashion brand for all of their suppliers.

Table 11. Sector-level risk evaluation results related to the Tier 1 manufacturing organization. Assessment presented in Appendix X.

Category	Module	Specified risk	Ranking category
Fair business practices	Market distortion & competition	Poor forecasting, poor payment terms and unfair penalties to workers, due to buyers providing low purchasing prices	Monitor
Human rights & ethics	Consumer interests & product safety	Personal data is not always used in a secure way.	N/A
Labor rights	Freedom of association	Violation of the right of freedom of association	Action
		Dissuasion or unfair punishment of workers participating in strikes	Action
		Firing of a worker part of a trade union	Monitor
		No guarantee of workers' rights for workers	Monitor
		High violation against human rights defenders	Monitor
	Labor conditions	Workers are forced to make long working days under bad conditions	Monitor
		Workers are unaware of their rights	Monitor
		Subcontracting leading to little oversight on working conditions	Monitor
		Work weeks of over 60 hours a week	Urgent action
	Child labor	Occurrence of child labor, possibly in worst forms of forced labor.	Monitor
	Discrimination & gender	Women are discriminated based on their gender, where men occupy technical and managerial positions, and women work low-skilled and low-paid.	Stop
		Women experiencing sexual intimidation, violence, and discrimination	Monitor
	Wage & renumeration	Excessive overtime hours apply under the conditions of low wages	Urgent action
		Due to lack of income, workers are separated from their children which are mostly raised by family members	Monitor
	Health & safety at work	Unsafe working conditions with poor medical providence	Monitor
		Insufficient building safety	Monitor
		Women not being allowed to go to the toilet during working hours	Monitor
		No penalties are in place from higher up when safety or human rights violations occur	Monitor

6.3. IFC Standard 2 — requirement assessment of the 3 organizations

The three prioritized organizations in the product system—the fashion brand, Tier 1 manufacturer and Tier 2 yarn supplier—are assessed according to the requirements listed in IFC Standard 2. This assessment can be found in Appendix D. It takes form of a checklist method, by checking whether the requirements listed in the IFC Standard are met. It is checked whether there is (i) full compliance, (ii) medium compliance, (iii) no compliance, or if (iv) compliance is unknown due to data availability. Hereby, the social performance of the organizations is evaluated. The assessment shows that on no requirement of the standard, a non-compliance is found, for none of the three organizations. However, a lack of sufficient data has led to many requirements not properly addressed, therefore labelled as 'unknown'. Further elaboration is presented in Appendix D.

The fashion brand scores full compliance to the requirements in terms of workers' organizations (collective bargaining), non-discrimination and equal opportunities, child labor, forced labor, and health and safety for its employees. Furthermore, as it is a key stakeholder in the supply chain, also conditions for supply chain workers are considered for requirements for this stakeholder. On the three aspects of work force protection (child- and forced labor), health and safety, and management control,

the fashion brand scores full compliance to the IFC Standard 2 requirements. Medium compliance is found under the category of equal terms and conditions for migrant workers, as there is no explicit mentioning of migrant workers in the policies. However, this is implied through the policy on terms and conditions without differentiating on any way in terms of social background. Lastly, unassessed requirements are related to if human resources policies are consistent with national law, retrenchment, and grievance mechanism for the fashion brand's employees. These are unassessed due to insufficient data availability.

For the Tier 1 manufacturer, most of the requirements also achieved full compliance. This organization is only assessed on requirements for its direct workers, as the conditions for workers further in the supply chain—thus at the Tier 2 yarn supplier—are assessed through the fashion brand on the requirements as mentioned above. The topics of full compliance for the organization's performance on requirements for its direct employees involve human resources policies and procedures, non-discrimination and equal opportunity, grievance mechanism, child labor, forced labor, and health and safety. A medium compliance is identified for equal terms and conditions for migrant workers, as there is no explicit mentioning of migrant workers in their discrimination and harassment policy. Furthermore, medium compliance is found in the case of workers' organizations. This aspect covers the fact that workers are free to join associations, but this is not promoted (nor prohibited). No workers are however part of any other association than their in-house participation committees—where each committee consists of around 50% of workers, as presented in the sustainability report. This shows a deep-rooted issue of freedom of association and collective bargaining in Bangladesh—still as of today—(International Trade Union Confederation, 2022). Lastly, as no data or information was available regarding retrenchment, this requirement is not assessed.

The Tier 2 yarn supplier is evaluated through available policies from the fashion brand—due to not having any direct data of the supplier or policy information available. This has led to most of the requirements not being able to be assessed, as these mostly relate to company-specific policies and practices. A full compliance is found through the confirmation of the fashion brand that no child labor occurs. Medium compliance is found on four requirements. Firstly, the fashion brand only has information available on social benefits of workers, but no information on hours of work, wages, or overtime seems to be available. Furthermore, also for this supplier it is unclear if documentation is available on equal terms and conditions for migrant workers. Thirdly, the workers of the yarn manufacturing are accommodated in a boys and a girls hostel, as specified on the Tier 2 yarn suppliers' website. Quality and management policies of these hostels are not available, but the fashion brand has an exhaustive policy on hostels in India in place. Lastly, the fashion brand's Code of Conduct for suppliers explicitly states that forced labor in their supply chains is not allowed. It is assumed that the Tier 2 yarn supplier adheres to this policy, but no direct information is available. This implies that the requirements on consistency of human resources policies with national law, respect of collective bargaining agreements and any workers organizations', non-discrimination and equal opportunity principles, retrenchment, grievance mechanism, and health and safety are not assessed. It should be further investigated why the fashion brand itself does not have any information available in this regard.

Furthermore, their supplier-monitoring processes should be analyzed to see if it is really the case that there is high unawareness of the practices of the supplier in these aspects.

Through assessing the three companies on their organizational performance by the compliance assessment to the IFC Standard 2 requirements (IFC, 2012), insights were provided on the performance of the companies in terms of their policy formulation and business ethics. Here, it is found that generally the fashion brand and the Tier 1 manufacturer comply to most of the requirements. Where no full compliance was achieved, this is caused due to not having information to properly conduct the assessment. Therefore, it is recommended to evaluate the three companies against the IFC Standard through a more thorough assessment, e.g., by including the sourcing of more in-depth data, access to monitoring assessments, evaluation with workers and employees, and site-visits, to name a few. Here, a focus should be on the further tier suppliers, as generally these companies involved in the chain might be monitored to a lesser extent. The unavailability of any data through the fashion brand, on the Tier 2 yarn supplier, should be evaluated regarding if they were not able to share this data or that there is no information available due to the fashion brand not having monitored the Tier 2 supplier on the aspects of the IFC Standard 2 Requirements—thus being unaware of their business ethics in this regard.

6.4. Key findings

This paragraph answers the third sub question, on what the social issues along the supply chain of a textile product under study identified from a qualitative analysis are. It is understood that through following the Roadmap to CSR Risk Management and the IFC Standard compliance assessment, these 'social issues' are addressed as assessing social risks and company social performance. By following the first four steps of the Roadmap to CSR Risk Management framework (MVO Nederland, 2020), CSR risks are identified in relation to the product system of the product range under study. The identified risks are—through the Roadmap—based on the OECD Due Diligence process and the UNGP Principles for Business and Human Rights (MVO Nederland, 2020). Concerning the production of the garment product range—excluding the production of yarn—taking place in Bangladesh, this is the point in the supply chain where many activities take place and thus many risks can occur. These corresponding sectorial risks in the Bangladeshi garment industry are identified through the corresponding CSR Risk Check Tool (MVO Nederland, n.d.). These sectorial risks are addressed together with characteristics of the Tier 1 manufacturer—which reflect the company's performance—, through the rating of the risk with the severity and likelihood. This assessment method allows for specifying company-specific risks. It allows for 'scaling' the sector-level risk to the company, but does not say anything about a potential effect this can cause leading to a certain potential impact. Therefore, the social risks along the supply chain of the textile product under study are presented here, with a specific focus on the Tier 1 manufacturer, due to unavailable information available to assess the Tier 2 yarn supplier and the CSR Risk Check Tool not covering the processes where the fashion brand directly is involved.

The assessment identified social risks arising on the Tier 1 manufacturer company-level on topics concerning;

- Freedom of association, including the participation of workers in public strikes;
- 60 hour work weeks including excessive overtime hours;
- Insufficient earnings to cover living expenses;
- Gender inequality in terms of female workers having fewer opportunity than men and are generally working on lower-skilled positions.

Through the IFC assessment, an additional analysis is done on policy level, thereby assessing the performance of the companies through a compliance-checklist method. This shows that both the fashion brand and the Tier 1 manufacturer have set adequate policies with regards to employees and workers. Through unavailability of sufficient information, not all requirements could be assessed on desired level, meaning it is recommended to further follow up on this assessment. Especially a situation for further assessment is found in the inability of the fashion brand to provide any information on the Tier 2 yarn supplier, under the notion of 'No information available' (through the fashion brands' questionnaire on the Tier 2 supplier). If this implies that the fashion brand is unaware of the circumstances at this supplier, immediate action should be initiated. However, as they mention they have a monitoring system of compliance of suppliers to their supplier CoC in place, it can be assumed that the information was only unavailable for this assessment—for which no explicit reasons are provided.

6.4.1. Methodological limitations and comparison

Through following the framework of the Roadmap to CSR Risk Management (MVO Nederland, 2020), identified sector-level risks are complemented with company-level characteristics and thus allow for a specification of the sector-level risks to specific companies. Using the Roadmap framework, a supply chain perspective is taken, meaning it only allowed for a cradle-to-gate scope. With regard to the product system under study, social risks during transport can be integrated by using the CSR risk tool, but for practical reasons of time-constraints this is left out of scope. However, this also only would stay at the social risk level due to not having any company-specific data available on their characteristics.

Through the IFC Standard 2 compliance assessment (IFC, 2012), the performance of the companies was assessed. However, this assessment does not allow for a comparison of the performance of the specific company against averages of the sector. For example, it would be valuable to address the debatable situation regarding freedom of association at the Tier 1 manufacturer, against the average situations in the sector, to objectively be able to discuss this situation—but through the framework of assessing compliance to the IFC Standard 2, this unfortunately is not possible.

Comparing the Roadmap framework to the IFC compliance assessment, outcomes were assumed to be not contradicting, but complementing each other. The topics covered by both assessment frameworks, however, show some dealignment.

The IFC requirements focus on the identification of risks including retrenchment, grievance mechanism, and forced labor, and adds additional insights on migrant workers and accommodation services—topics not included in the CSR Risk Check Tool (MVO Nederland, n.d.). This can be due to the cause that there is no sector-related risk identified on these topics, or that the data on which the CSR Risk Check Tool is based does not include these aspects. In contrast, the CSR Risk Tool is going more

in-depth on working hours, right unawareness, subcontracting, gender inequality, or medical providence. The two ways of assessing are different in terms of their approach: the Roadmap starts at identifying all sectorial risks—focusing on the context of the specific company—, then narrowing this down to the company, whereby company-level risks on some topics remain. The IFC compliance assessment on its turn only focus on the specific company's performance where its context is not taken into consideration. There is thus no alignment between the frameworks on what exactly is considered in terms of social topics, and both only broadly covers working conditions/labor rights both in different ways.

6.4.2. Critical notes

With regard to freedom of association and collective bargaining the Tier 1 manufacturer has been providing some contradicting information. Firstly, answering on the questionnaire, they mentioned employees are not free to join an association of their own choosing. Instead, they can choose to join the internal Participation Committee (PC). This committee represents workers, through which they can express grievances. During the follow up interview, they mentioned this again; their employees generally join the internal PCs, and are not allowed to join or form any other association of their choice. In their Code of Conduct, however, it is expressed that workers are able to join or form any association of their choosing. Furthermore, when sharing preliminary assessment results with the manufacturer in this regard they shared the following: "*Our workers have the freedom to join any other trade union. The facility has a policy regarding this. As per facility policy, any workers have the right and freedom to join any other trade union if they want at any time.*" Hereby, it is assumed that this is the case, but it remains a very critical issue for further investigation. A potential cause for this contradicting information is the language barrier identified through communication with the Tier 1 manufacturer over different channels. This is an important aspect to keep in mind regarding validity of information acquired.

Furthermore, the issue of a 60 hour work week is of interest to assess against the benchmark to see whether this is an exceptional cause or not. 2023 statistics on working time by ILOSTAT (ILOSTAT, n.d.) show that the average weekly working time in Bangladesh is 46.9 hours. Although this number is not specified to the garment manufacturing industry, it shows that the issue of excessive working time at the Tier 1 manufacturer is of outstanding concern. Regarding the living wage earnings, also statistics could help with providing extra insights. The minimum wage in Bangladesh is 5710 BDT/month for the textile sector in 2018 (Bangladesh Minimum Wages Board, 2023). Through data provided on the Tier 1 manufacturer, it is found that garment workers earn 6420 BDT/month. This is thus significantly more than the minimum wage, but the living wage calculation provided by the Tier 1 manufacturer itself provides the insight that this does not cover average living expenses. There is, however, a specific in-house grocery store provided to the workers, where they can buy food products for a reduced price. If this all calculates up to a living wage, however, should be further investigated and thereby is a risk of high concern. Lastly, regarding gender inequality, statistics show that there is a 67% gender gap regarding economic participation and opportunities (World Economic Forum, 2022). This score is reflected through the low-skilled positions in which the female workers are employed at the Tier 1 manufacturer, and the opportunities to grow only until a certain level. However, the company acknowledges this gender inequality and is targeting to lower it. A target is set on 20% gender equality

in 2025 (compared to a 5% share of women covering management positions in 2020), still reflecting an 80% inequality in terms of women being employed at management level positions.

Therefore, as a next step, the identified company-specific risks and performance should be assessed to the benchmark of the country or local industry on the specific aspect, through e.g., statistics available. This could provide extra value for the evaluation of each issue.

With regards to the scope covered and as CSR risks can occur throughout the product's supply chain, similar risks should be identified for every other stage in the supply chain. Including e.g., 'Transport and logistics' in Bangladesh, India, The Netherlands—as it is assumed the products are shipped to the Rotterdam harbor—, and Germany, and 'Other organic chemicals' from the chemical producing countries, would allow for an assessment following more of a life cycle approach. These assessments are left out as the CSR Risk check has a too low resolution and no characteristics of suppliers can be identified to make it more fitting to the product under study. Also, the process of storing and distribution, retail, use, and end-of-life stage should be included in the assessment. However, as these risks are difficult to quantify and there is no possibility to assess this within the CSR Risk Check tool from MVO Nederland, this is now not identified here. But for a more thorough life-cycle perspective, these suppliers and stakeholders should also be taken into consideration eventually.

7. S-LCA – generic assessment

As presented in chapter 5, this generic assessment is conducted using the PSILCA database, allowing for a social risk assessment on a country/sector level via the direct quantification and the identification of potential risks through using the activity variable working-hours. By following the S-LCA method as described in the UNEP Guidelines the different phases of an S-LCA are aligned to the ISO14040 standard on E-LCA. Therefore, these four corresponding phases are addressed hereafter. This generic assessment is complemented by a company-specific S-LCA (chapter 8), whereby the social performances of companies involved in the product supply chain are addressed, through which the social performance of the product system is assessed.

7.1. Goal and Scope

7.1.1. Goal definition

The goal of the generic S-LCA is to assess the product system of the product range from the fashion brand on its social risks, and the product on potential social impacts. This assessment aims to identify sector-level risks associated with the product system and linking these to the life cycle of the product, for the purpose of identifying potential social impacts that can arise. This is done through two ways of conducting the generic assessment: using the direct quantification method for identifying sector-level social risks, and the worker-hour activity variable method to address these risks as potential social impacts. A RS S-LCIA approach is taken by using the PSILCA database. Results can provide insights to the fashion brand on the social risks behind their product system, and potential social impacts behind the product. These insights can be a basis for decision-making on providing a focus on areas where social risks arise, and how the potential social impact of their product can be minimized. As the generic assessment is conducted in two ways—via the activity variable worker-hours, and the direct quantification method of GreenDelta (Ciroth, 2020)—an additional goal is to evaluate the two methods on their procedure as well as differences in results and findings.

7.1.2. Scope definition

The product under study is a garment product range commercialized by a fashion brand in Europe, of which the headquarters are based in Germany. Shortly, cotton is sourced from Indian cotton fields, whereafter the garments are produced in Bangladesh, and shipped to the retailing country of Germany. The fashion brand is operating globally but has most stores in Europe. As the PSILCA database is sector and country bound (Maister et al., 2020), it was necessary to specify the retailing to a specific country. In this regard, it was found that the fashion brand has 1314 retailing stores over Europe of which 409 are located in Germany (see Appendix VI). This corresponds with a 31% of all stores, followed by France, The Netherlands and Belgium with 13, 8 and 8% respectively. Therefore, the location of the retail store is assumed to be in the middle of Germany, and the use stage is modelled in Germany as well. The assumed distances and means of transport are presented in Appendix VI.

A cradle-to-customer scope is thus taken, where the use phase is the last phase in the life cycle considered in this study. As to be bound to sectorial data available in the database, the end-of-life is left out of scope. This is since no relevant (end-of-life) sectors in the database were identified to represent

this phase properly. Furthermore, no primary social data for this phase is existing, as the fashion brand itself also has no data available.

The function of the product and corresponding functional unit are defined as follows:

- **Function**: Covering the body according to the code of decency established by society;
- **Functional Unit**: Wearing an average weight C2C® Certified garment over a period of washes corresponding with typical use behavior in Germany;
- **Reference flow**: 14.77 USD C2C® Certified garment over a period corresponding with 44 washes in Germany.

Data will be used coming from the PSILCA database version 3 of 2020. The data quality will be addressed in the Interpretation phase, assessing it against the data quality pedigree matrix (Figure 12). Through the direct quantification, no use is made of an activity variable. For the worker-hour assessment the use is made of the worker-hours activity variable, for which data is required and presented in section 7.2.3. The social risks and potential social impacts are quantified using PSILCA and assessed against the RS S-LCIA approach.

7.1.3. System boundaries and cut-off criteria

The system boundaries are set as cradle-to-consumer, meaning it includes the production of the garment, from raw material extraction up to production and the use stage. The below flowchart shows the product system, whereby modelled foreground processes are shown, as connected to background processes available in PSILCA.

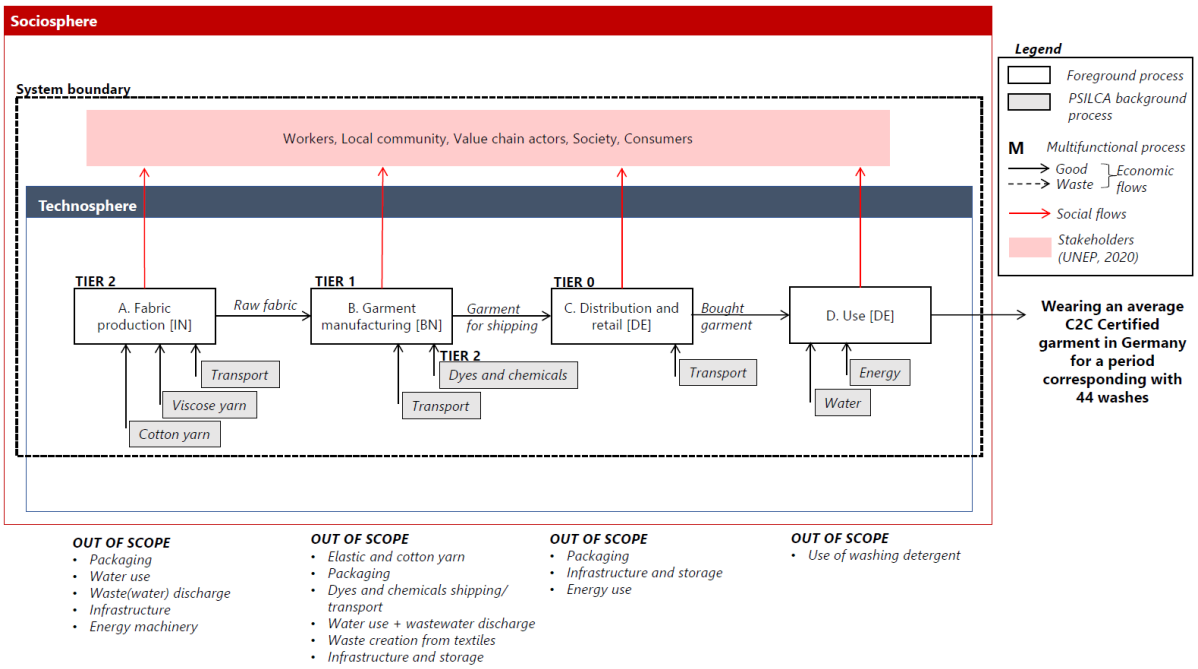


Figure 22. LCA flowchart. Own image.

As of only having the BoM available as primary data to model the product system, many aspects were left out of scope. Shown below each foreground process in Figure 22 are all the elements not considered for each corresponding life cycle stage. This implies that the assessment results can only speak about

the physical material flows and their transportation. Any additional elements as packaging, water and energy use, infrastructure and machinery, and waste discharge are not included. The waste generation of the textile industry should also be highlighted, as a big limitation of this study. Where the industry creates a lot of waste—both solid waste and waste water—(Mukherjee, 2015), this is also the case for the Tier 1 manufacturer, as presented in their sustainability report (see Appendix III). Identified waste solid waste streams by the Tier 1 manufacturer are shown in Table 12.

Table 12. Solid waste flows during garment manufacturing identified by Tier 1 manufacturer.

Section	Solid waste flow
Fabric cutting	Cotton fabric, paper, carton, fabric rolls, synthetic fabric, plastic bags, scissors, knives, blades
Sewing	Cotton fabric, cotton thread, cotton labels, paper, synthetic fiber, synthetic thread, synthetic label, poly, cutters, scissors, needles, plastic cones, buttons, zippers, rivets
Finishing	Cotton threads, cartons, needle, gum tape, tag pins, empty bottles of spot lifter

As these are not waste flows directly related to the specific product—i.e., no synthetic fibers are used—it gives an idea about the quantities of waste flows and that the exclusion of these flows will change results.

The PSILCA documentation suggests a cut-off criterion of 1e-7 to 1e-5 (Maister et al., 2020), which is adapted in this study. It should be noted that this correlates with a loss of detail in results, meaning the calculation results are sensitive to this cut-off criterion.

7.1.3.3. Stakeholder categories and subcategories involved

Stakeholders involved are mostly workers, as well as the local community surrounding production locations, but also value chain actors, consumers and society. As the generic assessment aims for the identification of social risks, all stakeholder categories and subcategories available through the PSILCA database are included in the assessment; see Appendix V. The stakeholder category 'Children' and 'Consumers' as shown in Table 7 are excluded in the assessment with PSILCA, as the PSILCA version 3 database of 2020 (Maister et al., 2020) does not yet include these stakeholder categories. Where the category 'Children' was not yet presented in the Guidelines in the year of development of the database, including the stakeholder group 'consumers' is being processed (Maister et al., 2020).

7.2. Inventory Analysis

For both the direct and worker-hours assessment method, certain data was collected through the procedure presented in section 5.3.

The BoM was used to model the product system. For both the direct quantification as worker-hour method, same procedures for the modelling were taken. Using the BoM as a starting point, a corresponding and suitable flow was sourced from the PSILCA database; see Appendix E for the Bill of Materials and an overview of Unit Process tables as modelled in the OpenLCA model, corresponding with the LCA flowchart in Figure 22.

Only for the material inputs of 'Elastic waist band' and 'Cotton sewing yarn' (material ingredient inputs from the BoM) were not available in a suitable PSILCA flow and process. Therefore, these have also been left out of scope. Corresponding to environmental flows that belong to a process in E-LCA modelling, for S-LCA corresponding social flows should be identified. For the generic assessment, these are sourced from the PSILCA database (Table 13). This presents that for the use phase, also social flows are added. Theses flows represent the social conditions of the country in which the garment is worn—in this case Germany—, and are added as social flows of the stakeholder groups 'society' and 'local community'.

Table 13. Foreground processes and PSILCA sector processes as generic sources for social flows.

Foreground process	PSILCA process/sector source for social flows	Proxy?
Yarn production (IN)	Manufacture of textile — IN	Yes, manufacturing of textiles instead of yarn. No better suiting process was available.
Garment manufacturing (BD)	Textiles and Wearing Apparel — BD	No, corresponding sector.
Distribution and retail (BD to DE)	Retail trade and repairs — DE	Yes, as the retail is assumed to be located in Germany, this sector is taken. However, this process contains the shipping from Bangladesh, to—assumed the transport process goes this way—the Calcutta port, to Rotterdam, and finally to the geographic middle of Germany. As no sufficient data was available to split these steps up in different processes, the most suitable way to approach this was modelling this way.
Garment use (DE)	Social flows are taken only for the stakeholder category 'Society', and 'Local community' from the corresponding country of Germany. These are taken from any PSILCA process related to Germany and selected based on their value being the same for each sector related to Germany.	No, only societal flows are taken, corresponding to all sectorial processes of Germany. This is because no activities of workers are directly involved, and local community and value chain actors are also not directly affected.

The PSILCA database is based on US Dollars at the rate of 2011 (USD2011) from the Eora MRIO database (Maister et al., 2020). All material inflows—except for the reference flow of each unit process—are sourced from corresponding PSILCA processes, thus contain this monetary unit of USD2011. To convert the mass-based data from the BoM—e.g., the amount of cotton yarn input—to monetary values, a conversion needs to take place. For this, one can make use of the ecoinvent database. Version 3.8 is used in this regard, where monetary values of different components in ecoinvent are assigned a monetary value in Euros at the rate of 2005 (EUR2005) (as can be found in each unit process dataset information in the version 3 database). Consequently, first a conversion of the ecoinvent prices to EUR2011 (*1.13) is done through using an online inflation tool (Inflation Tool, 2023), and into USD2011 (*1.2952) using the December 31st exchange rate of 2011 (ExchangeRates.org, n.d.), corresponding with the exchange rate used in PSILCA (Maister et al., 2020).

Some differences in the data related to unit processes between the direct quantification method and the worker-hour assessment, as well as inventory results from the two assessment methods are presented in the coming two sections. In the product system, no multifunctional processes are identified. Whereas the different organizations do not solely produce the C2C® Certified product range under study, there is no sufficient data available. Therefore, multifunctionality is not considered.

7.2.1. *Generic PSILCA Social Life Cycle Inventory Analysis — Direct quantification*

The direct quantification method allows for an analysis on social risk level, where the reference flows need to be modelled so that they can be summed up—i.e., are monetary. Therefore, the reference flows are added in monetary terms—based on converted mass quantities as through information from the BoM—and the related PSILCA flows are added in monetary values. Additionally, the social flows for each process are added as sourced from corresponding PSILCA sectors as presented in Table 13. As a next step, these should be adjusted in the direct quantification method. Only for the Tier 1 manufacturer the social flows were adapted to the specific situation at this organization (See Appendix E (Unit process tables)). However, this was also only for the workers stakeholder category, i.e., not for the local community. For the social flows regarding the stakeholder groups 'value chain actors', 'society' and 'local community', the standard values of the PSILCA database and corresponding sector—Textiles and Wearing apparel—were therefore taken.

However, for the social flows added in the garment manufacturing process, an additional evaluation round was added for the direct quantification. This was done through evaluation with the Tier 1 manufacturer. As the value of each social flow corresponds with a certain risk classification—e.g., a gender wage gap of more than 30% is considered 'very high risk', the corresponding values together with the risk classification (to give it a bit more tangibility) have been sent to the Tier 1 manufacturer for evaluation and adjusted accordingly. The inventory results, together with the overview of evaluation with the Tier 1 manufacturer are presented in Appendix E.

For the modelling of the product system for the direct quantification method, reference flows need to be set at 1 USD of output for each foreground process. This is caused by the direct quantification method (Ciroth, 2020) that is presented in the form of a python script. In this script, a rescaling step is not included causing all reference flows needing to be adjusted to 1 USD. The BoM provided mass quantities, that are converted to monetary values through the steps presented in section 7.2. As this rescaling step is not addressed in the method, this additional step had to be done manually. Important to note on this aspect:

- Outputs (1 USD) reflect the price of the product or service on the market, thus include "value added" and therefore always exceed the sum of input prices;
- Social flows need to be added for all foreground processes, as the method calculates social conditions by averaging these on all processes involved. Thus, for the use phase social flows should also be added. These represent the social conditions of the country in which the garment is worn, and are added as social flows of the stakeholder groups 'society' and 'local community'.

Calculations for these USD values (inputs versus 1 USD of output) are provided in Appendix E (Unit process tables).

7.2.2. *Inventory results*

Inventory results can be found in Appendix XI. Here, stakeholders and corresponding subcategories with each indicator are presented with the calculated inventory results. Please note that these results are presented in the 'Results' column. The 'Classification' column refers to the Impact Assessment

phase, where the inventory results are classified to different reference scales, through a basic weighting or aggregation method for different risks based on the PSILCA database reference scales; see section 7.3.1 for more elaboration on this aspect.

7.2.3. Generic PSILCA Social Life Cycle Inventory — Worker hours

For the assigning of values to the social flows in the worker-hours assessment, corresponding labor hours needed to be identified with the reference flow. For both the direct quantification and the worker-hours models, reference flows correspond to 1 USD of output; see discussion in section 7.2.1. Corresponding values of the worker-hours are presented in Table 14, whereas calculations can be found in Appendix E.

Table 14. Values of worker-hour per foreground process.

	Yarn production — IN	**Garment manufacturing — BD**	**Distribution and retail — BD to DE**	**Garment use — DE**
Reference flow	1 USD cotton and viscose yarn	1 USD C2C® Certified garment for shipping	1 USD bought garment to user	1 USD C2C® Certified garment after a period corresponding with 44 washes in Germany.
Activity variable (worker-hours)	0.253814571 h	0.191731102 h	0.017260015 h	0.256885716 h

7.2.4. Inventory results

Inventory results can be found in Appendix E (E.2). These results show the different risk assessed flows and their results. These results express certain social risks and their relation to certain risk levels. In the Impact Assessment, these social risks are characterized and multiplied with the worker-hours value.

7.3. Impact Assessment

Through using the PSILCA database, many of the steps that should be taken throughout S-LCA phases for RS S-LCIA approach (see Figure 19) are already automized. For example, reference scales are pre-determined in the database. Secondly, data on generic level is directly available through the database, meaning no further collection steps needs to be undertaken. For the Impact Assessment phase specifically, automatically the data will be assessed to the reference scales, as the Social Impacts Weighting method is applied. PSILCA also groups certain social indicators to subcategories—i.e., gender wage gap, men in sectorial labor force and women in sectorial labor force are all aggregated into the subcategory 'discrimination'. For the direct quantification, however, only inventory results can be provided, meaning that the steps on Impact Assessment and Interpretation are not directly done, and have to be manually added (see below).

7.3.1. Generic PSILCA S-LCIA — Direct quantification

The direct quantification method—available through the python code—only allows for the calculation of normalized inventory results. Hereby, the characterization of the impact assessment step needs to be done manually. This can be done through the simple weighting or aggregation method for classifying risks, as presented in the database (Maister et al., 2020).

Through this step, the inventory data on the different social topics is assigned a risk classification level, ranging from 'No risk' to 'Very high risk'. Appendix XI provides the characterized inventory results as well as the step of classifying risk levels to the indicators—through the basic weighting or aggregation method for different risks based on the PSILCA database reference scales. Table 15 provides three examples for the reference scales behind the basic weighting method. This evaluation scheme is available in the PSILCA database, under the information of each social flow. Also, each scheme is presented in the PSILCA documentation (Maister et al., 2020). As explained in Appendix E (E.1), there was however a misalignment found between the PRPs presented in the database and in the documentation. Therefore, the documentation was adhered to mostly and the evaluation scheme is thus adapted from this document. Commentary on which PRPs were different are summarized in Appendix E (E.1).

Table 15. Basic PSILCA weighting method through evaluation scheme, three examples.

				PSILCA evaluation scheme					
Stakeholder category	**Subcategory**	**Indicator**	**Unit**	*No risk*	*Very low risk*	*Low risk*	*Medium risk*	*High risk*	*Very high risk*
Workers	Freedom of association	Right to strike	4 pt scale	3		2		1	0
Local community	Safe and healthy living conditions	Sanitation coverage	%	100%	>95% - <100%	>90% - <95%	>85% - 90%	>80% - 85%	<=80%
Society	Health and safety	Global Peace Index	ratio		1- <1.45	1.45- <2	2 - <2.3	2.3- <2.8	>=2.8

Table 15 shows that the evaluation of the indicator on assigning a certain risk level is done through various scales, depending on the unit of the indicator. For example, the 'Right to strike' is evaluated through a 4 point scale. Each scale then corresponds with a certain risk level which can be assigned. For the 'sanitation coverage', a certain percentual scale applies for assigning certain risk levels. Lastly, the Global Peace Index is presented as a ratio value, therefore here other criteria are evaluated through the reference scale. All these reference scales have been set up by PSILCA, based on various sources, including official statistical agencies (e.g., ILOSTAT, WHO, World Bank, and other qualified sources as ICTWSS and World Factbook) (di Noi et al., 2020). For the worker-hours assessment, the same reference scales are used, as they are embedded in the Social Impacts Weighting method.

Impact assessment results show that a very high risk is identified for 'Trade union density', 'Extraction of biomass', 'Level of industrial water use', and 'Indigenous people rights protection index'. Furthermore, high risks are identified in terms of 'Living wage', 'Embodied CO2 footprint', 'International migrant stock', 'Number of asylum seekers', 'Promotion of social sustainability', 'Contribution to economic development', and 'Public expenditure on education'.

One notable aspect is the overlap with E-LCA in terms of indicators; the 'Extraction of biomass', 'Level of industrial water use' and 'Embodied CO2 footprint' are indicators strongly related to environmental aspects. These are indicators belonging to subcategories of the stakeholder category 'local community', namely 'Access to material resources', and 'Environmental Footprint' as well as 'GHG Footprint'.

The PSILCA documentation describes the relevance of the subcategory 'Access to material resources' as assessing the access of local communities to these material resources, in terms of commercial and

industrial activities in the local regions (Maister et al., 2020). Here, the environmental aspect of material resources comes very close to the social dimension; environmental implications (e.g., a high level of industrial water use) have a direct link with social implications (e.g., no availability of water for the local community). The 'Environmental Footprint' and 'GHG Footprint' however do not show a direct link with social aspects, therefore the reasoning of the developers for including these in the PSILCA database should be further evaluated.

This method, however, only allows for the identification of these risk levels, but does not express this in the form of a possibility or contribution analysis. This means that when a 'very high risk' on a certain social indicator is found as a result, no further information can be addressed on where this 'very high risk' result traces back to. Also, it can lead to important high impacts to not show up in the final results. For example, prevailing risks in the industry in Bangladesh and India, as presented in section 6.1, are child labor, wages, worker' rights, equal opportunities, overtime, trade union repression, gender discrimination, and health and safety of workers, do—except for the trade union density—not show up in the impact assessment results. There are, however, very high risks identified at unit process level on these aspects (see Appendix E (E.1)); for the yarn production in India a very high risk occurs for male child labor, wages, social security expenditures, illiteracy rates, and health expenditure. For the garment manufacturing in Bangladesh, similar risks occur in terms of right to strike, weekly working hours, social security expenditure, illiteracy rates, and health expenditure. These are identified as the risk-assessed social flows per unit process, but are through the life cycle calculations that are not allowing for any contribution analysis not showing anymore. Where a very important aspect as e.g., the 82.6% risk on male child labor in the yarn production sector in India is thus not shown in final impact assessment results, it should be evaluated what the value added of this life cycle calculation actually is. Since talking about social issues at the heart of human rights, such prevailing hotspots as a 82,6% risk at male child labor in the yarn production sector should not be overlooked, but currently is inadequately addressed through the direct quantification method.

In its current form, the direct quantification method thus does not allow for useable results, and does not adequately address important social hotspots. It can be argued that social flows for unit processes specifically can at least say something for this specific unit process when manually risk-assessing the values of each social flow.

7.3.2. Generic PSILCA S-LCIA — Worker hours

Results of Impact Assessment phase present potential social impacts, resulting from activities and behaviors of organizations that are linked to the life cycle of a specific product or service through the use of the activity variable (UNEP, 2020).

The Social Impacts Weighting method of PSILCA describes the exponential relationship (see Table 6) between characterization factors on assigning risk levels to indicators. For each indicator risk levels are assigned following these characterization factors. The characterization factor 1 assigns a medium risk level to a flow, whereas lower and higher factors assign higher and lower risks, respectively (see Table 6). Through the impact assessment method, characterization factors of these risk-assessed flows are multiplied with the specific characterization factor. Results of this impact assessment method are

expressed in relation to the medium risk level, the unit representing a 'medium (med) risk hour' (see section 3.6) and presented in Appendix XII.

A 'med risk hour' expresses the impact subcategory in terms of its risk value, in relation to a medium risk level. The higher the value, the more risk can be associated with a specific impact category. However, the 'med risk hour' is an incomprehensible unit, which can only provide some insights when a comparison between two alternatives is made, or sensitivity analysis is performed—as a '0.4 med risk hour' on its own cannot be interpreted.

By the calculation through the worker-hour variable, social risks are related to the product system and these are labelled in the Guidelines as a 'potential social impact'. However, it can be noted that calling this a 'potential social impact' might be seen as unfair. This is because the activity variable worker-hours only says something about the categories under the stakeholder category 'workers', and the company is not in any way responsible for the 'social impacts' related to the stakeholder category 'society', and the countries' 'illiteracy rate' for example. No causal link can be identified; therefore, it should be considered to—even though related to the product system through the activity variable—refer to the results for other stakeholder categories than 'workers' as 'social risks' and not using the worker-hours model for this.

7.4. Interpretation

The Interpretation phase addresses a completeness and consistency check, data quality analysis, contribution analysis, and sensitivity analysis (UNEP, 2020).

The completeness and consistency check should be answered through a narrative way, answering the guiding questions proposed in the UNEP Guidelines (UNEP, 2020, pp.110-111). The completeness check reviews if relevant issues of the goal and scope are addressed adequately through the assessment, whereas the consistency check evaluates a consistent use of method applied and data used throughout the study.

7.4.1. Completeness check

The goal and scope are defined in section 7.1.1 and 7.1.2 respectively, presenting which stakeholders and subcategories are included, which are all the categories available through the PSILCA database. All possible life cycle phases for which data was available were taken into consideration and included in the assessment. The inventory consisted of collecting data in the form of the BoM and linking these to sectors available in PSILCA. Therefore, not necessarily all social data is accurate as it might be linked to a sector where a certain proxy is taken for, but this is due to the nature of the social database not being as elaborate yet due to its basis on the Eora MRIO Input-Output database (Maister et al., 2020). Results allow for the answering of the research question, but under the limitations of having left many aspects out of scope as presented in the scope definition.

7.4.2. Consistency check

Consistent use of terminology—the direct quantification assessing social risks, and the worker-hours method assessing potential social impacts—is used throughout the document. However, a critical note

is provided in the discussion during the Impact Assessment phase (section 7.3)—as will also be addressed in section 7.5—that naming these results 'potential social impacts' is unfair. This is due to the specific company involved, e.g., the Tier 1 manufacturer, not having any responsibility in terms of for example, the illiteracy rate, life expectancy, or number of asylum seekers, which is implied when calling this a 'potential social impact'. The FU being defined as the wearing of a garment for a period of 44 washes, reflecting typical behavior in Germany, ensures the capturing of relevant properties of the product system, including the cotton raw material extraction until the end of use phase. In the Inventory Analysis phase, consistency in data can be ensured. This is because all background activity data comes from the PSILCA database v.3. Furthermore, initial mass quantities for the modelling of the foreground system are adapted from the provided BoM and converted to USD following the same method for each flow, see explanation in section 7.2. Generic PSILCA background data is used consistently throughout the model. Only a minor inconsistency is found in that the social flows for the stakeholder category 'workers' are adapted to the Tier 1 manufacturer specifically, whereas for the other processes—the Tier 2 yarn production and distribution and retail—this is not done due to not having data available to adapt the generic PSILCA values for the social flows to the specific company. For the use phase, the social flows reflect the social conditions in the country, namely Germany, thus including only the flows for 'society' and 'local community'. Through the modelling of the product system, sufficient geographic context has been embedded.

The impact assessment methods are consistent with what was stated in the goal and s cope. Reference scales and corresponding PRPs are used consistently through the study, applying the pre-determined set of reference scales available through the PSILCA database.

7.4.3. Data quality analysis

The PSILCA database includes a data quality assessment that is currently only available through the Developer database (Maister et al., 2020). As the Professional database was used for this assessment—and the data quality assessment is not included here—the social data from the database cannot be assessed.

A few things can be said about the three aspects of data quality as defined by (UNEP, 2020):

- **Reliability**: Reliability is referred to as results being accurate as well as scientifically robust and consistent (UNEP, 2020). Results are consistent through having used the PSILCA database, and in the case of labelling them as 'social risks' reliability can be ensured. However, when labeling results from a worker-hour assessment as 'potential social impact', reliability cannot be assured due to the use of the worker-hours activity variable which does not have a causal link with all social indicators assessed. The Guidelines acknowledge the issue around the activity variable and state that this should be subjected to a sensitivity analysis (UNEP, 2020).
- **Validity**: It is questionable whether the worker-hour results can be interpreted as 'potential social impacts', since calling it this seems unfair to allocate for example illiteracy and sanitation coverage to specific products and companies.

- **Objectivity**: As this study is executed as a master's thesis from independent external perspective, the practitioner takes an objective perspective through which objectivity can be ensured.

7.4.4. Contribution analysis

Only for the worker hour assessment a meaningful contribution analysis can be done. This is because the direct quantification only calculates inventory results, that are further classified in risk levels by the manual way presented in section 7.3.1. The worker-hours assessment does allow—through the use of this activity variable—a contribution and sensitivity analysis to be performed, similar to what is part of the Interpretation phase in E-LCA. Appendix E (E.2) provides the process impact contributions, for which a top 5 of main contributors is added. Some insights should be highlighted:

- Regarding the subcategories for the stakeholder category 'workers', the garment manufacturing process is in almost all categories the highest contributing process, with a considerably higher contribution.
- The garment use process is the highest contributor for 'local community', with regard to the subcategories 'access to material resources for biomass', 'fossil fuel and mineral consumption', as well as 'industrial water depletion'. This is because this process is the most exhaustive in terms of water and energy use. However, it should be noted that for the production processes water use is actually not considered, while this would most likely lead to an even higher contribution. The garment manufacturing also appears to have a quite high contribution to subcategories of this stakeholder group.
- Also, regarding value chain actors and society a high contribution for the garment manufacturing process is found. Here, e.g., for illiteracy subcategories, the second largest contributor is the yarn production process most of the times.

7.4.5. Sensitivity analysis

The robustness of results should be subjected to sensitivity analyses (Guinée et al., 2002). Here, the influence on the results in terms of variations in process data, variables, and modelling choices is assessed. Therefore, aspects which should be analyzed on their sensitivity in this study are presented below, as well as reasoning of carrying out sensitivity of each aspect;

- The yarn production process
    - Costs of viscose versus cotton
        - Now: assumed viscose to be 15% less costly than cotton
        - Sensitivity: 10 and 20%
        - ***Reasoning**: viscose as a raw material is less costly than cotton, but no exact prices are provided in this regard. Therefore, the 15% is an assumption retrieved from grey literature (see Appendix E), and a +-5% sensitivity should be applied. When available, primary data on the costs of these materials should be used.*
    - Transportation distance from the cotton fiber sourcing to the production location
        - Now: assumed 150 km
        - Sensitivity: 100-200 km

        - ***Reasoning***: *There is no information on the distance between the cotton fields and the cotton and viscose yarn factory. A 150 km is assumed, from a commonly known cotton cultivation area to the city where the supplier is located; therefore a +-50 km sensitivity seems reasonable.*
- Garment manufacturing
    - Energy usage during production (process data / modelling choice);
        - Now: not modelled (as it is on-site produced renewable energy through solar panels);
        - Sensitivity: Including the solar panels, by adding the manufacturing of glass and aluminum, through available PSILCA sectors ('Manufacture of glass and glass products' and 'Manufacture of fabricated metal products')
        - ***Reasoning***: *not modelling any energy usage leaves out the social impacts behind the production of the solar panels (through which the energy is generated). Therefore, these should be added, but no sufficient sector is available through PSILCA, and sensitivity analysis can be conducted through modelling these as above mentioned.*
- Distribution and retail
    - Transportation distance
        - Now: 300 + 14460 + 554 km
        - Sensitivity: for each process + and — 15%
        - ***Reasoning***: *Transportation distances and exact locations of ports and distribution centra are not known. Appendix E and Appendix VI show the reasoning behind the transportation distances, which should be under sensitivity of around 15% to account for correcting errors.*
- Use
    - Washing detergent use
        - Now: without
        - Sensitivity: with washing detergent (through the proxy 'Manufacture of chemical products' PSILCA sector)
        - ***Reasoning***: *No information is available on amounts and kinds of washing detergent, whereas the missing of a relevant PSILCA sector is the biggest barrier in modelling this aspect. Through using a proxy it should be estimated to what extent modelling washing detergent could influence final S-LCA results.*
- Cut-off criterion
        - Now: 1e-5
        - Sensitivity: 1e-7
        - ***Reasoning***: *The PSILCA documentation* (Maister et al., 2020) *presents 1e-5 and 1e-7 as reasonable cut-off values. Therefore, both these values should be under sensitivity analysis.*
- Worker-hours activity variable values
        - Sensitivity: + and - 10%

- ***Reasoning***: *No primary data is provided on how many hours workers work at the different organizations for producing a certain output. Therefore, generic PSILCA values for this worker-hours variable are used. As these might not sufficiently reflect the actual amount of hours worked at the different unit processes, but they do provide a good estimate as it is based on research done by PSILCA developers, this value should be under sensitivity analysis of around a + and — 10%.*

7.5. Key findings

This assessment has identified product-specific social risks and potential social impacts as social issues behind the product system of the garment range analyzed in this study.

The direct quantification method identified very high risk for 'Trade union density', 'Extraction of biomass', 'Level of industrial water use', and 'Indigenous people rights protection index'. These can be traced back to a (i) very high risk regarding 'Trade union density' for the garment manufacturing process, and (ii) a high risk on level of 'Industrial water use' for the distribution and retail as well as use phase. However, the different foreground processes with their related social flows do not show risks on 'Extraction of biomass', or 'Indigenous people rights protection index'. The limitation of the method is hereby shown, as it cannot provide any more detail on which processes contribute to this high risk classification. For example, the high risk related to 'Indigenous people rights protection index' is related to background processes that cannot be more specifically identified. An overview of all subcategories and their identified risk levels is presented in Appendix XI.

The worker-hour assessment identified levels of 'med risk hours' for each subcategory. This method shows outcomes more similar to E-LCA, where the assessment of two alternatives provides insights into better performance of one product against the other in terms of potential social impact. This method does allow for contribution analysis and identified that potential impacts for the stakeholder category 'workers' are mostly related to the garment manufacturing process in Bangladesh, as this process also contributes most in terms of worker-hours. Generally, the garment manufacturing and yarn production processes score high contribution related to 'labor conditions' and 'human rights' aspects. Furthermore, the distribution and retail process contributes highly to 'health and safety aspects', 'violations of regulations', 'GHG footprint', and 'promotion of social sustainability'. Lastly, the use phase of the garment contributes mostly on of 'local community' aspects, e.g., on 'biomass, fossil fuel, and minerals consumption', as well as 'industrial water depletion', 'unemployment', and 'migration'.

Calling these 'potential social impacts', however, should be noted as unfair, as the worker-hour activity variable only should only be applied to worker-related social flows, while so far, it has been applied as an activity variable over all subcategories in S-LCA.

7.6. Methodological comparison and evaluation of results

The PSILCA database as a social risk database was used to identify social risks related to a certain product system. Using the direct quantification method, certain social risks can be identified per foreground process (i.e., classifying the social flows for each process in the risk classes through the evaluation scheme of PSILCA). This is of interest for the specific company involved in this specific process, whereby identifying social risks on process level is an added value of this method. However, the life cycle perspective, when assessing the life cycle inventory results in terms of risks, does not provide any additional insights as compared to the social flows per unit process and thus per involved organization—when the generic PSILCA flows are adapted to company-specific data. The life cycle calculations can even show very unexpected results, e.g., a high risk on 'Indigenous people rights protection index' is identified, which is not at risk in any of the foreground processes. This result thus actually raises even more questions on where—which background processes—this high risk can be traced back to. Therefore, this method is useful in terms of its ability of assessing the risks of social flows per foreground process—i.e., identifying each value for the social flow and evaluating these through the assignment of risk classes to these values. Additionally, it does provide relevant insights of background processes, but the limitation of no contribution analysis leads to the method not being of great use as of now.

The worker-hours assessment allows for life cycle calculations more in line with E-LCA. However, the use of this activity variable—although highly debated already amongst S-LCA practitioners (see section 3.6)—does not portray 'fairly' potential social impacts related to a product, as the fact that a process takes place under certain social conditions—e.g., a high illiteracy rate in a specific country- should not be related to a certain product system as a 'potential social impact'.

8. S-LCA – company-specific assessment

As mentioned, the UNEP Guidelines do not provide any predetermined reference scales but leave the establishment of reference scales up to the practitioner. The PSILCA database already includes an established set of reference scales in the database. However, when conducting an S-LCA through other means and in the form of a company-specific perspective, these still need to be developed.

The presented PSILCA assessment in chapter 7 only stayed at the generic level. An additional site- or company-specific assessment therefore is desired to complement generic-level data with company-specific data (UNEP, 2020). This can be done through several ways, e.g., through adjusting specific social flows in the PSILCA database to be more fitting to the specific organization (thus complementing generic data with site- or company-specific data—allowing for a product-oriented study), or via other established impact assessment methods (UNEP, 2020). The first approach was added to the generic assessment, but it was only limitedly possible to adjust a few social flows related to the Tier 1 manufacturer. As mentioned, different practitioners each developed their own methods for developing reference scales (e.g., Ramirez et al., 2014; Wang et al., 2016).

Other than the social risks or potential social impacts identified through the generic assessment, namely by the direct quantification (social risks) and worker-hours method (potential social impacts), through the Subcategory Assessment Method (SAM) of Ramirez et al. (2014) the social performance of products is identified through the social performance of involved organizations. It was therefore chosen to do a complementary company-specific assessment, using the assessment method of Ramirez et al. (2014)—being an company-oriented impact assessment characterization model—to compare outcomes of the assessment methods. This allows for evaluation of different S-LCA assessment methods and their corresponding concepts under assessment—i.e., social risk, potential social impact, and in this case social performance. As SAM specifically focuses on the social profiles of organizations (Ramirez et al., 2014), it is thereby in line with a social-organizational approach as suggested by Zamagni et al. (2011) and addressed in section 1.2.6. The Subcategory Assessment Method is a characterization model used in the Impact Assessment phase of S-LCA. Therefore, the assessment is presented hereafter by following the four phases of S-LCA in line with ISO14040 and the framework of the Guidelines (UNEP, 2020).

8.1. Goal and Scope

The goal and scope definition of this company-specific assessment is different from the goal and scope definition of the generic assessment. This is because the methods used—SAM for the company-specific assessment and PSILCA for the generic assessment—are inherently different. Where the goal of the company-specific assessment is the assessment of company and product social performance, for the generic assessment the goal is more centered around the product system and social risks and potential social impacts occurring in various stages in the system. The scope definition for this company-specific assessment is company-oriented, over a product-oriented scope presented in section 7.1.2, which involves a FU approach.

8.1.1. *Goal definition*

The goal of the company-specific S-LCA is to assess the social performance of the garment range based on the social performance of companies involved in the product system. The study can be used by the fashion brand as a basis for acquiring insights into the social performance of their product range. These insights can then form a foundation for decision-making with regard to improving the social performance of the garment product range. Furthermore, the S-LCA research field can acquire relevant insights—for further development of S-LCA—regarding how different RS S-LCIA methods compare to each other in terms of their methods, their basic concepts, and difference in insights acquired.

8.1.2. *Scope definition*

The garment range under study has been introduced in chapter 4, and corresponds to the product under study as assessed and reported before in chapters 6 and 7.

As mentioned, this assessment takes a company-approach. As there is no information available on companies involved during the use phase—e.g., the companies providing energy and water for washing—, this stage is left out of scope. Therefore, the scope of takes a cradle-to-retail approach.



Figure 23. Cradle-to-use supply chain of the garment range

Figure 23 shows all different organizations involved throughout the product system, from fiber production up to consumer use. Data through questionnaires and interviews were acquired for the prioritized organizations—the fashion brand, Tier 1 manufacturer and Tier 2 yarn supplier—introduced in chapter 4. Focusing on these companies leads to limitations, through excluding other organizations involved in the product system. Table 16 presents all different companies involved in the product system. The prioritized fashion brand, Tier 1 manufacturer and Tier 2 supplier are highlighted. When looking at the other—non-prioritized—companies involved, it can be seen that it is either unknown which companies these are (in the case of transporting parties), or these are Tier 3 suppliers. Regarding the latter, these are the chemical or elastic suppliers, which supply materials which mostly only account for a maximum of 0.05% in the percentual weight share of the final garment, therefore do not provide 'main' ingredients (see the BoM in Appendix A). The only company (company A in Table 16), which has a higher share in the material ingredients—a 14.5% share of weight by printing chemicals—, has not been included in the assessment as a prioritized organization due to its positioning as a Tier 3 supplier while not having direct contact with this supplier.

Table 16. Companies involved in product´s life cycle. Prioritized companies highlighted.

Stage	Design	Yarn production	Transport	Chemical, dyes, + elastic suppliers	Garment manufacturing	Transport and shipping	Distribution to retail stores	Retail
Company	Fashion brand	Tier 2 yarn supplier	Unknown company	Company A, B, C, D, E, F, G	Tier 1 manufacturer	Unknown companies	Unknown company	Fashion brand
Direct data?	Yes	Limited	No	No	Yes	No	No	Yes

For the SAM, no specific formulation of a FU is needed, as it approaches the product system in terms of social conditions at different organizations in which different processes throughout the product system take place. The social performance of a product is addressed through the social performance of involved companies, which is a characteristic of the product and involved companies and thereby the same for one product, 1 kg of product, or the product system, to give a few examples.

Data on the company performance is gathered through questionnaires and complementary interviews, as part of the SAM framework. Furthermore, this assessment method also makes use of the worker-hours activity variable for determining the importance of different companies in the product system. The data collection process for this assessment method requires a time-consuming process in the form of acquiring company-specific data through questionnaires and interviews (introduced in section 5.3). Therefore, it is needed to prioritize data collection (UNEP, 2020). Which stakeholder categories and subcategories will be included therefore is presented hereafter.

8.1.3. Stakeholder categories and subcategories prioritized

Following the UNEP Guidelines, impact subcategories (or subcategories) should be defined before starting the data collection process (UNEP, 2020). Research on the most relevant social indicators in the fashion industry for social assessment showed that most apparent social issues are related to employee health and safety, child labor, fair salary, employment security, avoidance of discrimination, and fair competition (Zamani, 2016). Together with the identification of social issues in the textile industry in chapter 1, plus information provided in grey literature and media (e.g., The True Cost movie by Morgan (2015)), stakeholder categories to be prioritized are identified and presented in Table 17. The stakeholder category 'Children' (see Figure 7) is left out due to the nature of the subcategories not being of direct applicability to the specific product system. An overview of the definitions adapted from UNEP (2020) of each subcategory is presented in Appendix XIII.

Table 17. Stakeholder categories and impact subcategories from UNEP (2020), prioritized in the generic and company-specific S-LCA.

Stakeholder categories	**Worker**	**Local community**	**Value chain actors (not including consumers)**	**Consumers**	**Society**
Prioritized Subcategories	- Freedom of association and collective bargaining - Child labor - Fair salary - Working hours - Equal opportunities/ discrimination - Health and safety - Social benefits/ social security	- Access to material resources - Safe and healthy living conditions - Local employment	- Fair competition - **Supplier relationships**	- **Transparency** - **End-of-life responsibility**	- **Public commitments to sustainability issues** - Contribution to economic development
Excluded subcategories	- Forced labor - Employment relationship - Sexual harassment - Smallholders including farmers	- Access to immaterial resources - Decolonization and migration - Cultural heritage - Respect of indigenous rights - Community engagement - Secure living conditions	- Promoting social responsibility - Respect of intellectual property rights - Wealth distribution	- Health and safety - Feedback mechanism - Consumer privacy	- Prevention and mitigation of armed conflicts - Technology development - Corruption - Ethical treatment of animals - Poverty alleviation

8.2. Data collection

As presented in section 5.3, the data collection process for this assessment happened through sending out questionnaires to the three prioritized organizations: the fashion brand, Tier 1 manufacturer and Tier 2 yarn supplier. The questions are adapted from the supplementary material of Petti et al. (2016), building further on the SAM as originally presented by Ramirez et al. (2014). See Appendix B for these questionnaires. Also a questionnaire was sent to an independent external auditor party on social compliance in Bangladesh—providing a 3rd party perspective to the Tier 1 organization. As mentioned in section 5.3 these questions relate to the prioritized subcategories presented in Table 17, and are adapted from Petti et al. (2016), and complemented with questions adapted from Grönkvist (2019). The questionnaire for the Tier 1 independent external auditor party involves background information on the Bangladeshi textile industry as well as the performance of the Tier 1 manufacturer compared to the average industry in Bangladesh. Complementary interviews are conducted as a follow-up on the answers in the questionnaire.

The Tier 1 manufacturer and independent external auditor of this manufacturer returned the questionnaires that were sent out and filled them in accordingly. It is identified that the Tier 1

manufacturer only answered the questions with 'Yes', 'No', or 'N/A' in most cases (see Appendix B, questionnaire B.2.). Sufficient background information therefore was lacking. The information from the independent external auditor in this case was very valuable, since this party answered the questionnaire in a very elaborate manner (see Appendix B, questionnaire B.3.). The fashion brand did not answer any questions in the questionnaire (see Appendix B, questionnaire B.4.), due to them having unclarity whether the questionnaire was aimed at the supply chain workers, or their own employees. Therefore, this party only provided information through a follow-up interview on supply chain aspects and referred to their publicly available information online (e.g., sustainability report and supplier policies). The questionnaire on the Tier 2 yarn supplier was filled in by the fashion brand (see Appendix B, questionnaire B.1.). This party itself was not approached since not having any contact details, and as contact with the different companies is established through the C2C® certifying consultant party Eco Intelligent Growth.

Follow-up interviews were held with the Tier 1 manufacturer, independent external auditor with regard to the Tier 1 manufacturer, and the fashion brand.

- The first interview was held with the fashion brand. Here, the Junior Sustainability Consultant and Sustainable Supply Chain Specialist of the fashion brand were able to provide information related to the supply chain perspective of the fashion brand. This included some information on their monitoring process—steps they take to monitor suppliers on labor conditions among other things—and answering all questions in the questionnaire related to their supply chain. For questions on internal policies, they referred to the sustainability report, where no further information was acquired. However, also an internal personnel guide was provided after the interview, providing necessary information on labor conditions and human rights for the fashion brand's employees.
- Secondly, the interview with the Head of Operations of the independent external auditor party was held. This party provided extensive information on the textile and RMG (Ready-Made Garment) industry in Bangladesh, as well as provided a third party perspective on the Tier 1 manufacturer. Information was not directly used but was used to better understand the Tier 1 manufacturer's context.
- Lastly, the interview with the Tier 1 manufacturer was held. Here, six people from the Tier 1 manufacturer's side joined the meeting, all specialized on different topics addressed through the questionnaire. Through this interview, some questions on which follow-up elaboration was deemed necessary was acquired. A barrier in English proficiency was identified, making this interview the least smooth of the three. It therefore was of extra value to have had the interview with the independent external auditor party beforehand, as this interview provided some context background information already.

8.3. Impact Assessment

In the Impact Assessment phase, data gathered in the Inventory Analysis was analyzed through the SAM evaluation scheme presented in Figure 20. Through this scheme, a company is assigned an A to

D score per subcategory. This is done through a Basic Requirement (BR) as a baseline performance reference point (PRP) that assigns certain levels to certain conditions as presented in section 5.2.1. These levels correspond with so-called 'reference scales'.

Appendix F provides this scoring framework in more detail and defines the BR and other PRPs through which companies are assigned different scoring levels. The following sections present the impact assessment of the SAM used in this study. As a first step, the companies are evaluated on their performance, using these established reference scales for assigning scores on each subcategory per company (section 8.3.1). This step thus assesses the social performance of the different prioritized companies. Secondly, the step to assess the product's social performance is presented. Here, the company-specific performance is evaluated on its share of hourly labor, using the activity variable worker-hours. This step is presented in section 8.3.2.

8.3.1. Step 1 — evaluation of companies

For the evaluation of the companies, the information acquired through questionnaires, interviews, and available policies—for the fashion brand available online, and for the Tier 1 manufacturer through the consultant party Eco Intelligent Growth—was used as input for the assigning of the different performance levels per subcategory. See Appendix F for this assessment. Table 18 presents the outcomes of this step.

Table 18. Organizational performance of the three companies over the prioritized subcategories.

Stakeholder category	**Subcategory**	**Tier 2 yarn supplier**		**Tier 1 garment manufacturer**		**Fashion brand**	
		Score	Data quality	Score	Data quality	Score	Data quality
Workers (in the case of the fashion company these are the fashion company's employees)	Freedom of association and collective bargaining	D	2,1,4 (2.3)	D**	2,1,5 (2.7)	-	No data
	Child labor	B or D*	2,1,5 (2.7)	A	2,1,1 (1.3)	A	2,1,3 (2.0)
	Fair salary	D	2,1,4 (2.3)	D	2,1,4 (2.3)	A	2,5,5 (4.0)
	Working hours	B	2,1,4 (2.3)	D	2,1,1 (1.3)	A	2,4,2 (2.7)
	Equal opportunities/ discrimination	-	No data	A	2,1,3 (2.0)	A	2,2,2 (2.0)
	Health and safety	-	No data	A	2,1,1 (1.3)	A	2,2,2 (2.0)
	Social benefits/ social security	B	2,1,1 (1.3)	A	1,2,1 (1.3)	B	2,1,2 (1.7)
Local community	Access to material resources	-	No data	B	3,1,3 (2.3)	N/A	N/A
	Safe and healthy living conditions	-	No data	B	2,1,1 (1.3)	N/A	N/A
	Local employment	-	No data	B	2,1,1 (1.3)	N/A	N/A
Value chain actors	Fair competition	-	No data	C	2,1,1 (1.3)	-	No data
	Supplier relationships	-	No data	A	2,1,1 (1.3)	A	2,1,3 (2.0)
Consumers	Transparency	-	No data	N/A	N/A	B	2,1,2 (1.7)
	End-of-life responsibility	-	No data	N/A	N/A	A	2,1,4 (2.3)
Society	Public commitments to sustainability issues	-	No data	A	2,1,1 (1.3)	A	2,1,1 (1.3)
	Contribution to economic development	-	No data	B	2,1,2 (1.7)	-	No data

* No information is available if the Tier 2 supplier has a child labor policy in place.
** Contradicting answers were provided by the Tier 1 manufacturer, leaving this scoring as under high uncertainty levels.
Data quality range: 1 (highest quality) to 5 (lowest quality).
A: complying to the BR, plus showing proactive behavior by promoting CSR on this aspect amongst suppliers.
B: complying to the BR, but not showing any proactive behavior on top.
C: not complying to the BR and the organization being immersed in a context described in C (see Appendix F).
D: lowest scoring. Not complying to BR and immersed in a negative context (see Appendix F).

Most of the categories remain unassessed due to insufficient data available to assess these categories. A few categories however could be assessed as shown in Table 18. As mentioned, this information all is provided by the fashion brand through the questionnaire on the Tier 2 yarn supplier, and no primary data from the Tier 2 yarn supplier or in the form of any specific policies was available for this assessment. Therefore, results are only based on information provided through the fashion brand but are not validated through the Tier 2 yarn supplier itself. This Tier 2 yarn supplier scores a bad social performance on three aspects. Firstly, 'freedom of association' and 'collective bargaining' scores a D, as the fashion brand mentions there are no unions in the factory, and no employees are belonging to a union. Thereby, the BR is not met, and as the supplier is located in India where the workers' rights score is a 5 (on 0 (best) to 5+ (worst) scale) (International Trade Union Confederation, 2022), a D score is assigned. Secondly, 'child labor' is assigned a D score, if the Tier 2 supplier does not have a policy in place, and as the sector conforms to 'worst forms of child labor' (MVO Nederland, 2022b). However, it is unknown if the supplier has a policy, in which case a B score should be assigned (see Table 18). Lastly, 'fair salary' scores a D, as the salary does meet legal standards but cannot be considered directly a living wage.

The Tier 1 manufacturer does not meet the BR on four aspects, namely 'freedom of association' and 'collective bargaining', 'fair salary', 'working hours', and 'fair competition'. 'Freedom of association' is assigned a D score, as no union is in place and employees can instead join an internal Participation Committee (PC). Where workers, according to their policy, are free to join any union, in practice no worker has joined any other association. This leads to the BR not being met and due to Bangladesh scoring a 5 on workers' rights (International Trade Union Confederation, 2022) a D is scored. Secondly, workers at the Tier 1 manufacturer earn a legal—significantly more than minimum—wage, but this wage is not considered a living wage according to their own provided calculations. Therefore, a D level is assigned. However, the company does provide an in-house food products store where workers can get food products for reduced price. It is unclear if the in-house food products store is factored into the living wage calculation. Furthermore, working hours is assigned a D level as on average 90% of the Tier 1 manufacturers' workers work 60 hours a week. They note with this that they comply to legal national requirements, where workers cannot work more than 48 hours a week plus a maximum of 12 overtime hours. However, the BR on average work weeks of 48 hours is thus heavily exceeded. A D score is assigned as this also exceeds the average hours worked in Bangladesh, set at 46.9 hours (ILOSTAT, n.d.). Lastly, fair competition scores a C level. This is caused by the company not having any documentation on fair competition, anti-trust legislation or monopoly practices. However, there are no records of proven cases that anti-competitive behavior is executed, therefore a level C is assigned.

The fashion brand meets, excluding the unassessed subcategories due to insufficient data being available, all the BR's of all subcategories. Both internally their labor conditions and human rights cover all BR requirements, as well as their supplier documents that are set up well on requirements of social aspects throughout their supply chains. Suppliers are monitored regularly, through formal assessments that lead to certain ratings, where fitting consequences are put in place. A critical note can be formulated on the occurrence of the fashion brand having "*No information available*" on many aspects of the Tier 2 yarn supplier, and e.g., on the aspect of child labor it was even mentioned that "*We cannot confirm for*

the Tier 2 yarn supplier, but as per our general experience, factories have child labor policies." Future research could investigate whether the fashion brand has additional information on these aspects.

8.3.2. Step 2 — life cycle calculations

As a second step, life cycle calculations can be made. This is done through the use of the activity variable worker-hours. According to Ramirez et al. (2014), this involves combining the scores of different companies per process into specific subcategories (i.e., in process 1 of the product system, different companies are involved, all with their different social performance scores. The shares of the different companies in terms of worker-hours involved in the process, can identify the highest contributing performance level per subcategory in this specific process). Using a life cycle perspective, this method evaluates the social performance of a product based on the performance of the companies involved, as described by Ramirez et al. (2014). Petti et al. (2016) approach this step by aggregating the performance also further by the subcategories. This results in an overview of a stakeholder category, and corresponding 'average' social performance for each subcategory, based on the company performances—without presenting these results per process.

For this assessment, only three companies, namely the Tier 2 yarn supplier, Tier 1 garment manufacturer, and fashion brand are assessed. In the actual product system, however, several other organizations and Tier 2 suppliers are involved, i.e., on the supply chemicals, dyes, and elastic, as well as packaging and transportation. The results for this step in the SAM therefore can only be aggregated to each subcategory based on the social performance of the three organizations.

During the product system, these three organizations are involved with different shares in worker-hours. As a reference flow, 1 kg of garment is taken. For this, 0.747 kg of yarn is needed, corresponding to a 0.624 worker-hour value (i.e., for the production of 0.747 kg, 0.624 hours of labor is performed). For the production of 1 kg garment, the Tier 1 garment manufacturer works for 3.97 hours (including all processes from knitting to preparing for transport). The fashion brand participates in both the design and retail processes, but there is no data available on how many hours of work are involved in these processes for the production of 1 kg of the garment. It is noted that assigning such a value to these processes in the product system is very difficult to quantify. An exemplary assumption is made that for both the design as well as the retail step, 0.001 hours of labor is performed—still with the reference flow of 1kg. However, no sufficient information is available to base any value on: it is highly impossible to be able to allocate a certain amount of time to 'the design of 1 kg of garment' and the 'retail of 1 kg of garment' by fashion brand employees. Given the large quantities in which the product is produced, it is reasonable to assume that the design and retail processes for 1 kg of the garment have a negligible amount of working hours. For the purposes of the assessment the amount of hours spent by the fashion brand employees will anyways not outweigh the 3.97 worker-hours during the garment manufacturing phase. As also companies are involved in the chemical and elastic production, as well as transportation in different phases of the product system, these should be considered but are left out for this assessment in terms of data unavailability.

These figures lead to a percentual contribution of an hour of work performed in the product system as follows (see Appendix F for calculations): Tier 2 yarn supplier: 14%; Tier 1 garment manufacturer: 86%; and the fashion brand: 0%.

This means that the social performance of the Tier 1 manufacturer contribute with a 86% to the product system as compared to the 14% of the Tier 2 yarn supplier, comparable to a neglectable 0% of contribution in terms of worker-hours by the fashion brand. Scaling the qualitative indicators (level A to D) to a numerical scale (Table 19), then can identify the product's social performance throughout its life cycle. This is presented in Figure 24.

Table 19. SAM Scale for interpretation of qualitative indicators on quantitative scale. Adapted from Ramirez et al. (2014).

Scale of levels	**A (best)**	**B**	**C**	**D (worst)**
Numerical scale	4	3	2	1

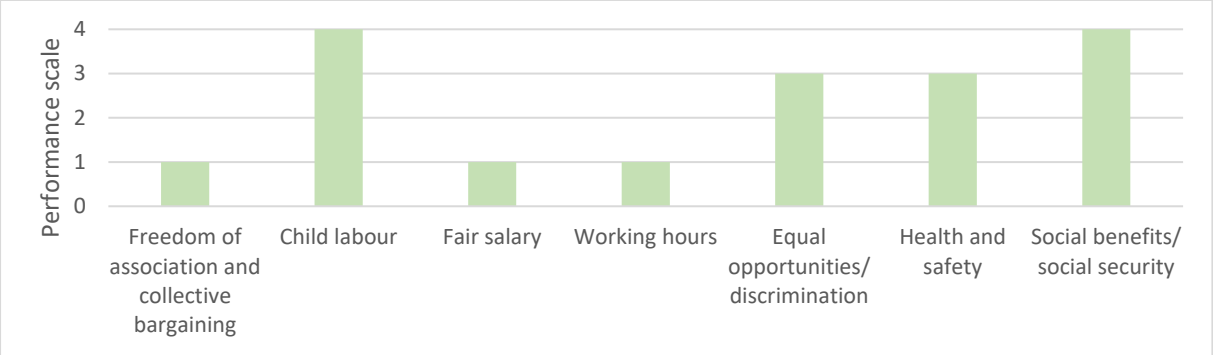


Figure 24. Results of worker subcategories´ assessment evaluation through life cycle calculations following SAM.

Results show a very good performance in terms of child labor—the garment manufacturing factory does not have any child labor and has adequate policies in this regard—, as well as social benefits/security—the organization provides many social benefits and security aspects to their workers. Lowest performance is found in terms of fair salary and working hours; the wage the workers receive cannot be considered a living wage, and employees work for 60 hours a week.

UA few aspects should be mentioned:

- The Tier 1 manufacturer has a contribution of 86% in terms of hours of labor performed throughout the garment's life cycle. This leads to the results in Figure 24 directly reflecting the social performance of the Tier 1 manufacturer as shown in Table 18;
- Through leaving out many Tier 2 or transportation companies involved, the share in terms of hourly labor performed is different from the actual situation;
- Only the stakeholder group 'workers' is assessed. This is because for the Tier 2 yarn supplier only categories for this group were assessed—due to data unavailability.

A further evaluation of these issues is provided later in section 8.5.

8.4. Interpretation

Here, completeness and consistency checks are presented, followed by conclusions, limitations and recommendations—following the requirements of the Interpretation phase presented by UNEP (2020). The completeness check and consistency check are presented in a narrative way, answering the questions on completeness (UNEP, 2020, p.110) and consistency (UNEP, 2020, p. 111) presented in the Guidelines.

8.4.1. Completeness check

The goal and scope are clearly defined in section 8.1., presenting stakeholders and subcategories included for which reasons. A life cycle perspective was taken with the largest scope possible in terms of data availability and whether applicable for this assessment—i.e., the exclusion of the use phase is justified through not having direct companies involved in this phase, as well as not having data available e.g., on the specific company providing the energy and water for washing during use. In the Inventory Analysis phase data is collected for evaluating the performance of companies on the different subcategories. Not for each category sufficient data was acquired, therefore these were left out of scope. For the categories that were assessed, a data quality check was added. Regarding the impact assessment, the different subcategories covered were sufficient for addressing the social performance of the companies involved. For the assessment of social performance of the product itself, only the stakeholder category 'workers' is considered as the other stakeholder categories were insufficiently assessed through not having sufficient data available. Additionally, some gaps can still be found in terms of companies involved in the product system which should be under assessment as well.

8.4.2. Consistency check

The next step in the Interpretation phase is the consistency check, to ensure the method and data used are applied consistently throughout the study. The terminology in the study is used consistently, regarding that this study evaluates the product's social performance through means of the social performance of the prioritized organizations involved in the product system. In the Inventory Analysis phase, some inconsistencies are found in quality of data, presented in Table 18. There was however no further consistency possible as no more data was provided. The impact assessment method (SAM) is consistent with what was stated in the goal and scope, and the different PRPs are duly documented in Appendix F. Lastly, the results are aggregated allowing interpretation in line with the goal and scope.

8.5. Key findings

Through the SAM, the product's social performance is assessed—based on the organizational performance of companies involved—throughout its supply chain. The performance of the product is assessed for the stakeholder category workers, and therefore includes labor conditions and human rights aspects regarding labor performed by workers throughout the product supply chain, until the garment use phase. In terms of child labor, equal opportunities and discrimination, health and safety and social benefits/ social security the product performs well. A lower performance is identified for the categories of 'Freedom of association and collective bargaining', 'Fair salary' and 'Working hours'. This performance is reflected through the Tier 1 manufacturer's performance as a company, because of its

86% contribution to the product system in terms of labor hours. Hereby, it does not reflect the actual system where also several other companies (i.e., chemical, dyes and elastic suppliers, as well as transportation and distribution parties) are involved, but not included due to data unavailability.

The Tier 1 manufacturers' performance can be improved on the three mentioned aspects where lower performance is identified. It should be noted however that this party is performing significantly better compared to the average performance of similar companies in Bangladesh, as the independent external auditor mentions. Whereas still improvements should be made, the company is performing relatively well as compared to its local industry, where many more systemic changes should be implemented for bettering the local RMG industry in terms of its social performance.

The fashion brand performs well in terms of internal performance on all subcategories. Their supplier monitoring on the Tier 2 yarn supplier should be evaluated to see whether more specific information can be found on this Tier 2 supplier to properly include this party in the assessment as well.

8.5.1. Identified SAM limitations and methodological insights

Some limitations on the BR's formulated by Ramirez et al. (2014) should be mentioned:

- The BR of 'Freedom of association and collective bargaining' is set up as the evidence of employees being member of at least one union. However, if this is not the case, it does not directly mean that workers do not have any freedom of association. This is not considered in the assessment. Also, a misalignment is found here with the Methodological sheets (UNEP, 2021), as there the subcategory is formulated including the aspect if workers are free to form and join associations, as well as the right to strike—these not being covered in the BR;
- The BR on 'Fair Salary' is formulated on assessing the compliance of the wage as higher than minimum wage. In the assessment, an additional requirement is added that this wage also can be considered living wage—in line with the definition in the Methodological Sheets (UNEP, 2021). Therefore, not including the aspect that the worker's wage can be considered a living wage is a shortcoming in the initial BR formulation by Ramirez et al. (2014);
- The BR on 'Working hours' does not consider low weekly working hours, but only focuses on exceeding 48h a week. Therefore, risks related to employment of only a few hours a week are not considered;
- Regarding 'Equal opportunities/ discrimination' there is another misalignment with the BR and the Methodological sheets (UNEP, 2021), particularly regarding the classification of an organization as C or D. The BR includes discrimination based on gender inequality, race, color, religion, political opinion, national extraction, or social origin. For the classification of an organization as C or D, however, the Global Gender Gap Index 2022 score is taken, meaning this only addresses gender inequality — leaving out the other aspects on which can be discriminated.

Furthermore, some methodological insights are acquired after performing the SAM to this specific case:

- The SAM does not allow for adding assumptions on not-included companies, as company-specific performance is used as data input. Therefore, when not having company-specific

performance data available, these parties immediately are left out of the assessment. Assumptions can be made on e.g., the share of transportation and manufacturing of chemicals, dyes, and elastic, adding these to the equation of contribution of hourly labor. However, as no data is then available on the performance of these stakeholders, final assessment results cannot be achieved;

- For the specific product system under study, together with its data availability, the second step in the Impact Assessment does not have any added value, as the results directly reflect the social performance of the Tier 1 garment manufacturer. Therefore, step 1 presents better information;
- Only addressing step 1 would however not lead to the method performed given the label 'S-LCA', as no life cycle calculations are performed. Concerning this specific assessment, the method of step 1 allows for a performance assessment of companies involved, thereby being of value but rather referred to as e.g., a 'qualitative company social performance assessment'. The second step is of great value and can be approached as an Impact Assessment method for S-LCA but requires data of—ideally—all different organizations involved, which is very time consuming and difficult to collect;
- To make the assessment feasible, subcategories should be prioritized for data collection purposes, leaving some subcategories out of scope of the assessment. This, however, goes against the original motivation of Ramirez et al. (2014) on developing a method allowing for assessment over all subcategories;
- In this assessment only the stakeholder category 'workers' was assessed in the second impact assessment step. This is due to data unavailability for the other stakeholder categories with respect to the Tier 2 yarn supplier (see Table 18). However, if this information were to be available, these categories still would be assessed through the worker-hour activity variable, whereas this variable does not directly relate to stakeholder categories other than workers;
- The SAM step 2 calculates over a life cycle, using the worker-hours activity variable which is transformed to the percentual contribution of hourly labor of companies in the product system. This thus means that no scaling to a specific FU takes place, but rather the performance of the social context around the product system is evaluated. This performance does not have any specific unit, and thus is the same for either one product, 1 kg of product, or the whole product system, to give a few examples, and even for any other textile product system situated in the same social context.

9. Discussion

ISO 14040 defines LCA as the "*compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle.*" As a tool for the analysis of environmental burdens throughout a product system, LCA allows for assessment at all stages of a product's life cycle (Guinée et al., 2002). In E-LCA an important step is the scaling of impacts to a certain FU—the quantified function as unit of measurement allowing for comparable assessments between two products, for example. Hereby, scaling to this unit can help to support decision-making in product design through assessing different material inputs and allow comparison between different products.

Taking a life cycle perspective, both E-LCA and S-LCA aim to provide a comprehensive and holistic assessment of impacts from a certain product or system. For both E-LCA and S-LCA this requires a vast need for data, gathered through iterative processes. Where E-LCA solely focuses on the quantification of environmental impacts associated with a certain product or service, S-LCA focuses on the social pillar of sustainability, aiming at quantifying social impacts related to a product or service.

The development of the S-LCA Guidelines (UNEP, 2020), has contributed greatly to the development of S-LCA as it has offered a uniformed framework accommodating a methodological discussion as basis for further development. These Guidelines really steer towards the adoption of E-LCA-like calculations: adopting a FU approach and using a social database with the worker-hour approach to scale social flows to a certain reference flows. Adopting this E-LCA-like framework and FU approach leads to S-LCA only being able to include limited (quantifiable) social issues in the assessment. This, however, does not allow for the processing of the qualitative and semi-quantitative nature of social data. Therefore, social assessments can greatly benefit from also including an organizational perspective: approaches barely recognized in the UNEP Guidelines. The Guidelines only present a short chapter at the end on approaching S-LCA from an organizational perspective—this only being an assessment method on assessing a specific company on its risks or potential impacts, instead of an assessment on a product system and companies involved herein (like the approach SAM takes).

The adoption of this E-LCA like framework comes with many identified consequences, the approach to the FU as mentioned above being one of the core ones. Therefore is of importance to adequately address methodological connections and disconnections that can be found by comparing S-LCA with E-LCA, as will be discussed in this chapter. Firstly, section 9.1 provides a discussion on the difference of results retrieved through the assessment methods, after which the following six sections address aspects on (dis)connections between S-LCA and E-LCA. Section 9.8 presents a short summary, and lastly limitations are presented in section 9.9.

9.1. Comparison of results through different methods used

Through the assessments (presented in chapter 6, 7, and 8) being inherently different from each other, different results are found per assessment. Appendix XIV shows an overview table of the main assessment results to allow comparison of results per life cycle stage.

This overview showcases different social risks, potential social impacts, and highlights issues related to the performance of different companies involved in the product system. The overview allows for an informative basis on the risks which should be evaluated and prioritized in decision-making processes for improving the social sustainability of the product system and involved companies. Hereby, assessment results are both informative for the fashion brand—allowing for insights on the specific product system—as well as e.g., the Tier 1 manufacturer on insights on their business practices and related performance.

Some important product-specific aspects are identified:

- Insufficient information was available to adequately address the Tier 2 yarn supplier as an organization. The sector in which the yarn production process takes place is however subject under many notable social risks, i.e., child labor and no freedom of association, identified through e.g., the CSR Risk Tool, a qualitative review of the industry, and the PSILCA database;
- The Tier 1 garment manufacturer can be held responsible for its poorer performance on freedom of association, weekly working hours, and gender inequality—identified through both the PSILCA as qualitative social risk and performance assessment. Other risks associated with the industry are e.g., sanitation coverage, trade union density and a poorly scoring illiteracy rate, which are not of direct responsibility of the company but rather a societal issue related to Bangladesh;
- Risks identified for the distribution and retail process do not have a causal link with the fashion brand. The brand itself has adequate policies in terms of its internal labor conditions—i.e., for designers or employees in the retail stores—as well as the supply chain perspective. It should, however, be evaluated what has caused the fashion brand to not be able to confirm any issues related to the specific Tier 2 supplier, e.g., in terms of the existence of a child labor policy. Clarity on this aspect can either identify that the fashion brand has an insufficient monitoring system or not, as well as it can bring clarity regarding the performance of the Tier 2 yarn supplier, e.g., in terms of its performance regarding child labor;
- The distribution and retail as well as use processes should be investigated more in-depth to be able to adequately address these in the assessment and interpret its results.

Furthermore, some methodological aspects are identified by comparing the assessment results:

- The assessment results from the PSICLA assessments (direct quantification and worker-hours method) identify quantifiable social risks, overlooking any of the non-quantifiable issues identified through the SAM or qualitative assessment. For example, the important identified aspect through the qualitative social risks and performance assessment on female workers being employed in more low-skilled positions and having less or no opportunity to work at managerial positions, is overlooked in a quantitative S-LCA—which only is able to identify a quantifiable 'gender wage gap';
- Whereby the worker-hours assessment is able to identify contribution of a process to a certain indicator and the direct quantification method allows for identifying social risks, the two assessment methods show a great difference in results. Even though the basis of both

methods—the same product system modelled in LCA software—is the same, the use of the worker-hours activity variable and difference in nature of calculations makes these assessments inherently different in terms or results and interpretation. One noticeable aspect is the worker-hours assessment not allowing for proper adaption of some company-specific flows. The relation to the FU and the company is made through this variable, but does not reflect the value behind this in the database. For example, when modelling the garment production process in Bangladesh by copying the social flows of the PSILCA 'Textiles and Wearing Apparel' sector of Bangladesh, adjusting the worker-hours variable does not account for the data behind this being adjusted: the indicator 'weekly hours of work' is set at 44.58 hours in the database for this sector, whereas, for example, for the Tier 1 garment manufacturer it is the case that workers work for 60 hours a week. Being unaware of this issue can lead to faulty outcomes using the worker-hours method;

- It should always be carefully evaluated if a causal link can be found between the organization and the identified risks or potential social impact through S-LCA. If this is not adequately addressed, organizations might carelessly be pointed on some issues that they have not caused themselves—but rather are higher level issues related to the sector or country;
- A purely qualitative social risk and performance assessment as well as SAM show great potential for being better-equipped social sustainability assessment methods compared to product-S-LCA. However, as no use can be made of a database—other than general identification of risks through e.g., the CSR Risk Tool (MVO Nederland, n.d.)—, these assessments require extensive data-gathering processes, and improper assessments when data is gathered to a lesser extent.

9.2. Terminology

Social aspects under assessment: By assessing social sustainability of the garment product range from different methods, it is found that different social aspects are addressed per method. Through the purely qualitative method, social risk and performance are assessed both on sector- and company-level. This assessment allowed for assessing companies with a cradle-to-retail scope of the product system. Via the social database approach to S-LCA, potential social impacts and social risks are assessed, whereas the SAM approaches S-LCA from an organizational perspective and allowed for assessing company- and product social performance. Even though recognized before (e.g., by Petti et al., 2018), the newly updated UNEP Guidelines of 2020 are still not clearly presenting the difference between 'social performance', 'social effects', 'social risks' and 'social impacts'. Also in literature 'social impacts' are confused with e.g., 'social effects' (Chhipi-Shrestha et al., 2015; Macombe et al., 2011; Petti et al., 2018). Through the process of this study it is additionally identified that practitioners of social sustainability studies would greatly benefit from a proper definition of the various concepts and their differences, and an clear overview of which concept is addressed by which exact method. Properly addressing these concepts and their differences is of importance, as in S-LCA a great complexity is found in levels of data that can be used: generic data, unit process data, as well as company- or site-specific data are considered. Compared to E-LCA, S-LCA considers more levels of data due to its nature

of being linked to the 'human' aspect over an 'environmental aspect'. This is due to the stakeholder perspective which is added to the equation, as well as the nature of qualitative social data being inherently linked to several social issues and related indicators.

Terminology differences S-LCA and E-LCA: The UNEP Guidelines deviate on a few aspects from terminology as commonly used in the E-LCA field. For example, in E-LCA an 'activity' is the same as a 'unit process', whereas in S-LCA terms an 'activity' relates to a human or social activity that corresponds with a certain 'process' or 'unit process': e.g., the process of producing the garment comes with the activity whereby human labor is involved to transform a piece of fabric to a T-shirt. This labor is referred to as 'worker-hours' as an 'activity variable', reflecting the labor in terms of hours that is performed in this process. An 'activity variable' can be easily confused with a 'scaling factor' in E-LCA terms, whereas the UNEP Guidelines do not address the correspondence between these aspects and thus leave it up to the reader to make the link between these two. Where the scaling factor represents the amount of intermediate product flows (in monetary terms) needed to produce the output of the FU—same as in E-LCA—, the activity variable represents the amount of hours needed to produce the specific reference flow of the unit process. This variable can also be seen as a certain weighting factor on unit process level, as it reflects the greater importance of one unit process in terms of contribution with a higher amount of worker hours. Lastly, social flows are generally referred to as 'inventory indicator'. This is a counter-intuitive combination of words compared to E-LCA where 'indicator' refers to the LCIA phase. Figure 25 presents this concept placing S-LCA next to E-LCA and LCC pathways.

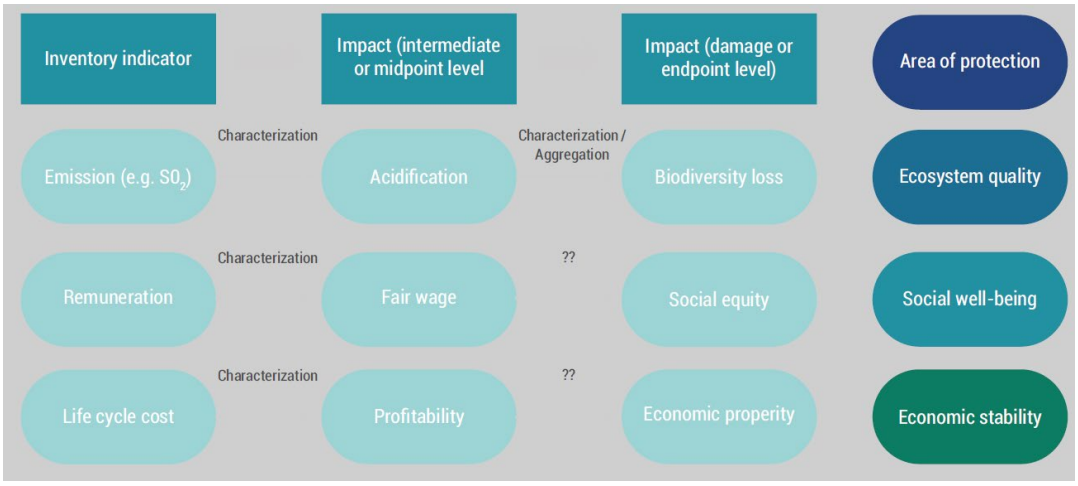


Figure 25. Impact pathway schemes for LCSA (from UNEP (2020)).

9.3. Complexity of data levels

For the sourcing of data, E-LCA uses both primary data as well as secondary data from databases. These databases usually present process data organized around unit processes, relating economic inputs to outputs and environmental inputs and outputs (Guinée et al., 2002). An example of a widely-adapted environmental LCA database is ecoinvent. Primary data from e.g., a company is often also organized around these unit processes. For S-LCA the same principle applies; collecting primary data at every unit process throughout a product's life cycle is not necessarily needed, but primary data gathering

should be prioritized in terms of stakeholder- and subcategories of most relevance to the assessment. Databases can be used complementary, possibly through using a proxy process or sector.

Data resolutions of environmental and social databases: When including many life cycle phases to an assessment, many different processes are involved, which on its turn are also linked to their own network of processes. Therefore, it is needed that system boundaries are set and processes where no primary data is available for, can be linked to background processes from databases. In this regard E-LCA has more extensive and further developed databases to fall back on, including many different production processes in different geographical regions. These life cycle inventory (LCI) databases are collections of datasets describing the inputs and outputs of economic processes. Taking the example of the ecoinvent LCI database for E-LCA, a global geographical coverage is provided in terms of a 'market' that reflects the market of a certain product. Producing processes are more regionalized. However, this is not aligned for each country. Many times there is referred to only a few countries—Switzerland being the most pronouncedly dominating as the development of the database origins here—, and other regions being referred to as e.g., 'Europe' or 'Rest of World'. Comparing this database to a social database as PSILCA, where data is presented on country and sector level, social data reflects a more specific geographical scale (e.g., 'Bangladesh' in PSILCA instead of 'Rest of World' in ecoinvent). The technological level of the specific process, however, is at a way lower resolution in the PSILCA database as this database only reflects a few sectors of the corresponding country. Therefore, not always a sector is present in the database to correspond with a certain process in the product system and low resolution proxy data should be used. For example, for the Tier 1 garment manufacturing process, many goods are left out of scope as also no data is available through PSILCA—e.g., water use could in no way be included in the system as no corresponding sector is available through PSILCA. This also has to do with the lower maturity level of social databases compared to environmental databases, which started development only in the last decade.

Data levels and collection: The 'company-specific' or company-level assessment (e.g., the SAM presented in chapter 8) is a widely accepted approach amongst S-LCA practitioners (Wu et al., 2014)—although not properly recognized in the Guidelines. For S-LCA, data can be collected on a generic level through the above mentioned social databases, or via surveys and interviews. In E-LCA, data generally is collected through these generic LCI databases, or via site-specific unit process data. Through different assessments with different levels of data collected, S-LCA can identify many different social issues at these different levels, all relating to different assessment terms—i.e., social risks, potential social impacts and social performance. Using a mix of both generic and company level data is done through social database approaches to S-LCA (i.e., the PSILCA worker-hours and direct quantification method) leads to low granularity of input data as well as results. Part of the results on social risks are company-specific, while for most risks they depend on the sector as well as country where the sector operates.

9.4. Nature of data

Data for E-LCA is quantitative of nature, whereas social data can also be purely qualitative or semi-quantitative. As E-LCA correspondingly only has quantitative impact assessment models, these have a

linear link with a FU. Different impact assessment models developed in the field of S-LCA include also more qualitative approaches to impact assessment, which can, for example categorize qualitative and semi-quantitative data in a semi-quantitative framework using reference scales. Through an impact assessment method like SAM, data sources as company reports, governmental statistics, or interviews and surveys can be translated to semi-quantitative frameworks.

Positive and negative indicators: The assessments in this study have mostly focused on negative aspects of social sustainability, through approaching social aspects from a risk perspective. The Guidelines provide an extensive set of stakeholder subcategories (Figure 7), all assessed through indicators from a 'social risk' perspective. The subcategories itself are not necessarily implying approaching them from a negative side. For example, child labor or corruption already imply a social 'risk' or negative aspect, whereas equal opportunity or fair competition do not necessarily imply approaching these categories from a negative perspective. How they are assessed, however, are through indicators on gender wage gap, men and women ratio, or presence of anti-competitive behavior or violation of anti-trust and monopoly legislation—all from a 'social risk' perspective over 'opportunity' (see e.g., Appendix V). The UNEP Guidelines (2020) do present that S-LCA addresses both positive and negative impacts—a distinction that is not made in E-LCA. Important aspects of social sustainability are aspects like job opportunities for unskilled people, or reducing poverty by providing job opportunities, currently remaining unassessed. It might be that social labor conditions are poor, but nonetheless (positive) livelihood is created for workers and possibly local communities. Therefore, there might be an added value for S-LCA additionally addressing positive impacts.

Only one category ('contribution to economic development') reflects something 'positive'—this aspect presented in the PSILCA database as an 'opportunity'. However, the absence of a negative impact, e.g., no child labor in the product system, is not referred to as a 'positive impact'. In E-LCA, no distinction is made between positive or negative impacts, where impacts are directly referred to as negative. In E-LCA software there is only referred to as positive and negative in terms of values for emissions as part of modelling these flows; if taken from the environment these are referred to as negative, whereas when returned to the environment (particularly another environmental compartment) these are referred to as positive (Guinée et al., 2002).

S-LCA methodology does not adequately address positive impacts, leading to not being able to match any social risk against opportunity created through a specific process and the further contribution it provides to e.g., society and consumers. In the context of the textile industry, this evaluation would be of particular relevance as it would be able to critically evaluate the current fast-fashion system and outsourcing principles.

9.5. Impact Assessment

Impact assessment methods: In the scope of E-LCA, many different impact assessment models are developed—e.g., ReCiPe, PEF, CML—for quantitatively assessing environmental impact of a product. In S-LCA the two developed databases (SHDB and PSILCA) both include their own impact assessment model—allowing for E-LCA-like impact assessment calculations. However, as social impacts also have

a lot to do with a certain organization involved, the social performance of such an organization—the company-level—is very important to take into consideration too. Therefore, practitioners (e.g., Ramirez et al., 2014; Wang et al., 2016) have developed their own impact assessment models (Wu et al., 2014), as the SAM assessment in chapter 8. The variety in impact assessment models is inherently linked with a great variety in impact assessment methods used in S-LCA.

Distinction between Inventory Analysis and Impact Assessment phases: In E-LCA clear distinctions take shape between the Inventory Analysis and the Impact Assessment. However, in S-LCA a less clear division can be identified for a database S-LCA. This is due to the nature of the social flows, performed under certain social conditions that have a nature (e.g., children in employment) as well as a certain magnitude (e.g., high or low and good (opportunity) or bad (risk)) (see section 3.2.2). During the Inventory Analysis, the flows are already classified on their magnitude, using reference scales set through impact assessment models (e.g., the Social Impact Weighing method in PSILCA). These social flows reflect the social risks, and can intuitively be compared to environmental flows when thinking of these latter as 'environmental pressures'.

Environmental and social impact categories: E-LCA focuses on environmental impact categories, such as climate change, ozone depletion and land use. Different environmental emissions are classified and then aggregated to such an impact category. For example, carbon dioxide, ethane, methane and several other emission flows are all classified and aggregated under the impact category 'Climate change', with a unit in kilograms and magnitude in CO_2-eq. In S-LCA, the different indicators (e.g., the right to strike) are linked to certain subcategories (here freedom of association and collective bargaining) and on its turn related to stakeholder categories (here workers). Furthermore, some categories that should be mentioned are the subcategories 'environmental footprint' and 'GHG footprint', which are added in the last version of the PSILCA database (version 3). However, these categories better reflect environmental impacts, and it can thus be questioned why it is chosen to include those in such a social database. In the PSILCA documentation (Maister et al., 2020) these newly added indicators are only briefly presented without any further elaboration on why it is considered to include them. Lastly, per indicator the PSILCA database provides an evaluation scheme on which indicator value corresponds with which risk-level. An inconsistency is found between the PSILCA v3 documentation document and the evaluation scheme presented in the database itself (see section 7.3.1 and Appendix E (E.1)).

Potential and actual impacts: In the UNEP Guidelines, a distinction is made between potential and actual impacts, whereas in E-LCA impacts are only considered as potential. Actual social impacts are referred to as "*changes that affect stakeholders as a result of an activity. Their assessment is based on observed data*" (UNEP, 2020, p. 25). Here, an activity is thus referred to as a human activity. Actual social impacts are assessed through IP S-LCIA. With regard to actual impacts, in E-LCA it is acknowledged that actual impacts cannot be assessed, as the cause-effect relationship of environmental impacts is complex, and it is recognized that this relationship is only established at a very high level of aggregation (Guinée et al., 2002).

9.6. Supply chain focus

Focus on lower-level needs: It is found that in social sustainability assessment frameworks—whether S-LCA or the qualitative ways of assessing based on OECD, GRI, or the IFC Guidelines—a focus is put on the supply chain perspective of a certain product system. A profound focus of these assessments lies on assessing activities from certain companies from which production processes are relocated to countries where human rights or labor conditions are not safeguarded by legal systems. In S-LCA assessments this is reflected through e.g., labor involved being referred to as conducted by 'workers' over 'employees'. In this study, the labor conditions of the fashion brands' employees were thus assessed through the category 'workers' in S-LCA. It is identified that in S-LCA, 'workers' are generally referred to was workers in developing countries, whereas S-LCA data and social databases generally do not directly suit for a coverage of 'workers' or 'employees' in more developed countries. This is also reflected through the indicators, as e.g., freedom of association might be a less relevant indicator for sectors in developed countries, whereas these might benefit from other indicators as e.g., wellbeing activities initiated by a company. As a result, there is a shortage of subcategories to measure the impacts related to higher-level needs in the hierarchy (Arcese et al., 2017). The employees of the fashion brand, which are employed in Germany, might need to be assessed on other aspects then the workers in the supply chain.

Incorporation of the use phase: It is difficult to incorporate the use phase of a product system in social studies as generally a focus is put on the supply chain and working conditions in the production processes. As there is no sector related to the use of a product or service, it is difficult to account for social flows in this phase. Social flows related to a specific country—i.e., the flows related to 'society' and 'local community' for any sector of this country in PSILCA—should be added in this regard.

The aspect of culture in social assessments: S-LCA being developed from a 'western' perspective, tries to portray a vision on developing countries in terms of what is good for them, embedded in the indicators and reference scales used in these assessments. However, also as identified by Pollok et al. (2021) (see section 1.2.5), there is a need for embedding cultural aspects in the different impact categories and social indicators to also allow for the incorporation of cultural settings in which specific processes and related labor conditions take place. Where we now point fingers at companies employing women at lower-skilled positions, it might be that in this culture it is not even desired for women to work at any other position than low-skilled.

9.7. Product- vs organizational approach to S-LCA

With the aim of product-S-LCA on adapting E-LCA-like structures and calculations for the purpose of LCSA, it misses the point on many aspects as discussed throughout this chapter. For example, a product-focus on S-LCA through social database assessments is only able to address quantifiable issues, and as talking about social conditions, impacts or risks do not directly have a causal link to a specific company, process, or product. Therefore, S-LCA only taking a product-focus—as currently the Guidelines steer towards—will ideally always require additional social assessments to be done

alongside as the company perspective and related social conditions are identified to be of great importance when assessing social issues.

For the ultimate purpose of aligning S-LCA to E-LCA for LCSA purposes, many more barriers are identified. Bringing together the three pillars of sustainability in LCSA, through E-LCA, S-LCA and LCC, will lead to the rise of inconsistencies. Ideally, environmental, social, and economic data should be available on the same geographical scale and with the same level of technical resolution, i.e., covering all and the same processes. Related to data collection for S-LCA, differences in the nature of social and environmental data, and the differences in resolution of databases, it is, however, found to be very difficult—almost impossible—to achieve alignment in the E-LCA and S-LCA system boundaries of a product under study. Due to is difference in nature, reaching a full alignment between E-LCA and S-LCA for LCSA purposes is unlikely. Reflected through its importance, the organizational aspect social issues should be addressed in social sustainability studies, going beyond a purely product-focus as the Guidelines present.

9.8. Summary

This chapter addressed the methodological connections and disconnections between S-LCA and E-LCA that can be identified. It is found that whereas product-S-LCA tries to adopt E-LCA principles as much as possible, this comes with methodological barriers (see section 1.2) caused by the contrast in nature between environmental and social aspects. Firstly, E-LCA has a more elaborate database to fall back on when no primary data can be gathered on a specific aspect. This leads to more aspects being left out of scope in S-LCA over E-LCA, due to not having any suitable background processes available in social databases. A difference is identified in resolution on the technical level between environmental and social databases, as the latter have started development later on. The social database PSILCA is based on sector/country level. Hereby, it has a well-developed geographical coverage as compared to e.g., ecoinvent, where many processes are presented having a 'global' coverage. The environmental databases, however, cover many more and more specific processes, leading to using proxies to a greater extent—compared to E-LCA—when modelling product systems for S-LCA purposes based on these social databases.

More complexity is found in the levels of data used for S-LCA over E-LCA, corresponding with the ability of S-LCA to assess 'social impacts', 'social risk' and 'social performance'. This is because next to E-LCA-like calculations, the company-level assessment is identified as an important complementary assessment to do when wanting to assess social impacts, as product's social impacts are rather related to the behavior (reflected in performance) of a certain company over the function delivered by a certain product—importance is found in going beyond a purely product-focused S-LCA.

Due to its nature of being linked to the 'human aspect' over an 'environmental aspect', S-LCA adapts a stakeholder-structure under which different subcategories are formulated—each of which includes several social indicators. These indicators have mostly a negative outlook and social aspects are mostly addressed as a 'social risk'. Aspects on (positive) livelihood created for workers—although social labor conditions might be poor—currently remain unassessed. In terms of 'environmental aspects', the

PSILCA database contains overlapping indicators with E-LCA—e.g., 'GHG Footprint'—without elaborating why these are considered as relevant to include in a social database.

For both E-LCA and S-LCA a wide range of impact assessment models and corresponding methods are available. For E-LCA these different models are available through databases (e.g., ecoinvent), whereas the social databases only include one—their own—method. This inherently has to do with the unclear delineation in S-LCA between the Inventory Analysis and Impact Assessment phases (see section 3.2.2). Further methods as e.g., SAM, should be acquired through literature and following the steps described in corresponding papers presenting these methods. These are not recognized in the UNEP Guidelines, as not adopting a FU approach. The UNEP Guidelines really steer toward the adoption of E-LCA like calculations and therefore using a social database with the worker-hour approach to scale social flows to a certain organization. These databases are quantitative, thereby only able to assess a limited set of (quantitative) indicators. Using these databases—thus conducting product-S-LCA—does not allow for any further assessment of qualitative and semi-quantitative social issues. This is a great limitation, as social issues are not directly quantitative by nature. The UNEP Guidelines being the most adopted framework amongst S-LCA practitioners, additionally uses terminology which is not always aligned with terminology used in the field of E-LCA. For example, they make a distinction between potential and actual impacts, as well as positive and negative impacts, not made in E-LCA terms.

Due to the supply chain focus of product-S-LCA, a lack of subcategories for measuring impacts related to higher-level hierarchical needs is identified. S-LCA results focus on portraying a vision on developing countries in terms of what is 'good' or 'bad', additionally leaving out the aspect of culture, which intrinsically related to social issues. In line with this supply chain focus is the issue arising on the difficulty of incorporating the use phase in product-S-LCA. This is because it is found to be challenging to quantify social conditions related to the use of a certain product.

Product-S-LCA alone misses out on important aspects related to the organizational dimension of social issues, reflected through the social conditions in which different processes take place. These conditions many times reflect sector- or country-level contexts, which do not have a causal link to a specific product system or function of a product. If this is not adequately addressed in reporting of product-S-LCA, it can cause issues of addressing organizations or production processes on aspects not caused though the organization responsible for this.

9.9. Limitations

A few limitations are found related to the different assessments conducted in this study. Firstly, by including only these three mentioned organizations in the sample of the questionnaires and interviews, a limitation in terms of perspective can be found. Only for the Tier 1 manufacturer a 3rd party perspective is provided by receiving information from the independent external auditor. The assessment would greatly benefit from a more holistic approach by including the perspectives from e.g., (i) workers and workers on managing positions at the Tier 1 manufacturer, (ii) trade unions and labor rights NGO's in Bangladesh and India, (iii) different municipalities to address aspects related to

'local communities' in throughout the product system, (iv) workers and workers on managing positions at the Tier 2 yarn supplier, (v) designers and retail-store employees of the fashion brand.

Related to the PSILCA assessment, this database presents 74 indicators measuring 20 different subcategories over 4 stakeholder groups. Hereby, already a limitation is found in that this version of the database does not yet present the stakeholder categories 'consumers' and 'children' presented in the UNEP Guidelines.

In line with the step of identifying data to be prioritized for collection during the Inventory Analysis phase in S-LCA (UNEP, 2020), a choice has been made on focusing on certain stakeholders and subcategories for the SAM. This step is necessary to take in terms of feasibility, but does limit the assessment to only including these subcategories. A choice is made to exclude subcategories that are of less relevance but potential insightful findings might be missed out on. Furthermore, a misalignment between the SAM and PSILCA assessment is found in the coverage of the different subcategories, not allowing for a proper comparison between outcomes for each indicator. For this study, this approach is in line with the objective of identifying what different assessments lead to in terms of results and how these are comparable to each other. However, the more the subcategories and indicators of different methods would be harmonized, the more in-depth comparisons on the specific indicators can be made. Next to the focus on certain subcategories for the SAM, not all companies involved in the product system are assessed. Focusing on the fashion brand, Tier 1 manufacturer and Tier 2 yarn supplier limited the assessment by excluding Tier 3 suppliers and companies involved in the transportation phases. Also for the assessment through the Roadmap to CSR Risk Management, only the Tier 1 manufacturer and the Tier 2 yarn supplier are assessed, due to practical reasons as time constraints. However, also including e.g., the assessment of the chemical and transportation sector would allow for a more holistic life-cycle perspective.

In terms of level of data quality, for both the qualitative assessment, the SAM, and adjusting social flows in the PSILCA assessment to the specific companies, mostly only policy documents are evaluated. This means that the perspective of workers in the supply chain, as well as employees from the fashion brand, are left out of scope. When assessing the social rights and health and safety conditions of workers at these companies, it is of great importance to also consider the perspective of the workers itself in the social assessment. Only for the Tier 1 manufacturer a 3rd party perspective is provided through the independent external auditor, which is found to be very useful as with the communication directly with the Tier 1 manufacturer a barrier in English proficiency was found.

A general limitation is that due to time issues, only a feedback round is conducted with the Tier 1 garment manufacturer. The fashion brand, nor any other specific stakeholders—i.e., workers on their view related to working conditions at the Tier 1 or Tier 2 factories—have evaluated the assessment, therefore before validly interpreting the assessment results and setting up any action plans, the different perspectives should be included in the evaluation of the assessment.

10. Conclusion

This research aims at evaluating the usefulness and feasibility of S-LCA as a method for social impact assessment throughout a product's life cycle, reflected through the main research question:

"What is the value added in terms of usefulness and feasibility for quantifying social impacts throughout a product's life cycle by conducting a Social Life Cycle Assessment over a purely qualitative analysis of social risks and performance, using the textile industry as a case?"

Value-added can be assessed by evaluating the usefulness of insights obtained from different assessments and secondly by evaluating the feasibility of the assessment methods in terms of resources required, i.e., data needs, time requirements, and expertise needed to conduct these assessments.

The first two sub-questions related to the identification of commonly used methods in social sciences for assessing social issues as well as the identification of S-LCA frameworks, and identifying which are the most pragmatic for this research. Commonly used methods in social sciences for assessing social issues in product supply chains are identified as mostly having a project-focus, thereby not directly suitable for the social assessment related to a certain product (see section 2.4). The Roadmap to CSR Risk Management (MVO Nederland, 2020) and IFC Standards (IFC, 2012) were identified as pragmatic frameworks to use for this research (section 2.4). Secondly, the UNEP Guidelines (UNEP, 2020) were identified as the most pragmatic S-LCA framework (section 3.8), and complemented with a company-specific impact assessment method (SAM) developed by (Ramirez et al., 2014) (see section 5.2.2).

Social issues identified from the qualitative assessment (sub-question 3) reflect 'social risks' and 'social performance' (section 6.4), the latter related to the performance of companies involved in the product system. Social issues along the supply chain of the textile product range under study identified from S-LCA (sub-question 4) are on its turn reflect 'social risks' as well as 'potential social impacts' (section 7.5) and 'social performance' through the SAM (section 8.5). The latter performance is related to the performance of companies involved in the product system, as well as these performances being scaled to the product's social performance. See Appendix XIV for an overview of main issues identified through the different assessment methods.

Relevant insights are obtained through conducting a purely qualitative social sustainability assessment, with the benefit of not needing to have any initial expertise to perform such an assessment. However, an extensive data-collection process lies at its basis: data should be gathered on the product's supply chain, company policies, and a general understanding of the company in terms of its management systems and supplier relationships is needed. This method assessing a policy level implies that in practice a monitoring step is needed to assure that the company is actually adhering to its formulated policies and principles.

Related to the feasibility aspect, more expertise is needed for conducting an S-LCA, on which steps are needed to take in this assessment and—when using a social database—how LCA software works, as well as how a social database is set up and how it should be used.

S-LCA ideally includes as much primary data as possible, also gathered through potentially extensive data-collection processes when not having direct data at hand. However, social databases are available

for product-S-LCA, having social risk data at hand on sector and company level, which—although having a more generic level—can be used when not having the ability to acquire primary data. Using data from such databases might lead to use of lower-resolution data, but allows for the ability to use time to gather primary data on prioritized aspects—i.e., stakeholder groups or subcategories and/or processes. Taking an organizational approach to S-LCA, for example, through the SAM impact assessment model, on its turn requires different levels of data. Here, primary data is needed and acquired through extensive data collection processes. Questionnaires should be established and complementary interviews need to be held, and data is needed on company policies and reporting.

The UNEP Guidelines, however, focus on product-S-LCA—aligning its method as much with E-LCA as possible for the ultimate goal of LCSA. This requires maintenance of methodological uniformity between E-LCA and S-LCA through the scaling to a certain FU, setting up system boundaries, and using both generic and primary data. Some methodological consequences however arise:

- When conducting product-S-LCA with the aim of adapting E-LCA-like principles as much as possible, the activity variable is needed for scaling social flows to a certain unit process. This variable tries to scale social flows as a social context to a certain quantitative output—i.e., the reference flow of a specific unit process. The worker-hours variable, however, does not correctly reflect all social flows not directly linked to a labor activity—as, for example, illiteracy rate—while these are scaled to a FU using the same activity variable and value. This causes a lot of redundant and even incorrect information in life cycle calculations, as these are not product-related and scalable impacts but rather the social conditions in which the product system processes are operating. Furthermore, using the activity variable gives very little possibility to adapt certain flows to a specific company. When the rate of health and safety violations at a specific company is for example 5%, the worker-hours value cannot properly reflect this because the worker-hours and health and safety violations are not linearly related;
- This directly links to the non-causality of social conditions and a specific organization or product. Consequently, it is imperative to undertake thorough assessments to determine whether a causal relationship is existing between the organization and identified social risk or potential social impact through product-S-LCA. Failure in addressing this issue adequately through S-LCA reporting might result in unwarranted accusations of the organization or product system on issues that are not of its making, but rather stem from higher-level issues related to the sector or country in which the organization operates or process exists in;
- Product-S-LCA results—through using the activity variable method—are expressed in 'med risk hour', causing a difficulty in communicating the results, especially if the subcategories are not linked to working hours and labor conditions. This is of particular constraint when results should support any decision-making or be communicated to a broader public. The discussed direct quantification method aims to solve these issues by working around the use of an activity variable. This method, however, only allows for an identification of certain social risks at inventory level. Social conditions—e.g., drinking water coverage—are also risk assessed, not implying any causal link to a certain reference flow. This method only allows for calculating

inventory results, which manually can be risk assessed, thereby is deviating again from E-LCA-like calculations possible through the worker-hours assessment for ultimate LCSA purposes;

- S-LCA focuses on the supply chain perspective of products, making it more difficult to account for the use and end-of-life phase in S-LCA studies. Also, as referring to 'workers' over 'employees' and focusing on issues as e.g., drinking water coverage, a focus on higher-level hierarchical needs is lacking.

These identified barriers reflect questions many practitioners have been asking; should a social assessment of a product be aggregated and reported on the basis of a FU? And is it desired to assess a quantitative relation between indicators and a FU of a product, whereas it can be argued that social issues are rather related to the behavior of certain companies over the function delivered by a product?

Ultimately, it can be concluded that the qualitative nature of social issues and their relation to organizations involved is not reflected through only relating quantifiable social aspects to the function a product delivers. Scaling to a FU (the approach the Guidelines take) implies only assessing limited (quantifiable) social issues, leaving out many important organizational aspects to social issues. Bringing together the three pillars of sustainability for purposes of LCSA will lead to many inconsistencies between the three assessment methods. Due to the quantitative and qualitative difference in nature between environmental and social issues, reaching a full alignment between E-LCA and S-LCA for LCSA purposes is found to be unlikely. Reflected through its importance as identified in this study, the organizational aspect of social issues should be addressed in social sustainability assessments, going beyond the product-focus of the Guidelines.

Other approaches to S-LCA by taking an organizational perspective—like SAM—seem to be more fitting to the nature of social aspects. Still here use is made of a quantitative activity variable to relate the performance of organizations to a specific product system. This value of this variable, however, comes with great uncertainty as for example, it is found to be difficult to address a valid value to this variable for a company involved in the design phase. Furthermore, most companies might only have quarterly data available on total production and do not necessarily have sufficient data available on how many hours exactly is worked for the production of the amount a certain reference flow. Also, only the scaling company-performance to product-performance through this variable (step 2 of the SAM, see section 8.3.2) is found to be of added value when a sufficient amount of companies are considered.

On another critical note on SAM, no use can be made of a database—other than general identification of risks through e.g., the CSR Risk Tool (MVO Nederland, n.d.). This assessment thus requires extensive data-gathering processes on as many subcategories and stakeholders as possible. However, comparing the SAM to purely qualitative ways of assessing social sustainability, this method does provide a link with a specific product system. Being able to address the social performance of a product can be of additional value for decision-making on one product over another. A purely qualitative way of assessing social risks or performance does not provide this extra step, thereby staying at the level of company-level risks and performance—without being able to address a product specifically.

11. Recommendations

This chapter presents recommendations for future work, identified through this study.

- No attention to the economic pillar was paid in this study. For LCSA development, careful evaluation should be put on the integration of LCC alongside E-LCA and S-LCA. A focus should be on the relation between, and integration of S-LCA with E-LCA as well as LCC;
- Social-organizational S-LCA needs to be further addressed and better recognized in the UNEP Guidelines. It seems to be of greater potential through its ability to address the qualitative nature of social issues (also see e.g., Martínez-Blanco et al. (2015)). Hereby the Guidelines need to acknowledge the relation of social impacts with the company behavior or performance (the social conditions in which certain processes take place) rather than the function delivered by a product. Currently, a focus is still put on the product's function and alignment with E-LCA, whereas this misses out on many organizational and context-related social issues;
- Social assessment methodology does not, but should, adequately address positive impacts, leading to not being able to match any social risk against opportunity created through a specific process and the further contribution it provides to e.g., society and consumers. The integration of positive aspects in social sustainability assessment should be addressed in future research;
- The Type II or Impact Pathway approach in S-LCA is underrepresented in S-LCA studies so far (Chhipi-Shrestha et al., 2015; Pollok et al., 2021). As this study assessed the value-added of S-LCA following the RS S-LCIA approach, the IP S-LCIA and role of the social area of protection (AoP) is not considered and should be evaluated on its further development potential. As also reflected in literature that this IP S-LCA approach is not adopted by many studies caused by the nature of causal relations of social impact generally not being known or not quantifiable, and the unpredictable nature of behavioral impact;
- IP S-LCIA allows for assessing consequential social impacts, by characterizing the cause-effect chain. Cause-effect is not considered in this study, whereas in terms of social impacts this is a very important aspect. Jørgensen (2013) discusses an example in this regard. Nike Sports discovered in 2006 that child labor occurred at one of their supplying factories in Pakistan. Therefore, they ended the contract with this party and moved production to a different supplier. However, as Nike was the main client of around 70% of all production of this specific factory, many workers were dismissed when Nike decided to withdraw orders. Workers as well as the local community were heavily impacted, as most of these people living there worked in the factory and depended on the income coming from Nike's orders. Therefore, it is important to further address these consequential aspects in S-LCA, and evaluate this in terms of the value-added of the adaptation of LCA-like frameworks in this regard;
- As it allows for a more direct approach to social flows, the direct quantification method in its basis is more promising than the worker-hours approach to S-LCA. It should be further investigated to what extent it is possible to allow further development and implementation of further contribution and sensitivity analyses through this assessment form;
- When desired to further develop S-LCA as the UNEP Guidelines present it, social databases need to be further developed to include a wider range of sectors.

12. References

AccountAbility. (2023). *Standards*. https://www.accountability.org/standards/

Arcese, G., Lucchetti, M. C., & Massa, I. (2017). Modeling Social Life Cycle Assessment framework for the Italian wine sector. *Journal of Cleaner Production*, *140*, 1027—1036. https://doi.org/10.1016/j.jclepro.2016.06.137

Asif, A. (2017). An Overview of Sustainability on Apparel Manufacturing Industry in Bangladesh. *Science Journal of Energy Engineering*, *5*(1), 1. https://doi.org/10.11648/j.sjee.20170501.11

Avesani, M. (2020). Sustainability, sustainable development, and business sustainability. In J. Ren & S. Toniolo (Eds.), *Life Cycle Sustainability Assessment for Decision-Making* (pp. 21—38). Elsevier. https://doi.org/https://doi.org/10.1016/B978-0-12-818355-7.00002-6

Bangladesh Minimum Wages Board. (2023). *Rates of Minimum Wages*. http://mwb.portal.gov.bd/site/page/8c809e54-b25a-46cc-a87b-9df264468e5b/Rates-of-Minimum-Wages-(Latest-Declaration)

Baskaran, V., Nachiappan, S., & Rahman, S. (2012). Indian textile suppliers sustainability evaluation using the grey approach. *International Journal of Production Economics*, *135*(2), 647—658. https://doi.org/10.1016/j.ijpe.2011.06.012

Becker, H. A., & Vanclay, F. (2003). *The international handbook of social impact assessment: Conceptual and methodological advances.* (F. Vanclay, Ed.). Edward Elgar Publishing.

Benoît, C., Norris, G. A., Valdivia, S., Ciroth, A., Moberg, A., Bos, U., Prakash, S., Ugaya, C., & Beck, T. (2010). The guidelines for social life cycle assessment of products: Just in time! In *International Journal of Life Cycle Assessment* (Vol. 15, Issue 2, pp. 156—163). https://doi.org/10.1007/s11367-009-0147-8

Benoît, C., Parent, J., Kuenzi, I., & Revéret, J. (2007). *Presentation: developing a methodology for social life cycle assessment: the North American tomato's CSR case, 3rd International Conference on Life Cycle Management, August 27-29, Zürich, Switzerland*.

Benoit-Norris, C., Cavan, D. A., & Norris, G. (2012). Identifying social impacts in product supply chains: Overview and application of the social hotspot database. *Sustainability*, *4*(9), 1946—1965. https://doi.org/10.3390/su4091946

Bhattacharjee, S. S. (2016). *Precarious Work in the H&M Global Value Chain*. Workers Voices from the Global Supply Chain. Asia Floor Wage Alliance (AFWA). Http://Asia. Floorwage. Org/Workersvoices/Reports/Precarious-Work-in-Thehm-Global-Value-Chain.

Brundtland, G. H. (1987). Our Common Future–Call for Action. *Environmental Conservation*, *14*(4), 291—294. https://doi.org/10.1017/S0376892900016805

C2C-Centre. (2021). *Apparel for Recyclability by Flamingo Fashions Ltd*. http://www.c2c-centre.com/product/fashion-textiles/apparel-recyclability-flamingo-fashions-ltd

Caro, F., & Martínez-De-Albéniz, V. (2014). *Fast Fashion: Business Model Overview and Research Opportunities*. Springer. http://en.wikipedia.org/wiki/Fast_fashion,

Chhipi-Shrestha, G. K., Hewage, K., & Sadiq, R. (2015). "Socializing" sustainability: a critical review on current development status of social life cycle impact assessment method. *Clean Technologies and Environmental Policy*, *17*(3), 579—596. https://doi.org/10.1007/s10098-014-0841-5

Ciroth, A. (2020). Direct quantification of indicators in Social LCA (beyond worker hours). In *Presentation: SLCA Conference 2020*. https://www.youtube.com/watch?v=aY84nRmbZOo&ab_channel=openLCA

Clean Clothes Campaign. (n.d.). *Fashion Checker*. Retrieved February 2, 2023, from https://fashionchecker.org/

Clift, R. (2014). Social life cycle assessment: What are we trying to do? In *Proceedings of Pre-Proceedings of the 4th International Seminar in Social LCA, Social LCA in Progress* (pp. 19—21).

Corona, B., Bozhilova-Kisheva, K. P., Olsen, S. I., & San Miguel, G. (2017). Social Life Cycle Assessment of a Concentrated Solar Power Plant in Spain: A Methodological Proposal. *Journal of Industrial Ecology*, *21*(6), 1566—1577. https://doi.org/10.1111/jiec.12541

Cradle to Cradle Products Innovation Institute. (2020). *Guidance for the Cradle to Cradle Certified Product Standard, Version 3.1*. https://www.c2ccertified.org/resources/detail/cradle_to_cradle_certified_product_standard_guidance_document

Cradle to Cradle Products Innovation Institute. (2021). *Cradle to Cradle Certified Version 4.0 Product Standard*. https://www.c2ccertified.org/resources/detail/cradle_to_cradle_certified_product_standard

Croes, P. R., & Vermeulen, W. J. v. (2021). The assessment of positive impacts in LCA of products. *The International Journal of Life Cycle Assessment*, *26*, 143—156. https://doi.org/10.1007/s11367-020-01820-x/Published

di Noi, C., Ciroth, A., Mancini, L., Eynard, U., Pennington, D., & Blengini, G. A. (2020). Can S-LCA methodology support responsible sourcing of raw materials in EU policy context? *International Journal of Life Cycle Assessment*, *25*(2), 332—349. https://doi.org/10.1007/s11367-019-01678-8

Dreyer, L. C., Hauschild, M., & Schierbeck, J. (2006). A Framework for social life cycle impact assessment. *Int J Life Cycle Assess*, *11*(2), 88—97.

Dreyer, L. C., Hauschild, M. Z., & Schierbeck, J. (2010). Characterisation of social impacts in LCA: Part 1: Development of indicators for labour rights. *International Journal of Life Cycle Assessment*, *15*(3), 247—259. https://doi.org/10.1007/s11367-009-0148-7

Esteves, A. M., Franks, D., & Vanclay, F. (2012). Social impact assessment: The state of the art. *Impact Assessment and Project Appraisal*, *30*(1), 34—42. https://doi.org/10.1080/14615517.2012.660356

ExchangeRates.org. (n.d.). *Live Currency Exchange Rates*. Retrieved December 16, 2022, from https://exchangerates.org/

Fairtrade International. (2016). *Fairtrade Textile Standard*. Fairtrade Labelling Organizations International e.V.

Fashion Revolution. (2022). *Fashion Transparency Index*. https://www.fashionrevolution.org/about/transparency/

Gbolarumi, F. T., Wong, K. Y., & Olohunde, S. T. (2021). Sustainability Assessment in The Textile and Apparel Industry: A Review of Recent Studies. *IOP Conference Series: Materials Science and Engineering*, *1051*(1), 012099. https://doi.org/10.1088/1757-899x/1051/1/012099

Goedkoop, M. J., de Beer, I. M., Harmens, R., Saling, P., Morris, D., Florea, A., Hettinger, A. L., Indrane, D., Visser, D., Morao, A., Musoke-Flores, E., Alvarado, C., Rawat, I., Schenker, U., Head, M., Collotta, M., Andro, T., Viot, J., & Whatelet, A. (2020). *Handbook for Product Social Impact Assessment - 2020*. www.product-social-impact-assessment.com

Good on You. (n.d.). Retrieved February 2, 2023, from https://directory.goodonyou.eco

GRI. (2021). *GRI Standards*. https://www.globalreporting.org/standards/download-the-standards/

Grönkvist, S. (2019). *Social Life Cycle Assessment in the Textile Industry: a case study in a small company* [Uppsala Universitet]. www.geo.uu.se

Guarnieri, P., & Trojan, F. (2019). Decision making on supplier selection based on social, ethical, and environmental criteria: A study in the textile industry. *Resources, Conservation and Recycling*, *141*, 347—361. https://doi.org/10.1016/j.resconrec.2018.10.023

Guinée. J.B. (2016). Life Cycle Sustainability Assessment: What Is It and What Are Its Challenges? In R. Clift & Druckman. Angela (Eds.), *Taking Stock of Industrial Ecology* (pp. 45—68). Springer Open.

Guinée, J. B. (Ed.), Gorrée, M., Heijungs, R., Huppes, G., Kleijn, R., de Koning, A., van Oers, L., Wegener Sleeswijk, A., Suh, S., Udo de Haes, H. A., de Bruijn, J. A., van Duin, R., & Huijbregts, M. A. J. (2002). Handbook on Life Cycle Assessment: Operational Guide to the ISO Standards. *Series: Eco-Efficiency in Industry and Science*, *7*(Springer, Dordrecht).

Herrera Almanza, A. M., & Corona, B. (2020). Using Social Life Cycle Assessment to analyze the contribution of products to the Sustainable Development Goals: a case study in the textile sector. *International Journal of Life Cycle Assessment*, *25*(9), 1833—1845. https://doi.org/10.1007/s11367-020-01789-7

Hirokawa, T., & Ihara, T. (2022). Social life cycle assessment of t-shirt supply chains using willingness to pay. *SN Social Sciences*, *2*(8). https://doi.org/10.1007/s43545-022-00437-1

Hosseinijou, S. A., Mansour, S., & Shirazi, M. A. (2014). Social life cycle assessment for material selection: A case study of building materials. *International Journal of Life Cycle Assessment*, *19*(3), 620—645. https://doi.org/10.1007/s11367-013-0658-1

IFC. (2012). *Performance Standards on Environmental and Social Sustainabiliy*.

ILAB. (2022). *List of Goods Produced by Child Labor or Forced Labor*.

ILOSTAT. (n.d.). *Statistics on working time*. Retrieved February 9, 2023, from https://ilostat.ilo.org/topics/working-time/

Indrane, D. (2019). *Product Social Impact Assessment. Lessons learned, and challenges faced while exploring social life cycle assessment data-bases. ArcelorMittal case study*.

Inflation Tool. (2023). *Inflation calculator*. https://www.inflationtool.com/

International Organization for Standardization. (2010). *ISO 26000: Guidance on social responsibility*.

International Trade Union Confederation. (2022). *ITUC Global Rights Index*.

ISO. (n.d.). *ISO/CD 14075 Principles and framework for social life cycle assessment*. Retrieved January 5, 2023, from https://www.iso.org/standard/61118.html

Jørgensen, A. (2013). Social LCA - A way ahead? In *International Journal of Life Cycle Assessment* (Vol. 18, Issue 2, pp. 296—299). Springer Verlag. https://doi.org/10.1007/s11367-012-0517-5

Jørgensen, A., Hauschild, M. Z., Jørgensen, M. S., & Wangel, A. (2009). Relevance and feasibility of social life cycle assessment from a company perspective. In *International Journal of Life Cycle Assessment* (Vol. 14, Issue 3, pp. 204—214). https://doi.org/10.1007/s11367-009-0073-9

Joy, A., Sherry, J. F., Venkatesh, A., Wang, J., & Chan, R. (2012). Fast fashion, sustainability, and the ethical appeal of luxury brands. *Fashion Theory - Journal of Dress Body and Culture*, *16*(3), 273—295. https://doi.org/10.2752/175174112X13340749707123

Karthik, T., & Gopalakrishnan, D. (2014). *Environmental Analysis of Textile Value Chain: An Overview* (pp. 153—188). https://doi.org/10.1007/978-981-287-110-7_6

Khan, M. A., Brymer, K., & Koch, K. (2020). The Production of Garments and Textiles in Bangladesh: Trade Unions, International Managers and the Health and Safety of Workers. *South Asian Journal of Human Resources Management*, *7*(2), 276—292. https://doi.org/10.1177/2322093720944270

Klöpffer, W. (2003). Life-Cycle Based Methods for Sustainable Product Development. *International Journal of Life Cycle Assessment, 8*(3), 157—159. https://doi.org/10.1065/ehs2002.03.028

Klöpffer, W. (2008). Life cycle sustainability assessment of products (with Comments by Helias A. Udo de Haes, p. 95). *International Journal of Life Cycle Assessment*, *13*(2), 89—95. https://doi.org/10.1065/lca2008.02.376

Köksal, D., Strähle, J., Müller, M., & Freise, M. (2017). Social sustainable supply chain management in the textile and apparel industry-a literature review. In *Sustainability (Switzerland)* (Vol. 9, Issue 1). MDPI. https://doi.org/10.3390/su9010100

Kühnen, M., & Hahn, R. (2017). Indicators in Social Life Cycle Assessment: A Review of Frameworks, Theories, and Empirical Experience. *Journal of Industrial Ecology*, *21*(6), 1547—1565. https://doi.org/10.1111/jiec.12663

Lehmann, A., Zschieschang, E., Traverso, M., Finkbeiner, M., & Schebek, L. (2013). Social aspects for sustainability assessment of technologies - Challenges for social life cycle assessment (SLCA). *International Journal of Life Cycle Assessment*, *18*(8), 1581—1592. https://doi.org/10.1007/s11367-013-0594-0

Lehtonen, M. (2004). The environmental-social interface of sustainable development: Capabilities, social capital, institutions. *Ecological Economics*, *49*(2), 199—214. https://doi.org/10.1016/j.ecolecon.2004.03.019

Lenzo, P., Traverso, M., Salomone, R., & Ioppolo, G. (2017). Social life cycle assessment in the textile sector: An italian case study. *Sustainability (Switzerland)*, *9*(11). https://doi.org/10.3390/su9112092

Luján-Ornelas, C., Güereca, L. P., Franco-García, M. L., & Heldeweg, M. (2020). A life cycle thinking approach to analyse sustainability in the textile industry: A literature review. In *Sustainability (Switzerland)* (Vol. 12, Issue 23, pp. 1—19). MDPI. https://doi.org/10.3390/su122310193

Macchion, L., da Giau, A., Caniato, F., Caridi, M., Danese, P., Rinaldi, R., & Vinelli, A. (2018). Strategic approaches to sustainability in fashion supply chain management. *Production Planning and Control*, *29*(1), 9—28. https://doi.org/10.1080/09537287.2017.1374485

Macombe, C., Feschet, P., Garrabé, M., & Loeillet, D. (2011). 2nd International Seminar in Social Life Cycle Assessment - Recent developments in assessing the social impacts of product life cycles. *International Journal of Life Cycle Assessment*, *16*(9), 940—943. https://doi.org/10.1007/s11367-011-0331-5

Mahiat, T., Alam, M. A. al, Argho, M., Corlett, J., Chowdhury, R. B., Biswas, K. F., Hossain, M. M., & Sujauddin, M. (2022). Modeling the environmental and social impacts of the handloom industry in Bangladesh through life cycle assessment. *Modeling Earth Systems and Environment*. https://doi.org/10.1007/s40808-022-01491-7

Maister, K., di Noi, C., Ciroth, A., & Srocka, M. (2020). *PSILCA v.3 Database documentation*. GreenDelta.

Mancini, L., Eynard, U., Eisfeldt, F., Ciroth, A., Blengini G, & Pennington, D. (2018). *Social assessment of raw materials supply chains. A life-cycle-based analysis*. https://doi.org/10.2760/470881

Mancini, L., & Sala, S. (2018). Social impact assessment in the mining sector: Review and comparison of indicators frameworks. *Resources Policy*, *57*, 98—111. https://doi.org/10.1016/j.resourpol.2018.02.002

Mapped in Bangladesh. (2022). *Mapped in Bangladesh, RMG Map*. https://mappedinbangladesh.org/

Martínez-Blanco, J., Lehmann, A., Chang, Y. J., & Finkbeiner, M. (2015). Social organizational LCA (SOLCA)–a new approach for implementing social LCA. *International Journal of Life Cycle Assessment*, *20*(11), 1586—1599. https://doi.org/10.1007/s11367-015-0960-1

Martínez-Blanco, J., Lehmann, A., Muñoz, P., Antón, A., Traverso, M., Rieradevall, J., & Finkbeiner, M. (2014). Application challenges for the social Life Cycle Assessment of fertilizers within life cycle sustainability assessment. *Journal of Cleaner Production*, *69*, 34—48. https://doi.org/10.1016/j.jclepro.2014.01.044

Mazzi, A. (2020). Introduction. Life cycle thinking. In *Life Cycle Sustainability Assessment for Decision-Making: Methodologies and Case Studies* (pp. 1—19). Elsevier. https://doi.org/10.1016/B978-0-12-818355-7.00001-4

Mesa Alvarez, C., & Ligthart, T. (2021). A social panorama within the life cycle thinking and the circular economy: a literature review. In *International Journal of Life Cycle Assessment* (Vol. 26, Issue 11, pp. 2278—2291). Springer Science and Business Media Deutschland GmbH. https://doi.org/10.1007/s11367-021-01979-x

Moazzem, K. G., Khatun, F., Hewage, K., Ahmed, T., & Pathirana, A. (2021). *Recovery of the apparels sectors of Bangladesh and Sri Lanka from the COVID-19 crisis: Is a value chain based solution possible?* www.southernvoice.org

Morgan, A. (2015). *The True Cost*. https://truecostmovie.com/.

Mukherjee, S. (2015). Environmental and Social Impact of Fashion: Towards an Eco-friendly, Ethical Fashion. *International Journal of Interdisciplinary and Multidisciplinary Studies (IJIMS)*, *2*(3), 22—35. http://www.ijims.com

Muñoz-Torres, M. J., Fernández-Izquierdo, M. Á., Ferrero-Ferrero, I., Escrig-Olmedo, E., & Rivera-Lirio, J. M. (2023). Social Life Cycle Analysis of Textile Industry Impacts for Greater Social Sustainability of Global Supply Chains. *Systems*, *11*(1). https://doi.org/10.3390/systems11010008

MVO Nederland. (n.d.). *CSR Risk Check Tool*. 2020. https://www.mvorisicochecker.nl/en

MVO Nederland. (2020). *Roadmap to CSR Risk Managment*. www.mvonederland.nl

MVO Nederland. (2022a). *CSR Risk Check. Bangladesh, Clothing of knitted or crocheted textile fabric (except swimwear or coated apparel) - 17 October 2022*. www.mvonederland.nl

MVO Nederland. (2022b). *CSR Risk Check. India, Cotton textile fibres - 01 November 2022*. www.mvonederland.nl

New South Wales Government. (2021). *SIA Guideline Technical Supplement*. www.dpie.nsw.gov.au

Norris, G.A. (2006). Social impacts in product life cycles: towards life cycle attribute assessment. *Int J Life Cycle Assess*, *11*(1), 97—104.

Oai Li, C., & Kruijssen, F. (2010). *Potential and constraints for integrating socio-economic aspects in LCA. Literature review and potential application to aquaculture in Asia*. www.seatglobal.eu

O'Brien, M., Doig, A., & Clift, R. (1996). Social and Environmental Life Cycle (SELCA) Approach and Methodological Development. *Int J. LCA*, *1*(4), 231—237.

OECD. (2018). *OECD Due Diligence Guidance for Responsible Business Conduct*.

Open Supply Hub. (n.d.). *Open Apparel Registry*. Retrieved February 12, 2023, from https://opensupplyhub.org/

Pande, B., & Kumar Adil, G. (2019). A Value Chain Framework for Assessment of Sustainable Practices in Manufacturing Firms. *European Journal of Sustainable Development*, *8*(3), 95. https://doi.org/10.14207/ejsd.2019.v8n3p95

Petti, L., Sanchez Ramirez, P. K., Traverso, M., & Ugaya, C. M. L. (2016). An Italian tomato "Cuore di Bue" case study: challenges and benefits using subcategory assessment method for social life cycle assessment. In *International Journal of Life Cycle Assessment*. Springer Verlag. https://doi.org/Advance online publication 10.1007/s11367-016-1175-9

Petti, L., Serreli, M., & di Cesare, S. (2018). Systematic literature review in social life cycle assessment. *International Journal of Life Cycle Assessment*, *23*(3), 422—431. https://doi.org/10.1007/s11367-016-1135-4

Pollok, L., Spierling, S., Endres, H. J., & Grote, U. (2021). Social life cycle assessments: A review on past development, advances and methodological challenges. In *Sustainability (Switzerland)* (Vol. 13, Issue 18). MDPI. https://doi.org/10.3390/su131810286

PRé Sustainability. (n.d.). *Development of a new ISO standard for Social LCA*. Retrieved January 5, 2023, from https://www.social-value-initiative.org/development-of-a-new-iso-standard-for-social-lca/

Projektgruppe Okologische Wirtschaft. (1987). *Produktlinienanalyse: Bedürfnisse, Produkte und ihre Folgen* (Projektgruppe Okologische Wirtschaft, Ed.). Kölner Volksblatt Verlag.

Quintana, S., Busset, G., Sablayrolles, C., Montrejaud-Vignoles, & Belaud, J. (2013). *Review on Social Life Cycle Assessment*.

Rafiaani, P., Kuppens, T., Dael, M. van, Azadi, H., Lebailly, P., & Passel, S. van. (2018). Social sustainability assessments in the biobased economy: Towards a systemic approach. In *Renewable and Sustainable Energy Reviews* (Vol. 82, pp. 1839—1853). Elsevier Ltd. https://doi.org/10.1016/j.rser.2017.06.118

Rahim, M. M. (2017). Improving Social Responsibility in RMG Industries Through a New Governance Approach in Laws. *Journal of Business Ethics*, *143*(4), 807—826. https://doi.org/10.1007/s10551-016-3131-9

Rainock, M., Everett, D., Pack, A., Dahlin, E. C., & Mattson, C. A. (2018). The social impacts of products: a review. *Impact Assessment and Project Appraisal*, *36*(3), 230—241. https://doi.org/10.1080/14615517.2018.1445176

Ramirez, P. K. S., Petti, L., Haberland, N. T., & Ugaya, C. M. L. (2014). Subcategory assessment method for social life cycle assessment. Part 1: Methodological framework. *International Journal of Life Cycle Assessment*, *19*(8), 1515—1523. https://doi.org/10.1007/s11367-014-0761-y

Ramos Huarachi, D. A., Piekarski, C. M., Puglieri, F. N., & de Francisco, A. C. (2020). Past and future of Social Life Cycle Assessment: Historical evolution and research trends. In *Journal of Cleaner Production* (Vol. 264). Elsevier Ltd. https://doi.org/10.1016/j.jclepro.2020.121506

Rietbergen-McCracken, J., & Narayan-Parker, Deepa. (1998). *Participation and social assessment : tools and techniques*. International Bank for Reconstruction and Development/World Bank.

Roos, S., Sandin, G., Zamani, B., Peters, G., & Svanström, M. (2017). *Will Clothing Be Sustainable? Clarifying Sustainable Fashion* (pp. 1—45). https://doi.org/10.1007/978-981-10-2182-4_1

Roos, S., Zamani, B., Sandin, G., Peters, G. M., & Svanström, M. (2016). 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*, *133*, 691—700. https://doi.org/10.1016/j.jclepro.2016.05.146

Sadowski, M., Yan, C., Cummis, C., & Aden, N. (2019). *APPAREL AND FOOTWEAR SECTOR, SCIENCE-BASED TARGETS GUIDANCE*.

Shen, B. (2014). Sustainable fashion supply chain: Lessons from H&M. *Sustainability (Switzerland)*, *6*(9), 6236—6249. https://doi.org/10.3390/su6096236

Social Accountability International. (2023). *SA8000 Standard*. https://sa-intl.org/programs/sa8000/

The Interorganizational Committee on Guidelines and Principles for Social Impact Assessment. (1994). *Guidelines and Principles For Social Impact Assessment*.

The Queensland Government. (2018). *Social Impact Assessment Guideline*. www.statedevelopment.qld.gov.au

Toboso-Chavero, S., Madrid-López, C., Villalba, G., Gabarrell Durany, X., Hückstädt, A. B., Finkbeiner, M., & Lehmann, A. (2021). Environmental and social life cycle assessment of growing media for urban rooftop farming. *International Journal of Life Cycle Assessment*, *26*(10), 2085—2102. https://doi.org/10.1007/s11367-021-01971-5

Traverso, M., Asdrubali, F., Francia, A., & Finkbeiner, M. (2012). Towards life cycle sustainability assessment: An implementation to photovoltaic modules. *International Journal of Life Cycle Assessment*, *17*(8), 1068—1079. https://doi.org/10.1007/s11367-012-0433-8

Traverso, M., Finkbeiner, M., Jørgensen, A., & Schneider, L. (2012). Life Cycle Sustainability Dashboard. *Journal of Industrial Ecology*, *16*(5), 680—688. https://doi.org/10.1111/j.1530-9290.2012.00497.x

Tseng, M. L., Wu, K. J., Ma, L., Kuo, T. C., & Sai, F. (2019). A hierarchical framework for assessing corporate sustainability performance using a hybrid fuzzy synthetic method-DEMATEL.

Technological Forecasting and Social Change, *144*, 524—533. https://doi.org/10.1016/j.techfore.2017.10.014

UNEP. (2020). *Guidelines for SOCIAL LIFE CYCLE ASSESSMENT OF PRODUCTS AND ORGANIZATIONS 2020* (C. Benoît Norris, M. Traverso, S. Neugebauer, E. Ekener, T. Schaubroeck, S. Russo Garrido, M. Berger, S. Valdivia, A. Lehmann, M. Finkbeiner, & G. Arcese, Eds.). United Nations Environment Programme (UNEP).

UNEP. (2021). *Methodological Sheets for Subcategories in Social Life Cycle Assessment (S-LCA) 2021* (M. Traverso, S. Valdivia, A. Luthin, L. Roche, G. Arcese, S. Neugebauer, L. Petti, M. D'Eusanio, B. M. Tragnone, R. Mankaa, J. Hanafi, C. Benoît Norris, & A. Zamagni, Eds.). United Nations Environment Programme (UNEP).

UNEP/SETAC. (2009). *Guidelines for social life cycle assessment of products*. United Nations Environment Programme.

UNEP/SETAC. (2013). *The Methodological Sheets for subcategories in Social life cycle assessment (S-LCA)* (C. Benoît Norris, M. Traverso, S. Valdivia, G. Vickery-Niederman, J. Franze, L. Azuero, A. Ciroth, B. Mazijn, & D. Aulisio, Eds.). United Nations Environment Programme and SETAC. www.lifecycleinitiative.org

UNICEF. (2020). *Children's rights in the garment and footwear supply chain. A practical tool for integrating children's rights into responsible sourcing frameworks*. https://www.unicef.org/reports/childrens-rights-in-garment-and-footwear-supply-chain-2020

United Nations. (n.d.). *The Ten Principles of the UN Global Compact*. Retrieved January 4, 2023, from https://www.unglobalcompact.org/what-is-gc/mission/principles

United Nations. (2011). *Guiding Principles on Business and Human Rights*.

United Nations. (2015). *Transforming our world: the 2030 agenda for sustainable development*. https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustaina ble%20Development%20web.pdf

Valdivia, S., Backes, J. G., Traverso, M., Sonnemann, G., Cucurachi, S., Guinée, J. B., Schaubroeck, T., Finkbeiner, M., Leroy-Parmentier, N., Ugaya, C., Peña, C., Zamagni, A., Inaba, A., Amaral, M., Berger, M., Dvarioniene, J., Vakhitova, T., Benoit-Norris, C., Prox, M., … Goedkoop, M. (2021). Principles for the application of life cycle sustainability assessment. *International Journal of Life Cycle Assessment*, *26*(9), 1900—1905. https://doi.org/10.1007/s11367-021-01958-2

van Dulmen, N., Wammes, P., Ahmed, N., Witteveen, P., Vandepaer, L., & Guinée, J. (2023). A Framework for Life Cycle Inventory Modeling of Chemical Substances in the Footwear and Apparel Industry. In S. S. Muthu (Ed.), *Progress on Life Cycle Assessment in Textiles and Clothing* (pp. 1—27). Springer Nature Singapore Pte Ltd. https://doi.org/10.1007/978-981-19-9634-4_1

Vanclay, F., Esteves, A. M., Aucamp, I., & Franks, D. M. (2015). *Social Impact Assessment: Guidance for assessing and managing the social impacts of projects*.

Vassilenko, E., Watkins, M., Chastain, S., Mertens, J., Posacka, A. M., Patankar, S., & Ross, P. S. (2021). Domestic laundry and microfiber pollution: Exploring fiber shedding from consumer apparel textiles. *PLoS ONE*, *16*(7 July). https://doi.org/10.1371/journal.pone.0250346

Wang, S. W., Hsu, C. W., & Hu, A. H. (2016). An analytic framework for social life cycle impact assessment–part 1: methodology. *International Journal of Life Cycle Assessment*, *21*(10), 1514—1528. https://doi.org/10.1007/s11367-016-1114-9

Wick, I. (2009). *The social impact of the liberalised world market for textiles and clothing. Strategies of trade unions and women´s organisations*. www.suedwind-institut.de

World Economic Forum. (2022). *The Global Gender Gap Index 2022*. https://www.weforum.org/reports/global-gender-gap-report-2022/

Wu, R., Yang, D., & Chen, J. (2014). Social life cycle assessment revisited. In *Sustainability (Switzerland)* (Vol. 6, Issue 7, pp. 4200—4226). MDPI. https://doi.org/10.3390/su6074200

Zamagni, A., Amerighi, O., & Buttol, P. (2011). Strengths or bias in social LCA? In *International Journal of Life Cycle Assessment* (Vol. 16, Issue 7, pp. 596—598). https://doi.org/10.1007/s11367-011-0309-3

Zamani, B. (2016). *The challenges of fast fashion. Environmental and social LCA of Swedish clothing consumption*. Chalmers University of Technology.

Zamani, B., Sandin, G., Svanström, M., & Peters, G. M. (2018). Hotspot identification in the clothing industry using social life cycle assessment–opportunities and challenges of input-output modelling. *International Journal of Life Cycle Assessment*, *23*(3), 536—546. https://doi.org/10.1007/s11367-016-1113-x

Appendices

Appendix I — Summarizing the main characteristics and steps of SIA frameworks

Table 20. Different SIA framework, highlighted in bold the impact assessment steps.

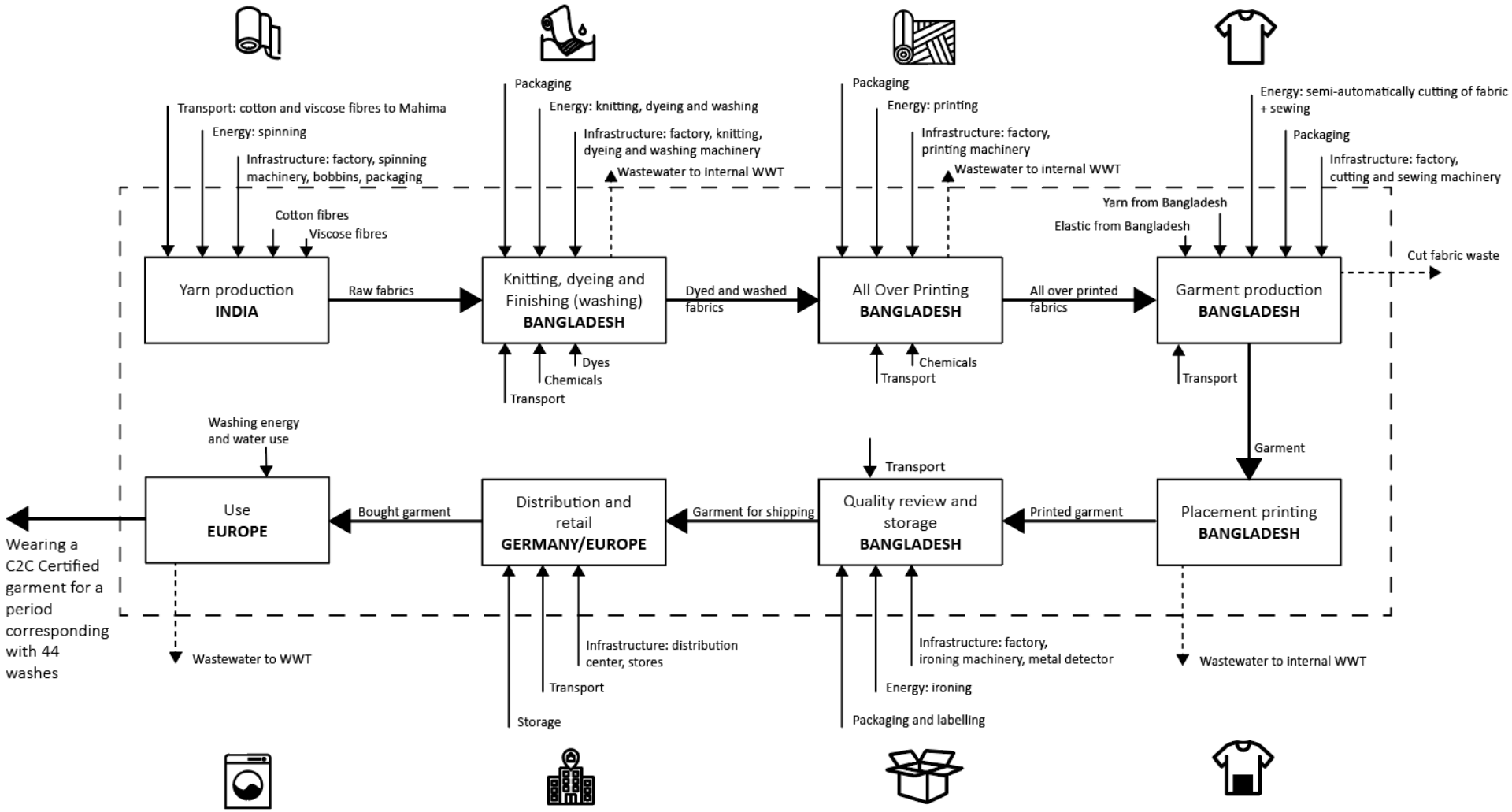
SIA methodology	Steps		Sub step / description
Interorganizational Committee on Guidelines and Principles for Social Impact Assessment. (1994). *Guidelines and Principles For Social Impact Assessment*.	1. Public involvement/participation		Develop an effective public plan to involve all potentially affected publics;
	2. Identification of alternatives		Described the proposed action or policy change and reasonable alternatives;
	3. Profile of baseline condition		Describe the relevant human environment/area of influence and baseline conditions;
	4. Scoping		After obtaining a technical understanding of the proposal, identify the full range of probable social impacts that will be addressed based on discussion or interviews with number of all potentially affected;
	5. Projection of estimated effects		Investigate the probable impacts: (i) comparative method; (ii) populated multiplier methods; (iii) scenarios; (iv) expert testimony, (v) computer modeling; (vi) calculation of "future forgone";
	6. Prediction of responses to impacts		Determine the significance to the identified social impacts;
	7. Estimate indirect and cumulative impacts		Estimate subsequent impacts and cumulative impacts;
	8. Changes to alternatives		Recommend new or changed alternatives and estimate or project their consequences;
	9. Mitigation		Develop a mitigation plan;
	10. Monitoring		Develop a monitoring plan.
Rietberg-McCracken and Narayan (1998) Participation and Social Assessment: Tools and Techniques	1. Analyze project context		Consider the context in which the project takes place;
	2. Identification and analysis of stakeholders		Analysis of relevant stakeholder groups, their interests, influence, and power, and how they will be affected by the project;
	3. Identification of social factors		Generally done by listening to affected groups, experts, and government officials who have knowledge of the larger sociocultural, political, and economic context that can affect project design and implementation;
	4. Analyze data and assess priorities		Data analysis should focus on answering operational questions and generating action-oriented recommendations;
	5. Consult stakeholders and develop mitigative plans		Ensuring conclusions and recommendations are appropriate;
	6. Implement mitigation		Implement a mitigation plan and include public participation;
	7. Ensure monitoring with active stakeholder involvement and modify it		Develop a monitoring plan.

(continued)

Vanclay, F., Esteves, A. M., Aucamp, I., & Franks, D. M. (2015). Social Impact Assessment: Guidance for assessing and managing the social impacts of projects.	1. Understand the issues	A	Gain a good understanding of the proposed project, including all ancillary activities necessary to support the project's- development and operation;
		B	Clarify responsibilities and roles of all involved in or associated with the SIA, including relationships to other specialist studies, and establish national laws or international guidelines and standards to be observed;
		C	Identify the preliminary ´social area of influence´ of the project, likely impacted and beneficiary communities, and stakeholders;
		D	Gain a good understanding of the communities likely to be affected with by the project by preparing a Community profile including: (i) a thorough stakeholder analysis; (ii) a discussion of the socio-political setting; (iii) an assessment of differing needs, interests, values and aspirations of various subgroups of the affected communities including a gender analysis;
		E	Fully inform community members about: (i) the project; (ii) similar projects elsewhere; (iii) how they can be involved in the SIA; (iv) their procedural rights; and (v) access to grievance and feedback mechanisms;
		F	Devise inclusive participatory processes and deliberative spaces to help community members: (i) understand how they are impacted, (ii) determine acceptability of likely impacts and benefits; (iii) make informed decisions about the project, (iv) facilitate community visioning about desired futures; (v) contribute to mitigation and monitoring plans; (vi) prepare for change;
		G	Identify the social and human rights issues that have potential to be of concern (i.e. scoping);
		H	Collect relevant baseline data for key social issues;
	2. Predict, analyze and assess the likely impact pathways	A	Through analysis, determine the social changes and impacts that will likely result from the project and its various alternatives;
		B	Carefully consider the indirect impacts;
		C	Consider how the project will contribute to cumulative impacts experienced by host communities;
		D	Determine how various affected groups and communities will likely respond;
		E	Establish significance of the predicted changes(prioritization);
		F	Actively contribute to design and evaluation of project alternatives;
	3. Develop and implement strategies		Address negative impacts; enhance benefits/opportunities; establish grievance mechanism; Social Impact Management Plan and establishment of relevant partnerships; implement ongoing social performance plans;
	4. Design & implement monitoring programs		Monitor change; participatory monitoring plan; implement adaptive management; periodic evaluation and review.

Appendix II — Product system mapping

Figure 26. Visualization of the product system of the C2C® Certified product range.



Appendix III — Sources for information on the three involved companies

(This appendix is left out in this version of the thesis for reasons of confidentiality)

Appendix IV — Overview of Social Sustainability Program from Tier 1 Manufacturer

(This appendix is left out in this version of the thesis for reasons of confidentiality)

Appendix V — Overview indicators per subcategory in PSILCA

Stakeholders and subcategories of relevance to the assessment with the different indicators and corresponding measurement units in the PSILCA database

Table 21. PSILCA Database coverage of the stakeholders and subcategories. Adapted from the PSILCA database documentation in OpenLCA.

Stakeholder category	Subcategory	Indicators	Measurement unit
Workers	Freedom of association and collective bargaining	Right of Association	4 point scale
		Right of Collective bargaining	4 point scale
		Right to Strike	4 point scale
		Trade union density	%
	Child labor	Children in employment, female	% of female children ages 7-14
		Children in employment, male	% of male children ages 7-14
		Children in employment, total	% of all children ages 7-14
	Fair salary	Living wage Lower bound	USD
		Living wage Upper bound	USD
		Living wage, per month	USD
		Minimum wage, per month	USD
		Sector average wage, per month	USD
	Working hours	Weekly hours of work per employee	hours
	Discrimination	Gender wage gap	%
		Men in the sectoral labor force	Ratio
		Women in the sectoral labor force	Ratio
	Health and safety	DALYs due to indoor and outdoor air and water pollution	DALY (Disability-Adjusted Life Year) rate
		Presence of sufficient safety measures	Cases per 100,000 employees
		Rate of fatal accidents at workplace	#/yr and 100,000 employees
		Rate of non-fatal accidents at workplace	#/yr and 100,000 employees
		Violations of mandatory health and safety standards	ratio
		Workers affected by natural disasters	%
	Social benefits	Evidence of violations of laws and employment regulations	Cases per 10000 employees
		Social security expenditures	% of GDP
	Forced labor	Frequency of forced labor	‰
		Goods produced by forced labor	#
		Trafficking in persons	Tier
Local community	Access to material resources	Certified environmental management systems (CEMS)	# of CEMS per 10000 employees
		Extraction of biomass (related to area)	annual t/km²
		Extraction of biomass (related to population)	annual t/cap
		Extraction of fossil fuels	annual t/cap
		Extraction of industrial and construction minerals	annual t/cap
		Extraction of ores	annual t/cap
		Level of industrial water use (related to renewable water resources)	% of total actual renewable water resources
		Level of industrial water use (related to total withdrawal)	% of total water withdrawal
	Safe and healthy living conditions	Drinking water coverage	%
		Pollution level of the country	Pollution Index
		Sanitation coverage	%
	Local employment	Unemployment rate in the country	%
	Environmental Footprints	Embodied agricultural area footprint	ha/$1
		Embodied forest area footprint	ha/$1
		Embodied water footprint	Mm3/$ (continued)

		Number of threatened species	# species/$1
	GHG Footprints	Embodied CO2 footprint	t per $
		Embodied CO2-eq footprint	t per $
	Migration	Emigration rate	Ratio
		Immigration rate	Ratio
		International Migrant Stock	%
		International migrant workers in the sector	%
		Net migration rate	‰
		Number of asylum seekers in relation to total population	Ratio
	Respect of indigenous rights	Indigenous People Rights Protection Index	6 point scale
		Presence of indigenous population	Y/N
Value chain actors	Fair competition	Presence of anti-competitive behavior or violation of anti-trust and monopoly legislation	Cases per 10000 employees
	Corruption	Active involvement of enterprises in corruption and bribery	%
		Public sector corruption	Index score
	Promoting social responsibility	Membership in an initiative that promotes social responsibility	Number of companies
Society	Contribution to economic development	Contribution of the sector to economic development	% of GDP
		Embodied value added total	$/$
		Illiteracy rate, female	% of female population
		Illiteracy rate, male	% of male population
		Illiteracy rate, total	% of total population
		Public expenditure on education	% of GDP
		Youth illiteracy rate, female	% of female population, age 15-24
		Youth illiteracy rate, male	% of male population, age 15-24
		Youth illiteracy rate, total	% of total population, age 15-24
	Health and safety	Domestic and external health expenditure	%
		Domestic general government health expenditure	%
		Global Peace Index	Ratio
		Health expenditure, external resources	% of total expenditure on health
		Health expenditure, out-of-pocket	% of total expenditure on health
		Health expenditure, public	% of total expenditure on health
		Health expenditure, total	% of GDP
		Life expectancy at birth	Years

Appendix VI — Assumptions for transportation means and distances

(This appendix is left out in this version of the thesis for reasons of confidentiality)

Appendix VII — Overview of publicly available policies from the fashion brand

Table 22. Publicly available policies of the fashion brand.

Document	Description
Sustainability report	Sustainability report containing information on environmental and social aspects, as well as the company's performance towards their 2028 sustainability targets. The reporting is including GRI, UNGC and SDG context, and key figures on performance in terms of emissions and material use.
Suppliers' factory list	List of all tier suppliers (Tier 1, 2 and 3) of the fashion brand, available through the Open Apparel Registry (Open Supply Hub, n.d.).
Better work factory list	List containing the factories of the fashion brand that are participating in a Better Work program, listing if the factory has a trade union or independent worker committee.
Social Stewardship program	Program of key activities in the fashion brand's global supply chains, summarizing all the policies and activities under one program.
Code of Conduct for suppliers + supporting guidelines	Basic values and standards where supplying parties need to adhere on to work with the fashion brand.
Zero tolerance issues in the supply chain	Highlighted overview of issues where zero tolerance applies to.
Migrant labor policy	Policy on labor of migrant workers in the supply chain of the fashion brand.
Hostel guidelines	Policy on guidelines for hostels in India, laying out requirements regarding infrastructure and amenities and health, hygiene, sanitation and wellbeing.
Animal welfare policy	As apparel products can contain animal products, this policy is focused on material sourcing, and standards protecting animal welfare.
Restricted substances list and wastewater guidelines	List of restricted chemicals used in the manufacturing processes, as well as how wastewater needs to be discharged.
External stakeholders	A list of different organizations and topics of collaboration; e.g., on workers' rights, human rights, animal welfare, environmental responsibility, or due diligence in the supply chain.
Key partnerships	Overview of collaborating parties on different initiatives (e.g., the Ellen MacArthur Foundation, Fashion For Good, or the UN Global Compact).

Appendix VIII — The fashion brands' sustainability scoring by 3rd party initiatives

(This appendix is left out in this version of the thesis for reasons of confidentiality)

Appendix IX — Tier 1 manufacturers' social sustainability program investigated

(This appendix is left out in this version of the thesis for reasons of confidentiality)

Appendix X — Risk assessment ranking through the Roadmap to CSR Risk Management

(This appendix is left out in this version of the thesis for reasons of confidentiality)

Appendix XI — Inventory results + Impact Assessment PSILCA direct quantification method

Table 23. Inventory results direct quantification - risk assessed through PSILCA reference scales.

Stakeholder category	Subcategory	SDG	Indicators	Measurement units	Result	Classification
Workers	Freedom of association and collective bargaining	8 - Decent work and economic growth	Right of Association	4 point scale	1.413001611	Medium risk
			Right of Collective bargaining	4 point scale	1.407191585	Medium risk
			Right to Strike	4 point scale	1.260071914	Medium risk
			Trade union density	%	10.59893838	Very high risk
	Child labor	8 - Decent work and economic growth	Children in employment, female	% of female children ages 7-14	1.565532781	Very low risk
			Children in employment, male	% of male children ages 7-14	3.735247299	Very low risk
			Children in employment, total	% of all children ages 7-14	1.904601767	Very low risk
	Fair salary	1 - No poverty + 8 - Decent work and economic growth	Living wage Lower bound	USD	710.6708065	High risk
			Living wage Upper bound	USD	1137.777479	High risk
			Living wage, per month	USD	933.0333569	High risk
			Minimum wage, per month	USD	829.8969937	Medium risk
			Sector average wage, per month	USD	2670.265556	Very low risk
	Working hours	8 - Decent work and economic growth	Weekly hours of work per employee	hours	32.50306109	Medium risk
	Discrimination	5 - Gender equality + 10 - Reduced inequalities	Gender wage gap	%	12.64760315	Medium risk
			Men in the sectoral labor force	Ratio	0.597542279	Medium risk
			Women in the sectoral labor force	Ratio	0.606260575	Low risk
	Health and safety	3 - Good health and well-being	DALYs due to indoor and outdoor air and water pollution	DALY (Disability-Adjusted Life Year) rate	3.77126618	Very low risk
			Presence of sufficient safety measures	Cases per 100,000 employees	0.000389574	Low risk
			Rate of fatal accidents at workplace	#/yr and 100,000 employees	1.140140201	Very low risk
			Rate of non-fatal accidents at workplace	#/yr and 100,000 employees	288.8004279	Very low risk
			Violations of mandatory health and safety standards	ratio	4.4345E-07	Low risk
			Workers affected by natural disasters	%	0.877687098	Very low risk
	Social benefits, legal issues	8 - Decent work and economic growth	Evidence of violations of laws and employment regulations	Cases per 10000 employees	2.002553166	Medium risk
			Social security expenditures	% of GDP	8.680376724	Medium risk
	Forced labor	8 - Decent work and economic growth	Frequency of forced labor	‰	1.499740467	Very low risk
			Goods produced by forced labor	#	0.143728367	No risk
			Trafficking in persons	Tier	0.769702846	Very low risk

(continued)

Local community	Access to material resources	2 - Zero Hunger + 4 - Quality Education + 6 Clean water and sanitation + 7 - Affordable and clean energy + 9 - Industry, innovation and infrastructure + 16 - Peace, justice and strong institutions	Certified environmental management systems (CEMS)	# of CEMS per 10000 employees	0.332931484	Very low risk
			Extraction of biomass (related to area)	annual t/km²	807.6123976	Very high risk
			Extraction of biomass (related to population)	annual t/cap	2.716216834	Low risk
			Extraction of fossil fuels	annual t/cap	2.14861873	Very low risk
			Extraction of industrial and construction minerals	annual t/cap	5.886207172	Medium risk
			Extraction of ores	annual t/cap	0.016642688	Very low risk
			Level of industrial water use (related to renewable water resources)	% of total actual renewable water resources	15.22444304	Very high risk
			Level of industrial water use (related to total withdrawal)	% of total water withdrawal	17.88481782	Low risk
	Safe and healthy living conditions	3 - Good health and well-being + 16 - Peace, justice and strong institutions	Drinking water coverage	%	95.14228674	Very low risk
			Pollution level of the country	Pollution Index	13.06280271	Very low risk
			Sanitation coverage	%	91.02536568	Low risk
	Local employment	8 - Decent work and economic growth	Unemployment rate in the country	%	3.93373017	Low risk
	Environmental Footprints	3 - Good health and well-being	Embodied agricultural area footprint	ha/$1	2.13091E-07	Low risk
			Embodied forest area footprint	ha/$1	4.19551E-08	Very low risk
			Embodied water footprint	Mm3/$	9.1601E-08	Very low risk
			Number of threatened species	# species/$1	2.75571E-08	Medium risk
	GHG Footprints	3 - Good health and well-being	Embodied CO2 footprint	t per $	5.73622E-05	High risk
			Embodied CO2-eq footprint	t per $	6.49524E-05	Medium risk
	Migration	10 - Reduced inequalities + 16 - Peace, justice and strong institutions	Emigration rate	ratio	0.008661152	Low risk
			Immigration rate	ratio	0.017308458	Very low risk
			International Migrant Stock	%	13.04051382	High risk
			International migrant workers in the sector	%	0.002475206	Very low risk
			Net migration rate	‰	0.896722641	Very low risk
			Number of asylum seekers in relation to total population	ratio	0.002076683	High risk
	Respect of indigenous rights	10 - Reduced inequalities	Indigenous People Rights Protection Index	6 point scale	0.468497368	Very high risk
			Presence of indigenous population	Y/N	0.150721998	No risk
Value chain actors (continued)	Fair competition	12 - Responsible consumption and production	Presence of anti-competitive behavior or violation of anti-trust and monopoly legislation	Cases per 10000 employees	0.00918993	Low risk

	Corruption	16 - Peace, justice and strong institutions	Active involvement of enterprises in corruption and bribery	%	2.04360033	Very low risk
			Public sector corruption	Index score	19.25743275	Very low risk
	Promoting social responsibility	17 - Partnerships for the goals + 12 - Responsible consumption and production	Membership in an initiative that promotes social responsibility along the supply chain	# per 100,000 employees	1.119395231	High risk
Society	Contribution to economic development	4 - Quality education + 8 - Decent work and economic growth	Contribution of the sector to economic development	% of GDP	8.939279608	High risk
			Embodied value added total	$/$	0.295804713	Medium risk
			Illiteracy rate, female	% of female population	5.240680643	Medium risk
			Illiteracy rate, male	% of male population	3.983581439	Low risk
			Illiteracy rate, total	% of total population	4.610042923	Medium risk
			Public expenditure on education	% of GDP	4.438712959	High risk
			Youth illiteracy rate, female	% of female population, age 15-24	0.899140538	Very low risk
			Youth illiteracy rate, male	% of male population, age 15-24	1.480879727	Low risk
			Youth illiteracy rate, total	% of total population, age 15-24	1.313139775	Low risk
	Health and safety	3 - Good health and well-being	Domestic and external health expenditure (% of current health expenditure)	%	64.96652934	Low risk
			Domestic general government health expenditure (% of current health expenditure)	%	76.34969849	Low risk
			Global Peace Index	ratio	1.644887354	Low risk
			Health expenditure, external resources	% of total expenditure on health	1.820168867	Very low risk
			Health expenditure, out-of-pocket	% of total expenditure on health	21.29379629	Medium risk
			Health expenditure, public	% of total expenditure on health	71.10661727	Low risk
			Health expenditure, total	% of GDP	10.03776172	Low risk
			Life expectancy at birth	Years	80.80286188	No risk

Appendix XII — Impact Assessment results worker-hours assessment

Table 24. Characterized results of the worker-hours assessment.

Impact category	Reference unit	Result
Active involvement of enterprises in corruption and bribery	AI med risk hours	0.496069922
Anti-competitive behavior or violation of anti-trust and monopoly legislation	AC med risk hours	0.409669498
Association and bargaining rights	ACB med risk hours	0.349002146
Biomass consumption	BM med risk hours	503.5495661
Certified environmental management system	CMS med risk hours	11.8754982
Child Labor, female	CL med risk hours	0.144357491
Child Labor, male	CL med risk hours	106.7200055
Child Labor, total	CL med risk hours	0.973409962
Contribution of the sector to economic development	CE med risk hours	1.285180713
DALYs due to indoor and outdoor air and water pollution	DALY med risk hours	1.066931713
Drinking water coverage	DW med risk hours	106.668919
Embodied agricultural area footprints	EAF med risk hours	0.004240961
Embodied biodiversity footprints	EBF med risk hours	0.158446915
Embodied forest area footprints	EFA med risk hours	0
Embodied water footprints	EWF med risk hours	0.018059113
Expenditures on education	EE med risk hours	9.781506997
Fair Salary	FS med risk hours	234.7472672
Fatal accidents	FA med risk hours	0.109086553
Fossil fuel consumption	FF med risk hours	0.050504658
Frequency of forced labor	FL med risk hours	0.025140176
Gender wage gap	GW med risk hours	11.00776245
GHG Footprints	GHGF med risk hours	2.465001488
Goods produced by forced labor	GFL med risk hours	0.021370523
Health expenditure	HE med risk hours	215.1631777
Illiteracy, female	I med risk hours	106.5588361
Illiteracy, male	I med risk hours	106.5583819
Illiteracy, total	I med risk hours	106.5587197
Indigenous rights	IR med risk hours	2.403830024
Industrial water depletion	WU med risk hours	396.8741448
International migrant stock	IMS med risk hours	39.66212867
International migrant workers (in the sector/ site)	IMW med risk hours	0.124339195
Life expectancy at birth	LE med risk hours	0.249089843
Men in the sectoral labor force	M med risk hours	0.012892609
Migration flows	MF med risk hours	832.7012553
Minerals consumption	MC med risk hours	0.564370735
Net migration	NM med risk hours	0.050401961
Non-fatal accidents	NFA med risk hours	0.159230944
Pollution	P med risk hours	94.28586835
Promoting social responsibility	PSR med risk hours	25.40945962
Public sector corruption	C med risk hours	106.713723
Risk of conflicts	ROC med risk hours	2.84168826

Safety measures	SM med risk hours	0.127145705
Sanitation coverage	SC med risk hours	11.06349895
Social security expenditures	SS med risk hours	106.5413009
Trade unionism	TU med risk hours	123.4807106
Trafficking in persons	TP med risk hours	9.550319269
Unemployment	U med risk hours	0.519103829
Value added (total)	VAT med risk hours	19.35167561
Violations of employment laws and regulations	VL med risk hours	0.577946662
Weekly hours of work per employee	WH med risk hours	1.683630442
Women in the sectoral labor force	W med risk hours	0.445870828
Workers affected by natural disasters	ND med risk hours	9.276759568
Youth illiteracy, female	YI med risk hours	2.377810653
Youth illiteracy, male	YI med risk hours	10.69160505
Youth illiteracy, total	YI med risk hours	2.372810241

Appendix XIII — Definition of subcategories included in assessment

Table 25. Assessment subcategories with their definition adapted from UNEP (2021).

Subcategory	Definition adapted from sheets and adapted in this thesis (UNEP, 2021). All definitions are directly adapted from the Methodological Sheets, presented at each first page of the subcategory.	Background sources, not included in assessment as not relevant for scoring
Workers		
Freedom of association and collective bargaining	Workers, employees, and employers have rights to, without prior authorization, join and establish organizations to promote and defend their interests. This includes a collective negotiation with other parties. Union activities should be executed freely, with no interference of any other party, and no discrimination against union membership should take place. Workers have the right to strike, and organizations have the right to draw up constitutions and rules, elect representatives in full freedom, organize activities freely, and formulate programs.	IFC Performance Standard 2 — Labor and Working Conditions + The UN Global Compact's ten principles (the 3rd principle)
Child labor	Child labor is work depriving children of their childhood, potential, and dignity, and is classified as work harmful to physical and mental development. It is work: • Mentally, physically, socially, or morally dangerous and harmful to children; • 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. In extreme forms, it can include children being enslaved, separated from families, exposed to illness and serious hazards, and/or left to look after themselves on the streets of large cities. Child labor is constituted if the child is below: • the age of 15 years; or • the national set minimum age for employment if it is higher; or • the age of completion of compulsory education if is higher. In addition, the minimum age for carrying out work which may be considered hazardous or morally dubious is fixed at 18 years of age. Under strict conditions, the minimum age may however be set to 16 years of age. However, if local minimum age law is set at 14 years of age in accordance with the developing country exception under ILO Convention 138, this lower age may apply. Moreover, children below the general minimum age (between the ages of 13 to 15 years old) may do light work, which on account of the inherent nature of the tasks involved and the particular conditions under which they are performed is not likely to be harmful to their health, safety, or development and is not impeding school attendance or their capacity to benefit from the instruction received.	IFC Performance Standard 2 - Labor and Working Conditions + UN Global Compact's Ten Principles (the 5th principle)
Fair salary	Fair wage means a wage fairly and reasonably commensurate with the value of a particular service or class of service rendered, and in establishing a minimum fair wage for such (class of) service. Codes of conduct which deal with wages and benefits have focused on three standards when assessing level of wages: • the minimum wage required by law; • the local „prevailing industry wage"; • the „living wage" (also designated as "floor wage" or "non-poverty wage"). The first is obviously the easiest to accurately measure but has been deemed inadequate in many instances because the legal minimum wage has been kept artificially low in many countries to attract investment. Market-basket studies have found that, without working excessive overtime hours, the minimum wage in many countries is not sufficient to meet a worker's basic needs. The „prevailing industry wage" is an ambiguous premise. It may be higher than the required minimum or may simply meet legal requirements, but in either case this language provides no measurable guarantee that the prevailing wage is sufficient to meet a worker's basic needs. For this reason, „living wage" is promoted and implemented by precursor organizations. It is a wage that enables workers and their families to meet their needs for nutritious food, water, shelter, clothing, education, healthcare, and transport as well as providing for a discretionary income. It is generally higher than the minimum wage in many locations.	C026 - Minimum Wage-Fixing Machinery Convention, 1928 (No. 26) + C102 - Social Security (Minimum Standards) Convention, 1952 (No. 102) + C131 - Minimum Wage Fixing Convention, 1970 (No. 131)
Working hours (continued)	The hours of work comply with applicable laws and industry standards. Workers are not on a regular basis required to work in excess of 48 hours per week and have at least one day off for every 7-day period. Overtime is voluntary, does not exceed 12 hours weekly, is not demanded on a	ILO Weekly Rest (Industry)

	regular basis, and is compensated at premium rate. Needs and expectations of the workers are considered in the organization of working hours. Higher restrictions apply if the working hours are made during the night.	Convention 1921 (No. 14)
Equal opportunities/ discrimination	Everyone has the right to be treated fairly and have access to equal opportunities. Equal opportunity or the principle of non-discrimination emphasizes that opportunities in education, employment, advancement, benefits and resource distribution, and other areas should be freely available to all people irrespective of their age, race, sex, religion, political association, ethnic origin, or any other individual or group characteristic unrelated to ability, performance, and qualification. Cases of discrimination can be clustered into three groups: Direct discrimination, when a person is treated less favorably than another person, in the same or similar circumstances, on one or more grounds, and in one of the areas of public life. Indirect discrimination happens when an apparently neutral rule has a negative effect on people with a particular attribute or characteristic, e.g., race, compared to people without that attribute or characteristic, and the rule is unreasonable in the circumstances. Reverse discrimination is discrimination that affects a dominant or majority group as a result of a provision intended to remedy discrimination suffered by a minority or disadvantaged group.	IFC Performance Standard 2 — Labor and Working Conditions + UN Global Compact's ten principles
Health and safety	Since 1950, the International Labour Organization (ILO) and the World Health Organization (WHO) have shared a common definition of occupational health. The definition reads: „Occupational health should aim at: the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention amongst workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities; and, to summarize, the adaptation of work to man and of each man to his job." All workers have the right to a safe and healthy workplace. Another possible definition of safe workplace, provided by OSHA, is a workplace that is free of serious recognized hazards and in compliance with OSHA standards. Workplace covers all the places where workers need to be or to go by reason of their work and which are under the direct or indirect control of the employer. The term health, in relation to work, indicates not merely the absence of disease or infirmity; it also includes the physical and mental elements affecting health, which are directly related to safety and hygiene at work.	ILO Guidelines on occupational safety and health management systems (ILO-OSH 2001)
Social benefits/ social security	Social benefits refer to non-monetary employment compensation which are typically offered to full-time workers but may not be provided to other classes of workers (e.g., part-time, home workers, contractual). Social security is a smaller set of benefits, oriented as social protection, in the form of insurances and social assistance. Four basic categories of social security benefits are often included and are paid based upon the record of worker's earnings: retirement, disability, dependents, and survivors' benefits. Other social benefits that may be provided include: Medical insurance, Dental insurance, Paramedical insurance including preventive medicine, Medicine insurance, Wage insurance, Paid maternity and paternity leave (parental leave), Paid sick leave, Education and training, Meal voucher, Agreements with gyms, kindergartens, etc. The social benefits provided to the workers could depend on the considered social context. As countries have different laws and policies regarding social security and social benefits, some benefits may already be covered by the national government.	
Local community		
Access to material resources (continued)	Communities and organizations may share the use of material resources (natural and man-made) and have a mutual interest in protecting and enhancing the quantity and quality of local resources and infrastructure. Expanding operations carry the potential for depletion of and conflict over natural material resources (e.g., water, forest land, home lands), especially in emerging or unstable countries. Organizations should conduct risk assessments with attention to potential conflict over material resources and engage with the local community over sustainable methods for sharing resources. Organizations should institute risk management plans for preventing, mitigating, and controlling environmental damage. This includes management attention to the sustainable use of natural resources, pollution prevention, and waste recycling. Environment management systems are certifiable systems that help organizations improve material resource conservation. Similarly, social and environmental impact assessments are encouraged for business operations that are likely to have significant adverse impacts on material resources. Organizations and communities may also benefit from improving quality of local infrastructure. Assessment should consider the extent to which project-related infrastructure, such as roadways and waste disposal systems, have positive long-term effects on local economic development.	

Safe and healthy living conditions	The generation and/or use of hazardous material and pollution emissions may lead to adverse health impacts. Organizations should institute environmental risk management systems for preventing, mitigating, and controlling health damage from their operations. Organizations may contribute to the health of local communities, for example by shared access to employee health services. Organizations should communicate potential health and safety impacts of their operations to surrounding communities. Organizations culpable for negative health effects should engage in remediation or compensation efforts.	IFC Performance Standard 4 — Community Health, Safety and Security + The UN Global Compact's ten principles (7-9)
Local employment	Local hiring preferences provide important income and training opportunities to community members. Organizations that develop relationships with locally-based suppliers will further encourage local employment and development. Organizations also may encourage local community development by training local employees in technical and transferable skills. Organizations can have a particularly strong effect on local community development when they hire local employees for senior management positions. This is likely to encourage open communication and trust with the community.	LO Convention concerning Employment Policy 1964 (No. 122) + ILO Concerning General Conditions to Stimulate Job Creation in Small and Medium-Sized Enterprises 1998 (No. 189)
Value chain actors		
Fair competition	Fair competition is assessed in anti-competitive behavior, anti-trust, or monopoly practices. Anti-competitive behavior: Actions of the reporting organization and/or employees that may result in collusion with potential competitors to fix prices, coordinate bids, create market or output restrictions, impose geographic quotas, or allocate customers, suppliers, geographic areas, and product lines with the purpose of limiting the effects of market competition. Some examples are: price fixing, where parties collude to sell the same product or service at the same price; bid rigging, where parties collude to manipulate a competitive bid; and predatory pricing, which is selling a product at very low price with the intent of driving competitors out of the market. Anti-trust and monopoly practices: Actions of the reporting organization that may result in collusion to erect barriers to entry to the sector, unfair business practices, abuse of market position, cartels, anti-competitive mergers, price-fixing, and other collusive actions to prevent competition.	
Supplier relationships	Affiliations with organizations that supply another organization with goods and services. The supplier relationships also concern all mutual activities, co-operations, agreements that regulate the exchanges, trade, and relation among organizations, bearing in mind that every organization in the value chain is responsible for complying with applicable laws and regulations. Organization's suppliers can be any business or individual - including subcontractors, agents, manufacturers, distributors, and consultants that provide goods and services.	
Consumers		
Transparency	Organizational transparency enables consumers having an informed choice without intent to mislead or conceal. Certification standards, labels, and special indices may be used to provide information about performance regarding social responsibility. While other strategies may be used to communicate with consumers, these approaches simplify the communication between organization and consumer.	
End-of-life responsibility	End-of-life refers to product disposal, reuse, or recycling. In an environmental context, this concept is commonly referred to as extended producer responsibility. Product disposal can lead to significant environmental and social concerns, such as environmental and public health impacts that stem from the accumulation of e.g., hazardous material in electronic waste. When countries transport waste to less developed countries, it is common for the poor to sift through landfills in search of waste with economic value that entails important public health and safety impacts.	
Society		
Public commitments to sustainability issues	A public commitment is a promise or agreement made by an organization to its customers, employees, shareholders, local community, or the general public whose fulfilment can be evidenced in a transparent and open way. Typically, this will take the form of performance improvement targets with defined dates for achievement and public reporting of progress. The promise or agreement is disseminated through the organization's website, promotional materials, or other means. These commitments relate to the contribution of organizations to the sustainable development of the community or society as the reduction of impacts from their activities.	
Contribution to economic development	The revenue creation, job creation, providing of education and training, or investment making of companies as a contribution to their national economy.	

Appendix XIV — Overview of identified social issues for prioritization

Table 26. Overview of assessment results from the different assessment methods conducted.

Organization / life cycle stage	Identified issue	Issue sort	Method through which issue is identified	Causality with related organization?
Tier 2 yarn supplier / yarn production	Insufficient information is available to address social risks related to the specific product system and the Tier 2 yarn supplier. For sector-related risks, please refer to Table 9 and Table 10. Company-performance in terms of compliance to IFC Standard requirements should be further assessed.	Social risk	Qualitative social risk and performance assessment	Yes, when sector level risks are scaled to the company
	• Very high risks with a potential causal link to the specific involved organization are identified for: children in employment (male), and sector average monthly wages; • Very high societal risks are identified for: trade union density, social security expenditures, extraction of biomass, drinking water coverage, sanitation coverage, illiteracy rates, health expenditure, and life expectancy at birth; • High societal risks are identified for: minimum wage, country pollution level, public expenditure on education, youth illiteracy rates, health expenditure and global peace index.	Social risk	Social Life Cycle Assessment — PSILCA direct quantification	Yes, but due to data unavailability for this specific Tier 2 yarn supplier the risks cannot be linked to this specific organization and reflect the generic sector data on 'Manufacture of textile — IN'.
	Weekly hours of work per employee and frequency of forced labor are indicators where subcategories the yarn production process contributes highly to. However, as no specifications are done to reflect the social conditions at the specific organizations these are skewed outcomes since the results do not reflect the actual situation since they are not adapted to the specific companies.	Potential social impact	Social Life Cycle Assessment — PSILCA worker=hours	No causal link can be made with any organization as the assessment should be labelled 'generic', and therefore only potential social impacts can be addressed, with no causal link between the impact and involved organization.
	The Tier 2 yarn supplier generally does not perform well on subcategories assessed. Only five categories were assessed, by which Freedom of association and collective bargaining, child labor, and the aspect of fair salary do not align with what is stated in related ILO conventions. However, as the policies of this organization were not consulted due to data unavailability the assessment results cannot be validated.	Company-performance	Social Life Cycle Assessment — SAM	Whereas not addressing any social risks or potential social impacts, there are no issues in terms of causality. There is a direct causality between the company and the company performance.

(continued)

Tier 1 garment manufacturer / garment manufacturing	• Action should be taken to ensure that workers have proper freedom of association, including the participation of workers in public strikes without any consequences. If this is the case, this aspect should be kept as an aspect under monitoring programs. Immediate action should be taken if freedom of association and collective bargaining cannot be ensured, to improve this situation; • 60 hour work weeks including excessive (12) overtime hours is the standard. A risk can be identified that 60 hour workweeks thus get exceeded on regular basis. Therefore, urgent action should be taken to ensure decent weekly working hours; • Overtime hours are standard, whereby workers receive double the standard wage. However, still workers receive insufficient earnings to cover living expenses. Urgent action should be taken to ensure workers work decent working hours under sufficient wages; • Gender inequality in terms of female workers having fewer opportunity than men and are generally working on lower-skilled position is a striking issue at the Tier 1 garment manufacturer. Immediate action should be taken to increase opportunities for female workers and employees.	Social risks related to company social performance	Qualitative social risk and performance assessment	Yes, as the sector-level risks are scaled to the company and listed here. For generic sector-related risks, please refer to Table 8.
	• Very high risks with a potential causal link to the specific involved organization are identified for: rights to strike, and weekly working hours; • Very high societal risks are identified for: trade union density, social security expenditure, extraction of biomass, drinking water coverage, pollution level of the country, sanitation coverage, illiteracy rates, public expenditure on education, and health expenditure; • High risks with a potential causal link to the specific involved organization are identified for: right of association, right of collective bargaining, average wage, gender wage gap, certified environmental management systems, membership in initiatives promoting social sustainability, and embodied value added; • High societal risks are identified for: minimum wage, workers affected by natural disasters, trafficking in persons, youth illiteracy (male), and health expenditure.	Social risk	Social Life Cycle Assessment — PSILCA direct quantification	Yes, as rights to strike, weekly working hours, right of association, right of collective bargaining, and average wage are adapted to the specific company involved. For the other aspects, data is lacking thus generic data is used. Therefore, no actual causality can be identified here.
(continued)	This process has a high contribution to impact categories with a potential causal link to the specific organization in terms of: • Association and bargaining rights and trade unionism; • Child labor; • Fair salary and gender wage gap; • DALYs due to indoor and outdoor air and water pollution; • Fatal and non-fatal accidents; • Social security expenditures; • Frequency of forced labor. High contribution to impact categories with no causal link to the organization, but related to the social conditions of the society; • Drinking water coverage, pollution, and sanitation coverage, • Embodied biodiversity and water footprints;	Potential social impact	Social Life Cycle Assessment — PSILCA worker=hours	A causality can be identified for the first list of impacts presented, to which this process contributes high in terms of impact. However, for the worker-hours assessment it was not possible to adequately address the company-specifications and change certain social flows to reflect better the social conditions at the specific organization. Therefore, even though no child labor is existing at the organization,

	• International migrant workers in the sector/ on the site; • Indigenous rights; • Corruption; • Contribution to economic development (also illiteracy rates and expenditure on education); • Health expenditure, risk of conflicts and life expectancy at birth.			the sector-level potential social impact is still reflected here. Therefore, it cannot be analyzed if any of these impacts have an actual causal link with the specific organization.
	The Tier 1 garment manufacturer performs generally well on all subcategories assessed. Only on Freedom of association and collective bargaining as well as Fair competition the BR is not met. This assessment addresses the policy level, thereby evaluates that the policies on these aspects are insufficiently covering what is stated in related ILO conventions.	Company-performance	Social Life Cycle Assessment — SAM	Whereas not addressing any social risks or potential social impacts, there are no issues in terms of causality. There is a direct causality between the company and the company performance.
Fashion brand / design + retail	Insufficient information is available to address social risks related to the specific product system and the fashion brand, whereby employees are working in the design and retail stages of the product system. Company-performance in terms of compliance to IFC Standard requirements should be further assessed.	Social risk	Qualitative social risk and performance assessment	
	• Very high risks with a potential causal link to the specific involved organization are identified for: living wage; • Very high societal risks are identified for: trade union density, and net migration rate; • High risks with a potential causal link to the specific involved organization are identified for: gender wage gap, embodied CO2 footprint, and membership in an initiative promoting social sustainability; • High societal risks are identified for: extraction of biomass, level of industrial water use, immigration rate, international migrant stock, and public expenditure on education.	Social risk	Social Life Cycle Assessment — PSILCA direct quantification	Yes, but due to data unavailability for this specific fashion brand the risks cannot be linked to this specific organization and reflect the generic sector data on 'Retail trade and repairs — DE'.
	A high contribution in terms of potential social impacts for the distribution and retail process is identified for: • Violations of employment laws and regulations; • Goods produced by forced labor; • Promoting social sustainability. This process does include the total transport stage from Bangladesh to Germany and reflects the retailing sector in Germany, therefore cannot solely be linked to the fashion brand itself.	Potential social impact	Social Life Cycle Assessment — PSILCA worker=hours	No, this process includes too many sectors and does not reflect any specifications to the organization. Therefore, there cannot be spoken about a causal link between impacts and certain organizations.
(continued)	The fashion brand performs well in terms of internal performance on all subcategories assessed through the SAM. Their supplier monitoring on the Tier 2 yarn supplier, however, should be evaluated to see whether more specific information can be found on this Tier 2 supplier. This would validate that the fashion brand also performs well in terms of their supplier monitoring, and is aware of any social aspects in terms of labor conditions and related policies from their Tier suppliers. As the fashion brand was not able to provide any documentation on the Tier 2 yarn supplier, this currently cannot be further validated.	Company-performance	Social Life Cycle Assessment — SAM	Whereas not addressing any social risks or potential social impacts, there are no issues in terms of causality. There is a direct causality between the company and the company performance.

Other life cycle stages / distribution, chemical production and use	When desired, low resolution sector-level identification of risks related to the transport stage can be assessed, through consulting the CSR Risk Tool on 'Transport & logistics' for Bangladesh, India, The Netherlands and Germany. Furthermore, 'Other organic chemicals' can be consulted for chemical producing countries. These stages can more properly be addressed through including the organizations related to transport stages and chemical production and evaluating their social performance.	Social risk	Qualitative social risk and performance assessment	Yes, when sector-level risks are scaled to the company (transportation or chemical production company)
	In the use stage, social risks are identified regarding number of asylum seekers (very high risk) and extraction of biomass, level of industrial water use, international migrant stock, and international migrant workers in the sector (high risk). A social risks are identified which cannot be traced back to any foreground processes of the specific product system in terms of evident contribution is the very high risk related to indigenous people rights.	Social risk	Social Life Cycle Assessment — PSILCA direct quantification	No, as for the identified risks for this assessment no causal link can be made with any company. It can be so that social risks from background processes are related to the transportation or chemical production processes.
	As the use stage is modelled as well, this stage becomes apparent in terms of high contribution on impacts related to; • Access to material resources: biomass, fossil fuel, and minerals consumption, as well as industrial water depletion; • Embodied biodiversity footprints; • International migrant stock and migrant flows. Only a few sectors can be identified where none of the foreground processes have highest contribution: • The transport sector in India has the highest contribution in terms of social impacts on women in the sectoral labor force; • The embodied agricultural area footprint has the highest contribution from the cotton sector in India, which can be associated with the Tier 2 yarn supplier; • High impacts are found in terms of contribution for the mining of coal and lignite industry in Germany, related to anti-competitive behavior or violation of anti-rust and monopoly legislation.	Potential social impact	Social Life Cycle Assessment — PSILCA worker=hours	As the impacts related to the use stage are related to the societal conditions in Germany, these are not directly related to the specific product system in terms of a causal link between the product system and social impacts. For the latter three mentioned impacts further (Tier 3) processes should be investigated and potentially addressed.
	No information was available to assess any other companies then the three prioritized organizations. Therefore, the SAM does not apply to any other life cycle stages and involved companies then the three stages addressed above.	Company-performance	Social Life Cycle Assessment — SAM	

Appendix A — Bill of Materials

(This appendix is left out in this version of the thesis for reasons of confidentiality)

Appendix B — Questionnaires

(This appendix is left out in this version of the thesis for reasons of confidentiality)

Interview questions are adapted from the supplementary material of (Petti et al., 2016). These questions are developed as questionnaires for the data collection of S-LCA, along a product's life cycle, and based on the methodological sheets of 2013 (UNEP/SETAC, 2013). The questions are developed for all stakeholders and related subcategories (Petti et al., 2016). Some additional questions are added and adapted from Grönkvist (2019). The questions are adapted where needed and complemented with some additional relevant questions.

Appendix C — Social policies and documentation of the Tier 1 manufacturer

(This appendix is left out in this version of the thesis for reasons of confidentiality)

Appendix D — IFC Standard 2 compliance assessment

(This appendix is left out in this version of the thesis for reasons of confidentiality)

Appendix E — PSILCA Assessment

(This appendix is left out in this version of the thesis for reasons of confidentiality)

Appendix F — Subcategory Assessment Method

(This appendix is left out in this version of the thesis for reasons of confidentiality)