Developing a Conceptual Framework For

The Comprehensiveness of Social Life Cycle Assessment

- A Case Study on Oiconomy Pricing

Wei-Ying Liao | 9168907

MSc in Sustainable Development, Earth System Governance Track

Utrecht University, Faculty of Geosciences

30 EC Master's Thesis

Thesis supervisor: Dr. Agni Kalfagianni

Second reader: Dr. Walter Vermeulen

December 2023

Summary

Achieving sustainability in global value chains is a complex challenge for businesses pursuing the 2030 UN Sustainable Development Goals (SDGs). The intricacies stem from diverse organizations across tiers and regions, resulting in inefficiencies in addressing cross-border environmental and societal impacts, often considered external costs. Lifecycle-based assessment approach helps practitioners identify environmental and societal risks in product life cycles and develop policies for sustainable practices. However, compared to environmental life cycle assessment (E-LCA), social life cycle assessment (S-LCA) is still in early development. The lack of a universal S-LCA methodology has led to discrepancies and difficulties in sharing and comparing assessment findings. To address this, there is an urgent need to develop comprehensive S-LCA impact categories and indicators for improved standardization and practical use. Additionally, there is a growing emphasis on internalizing environmental and social externalities for sustainability, with methods such as Oiconomy Pricing, a lifecycle-based methodology designed for monetizing sustainability impacts.

This research seeks to improve our understanding of S-LCA methodology comprehensiveness by creating a framework based on scientific discussions and applying it to a case study on Oiconomy Pricing. The study examines whether Oiconomy Pricing's design and social impact categories can universally evaluate social life cycle impacts. The main research question and two sub-research questions are formulated accordingly.

RQ: *How comprehensive is the Oiconomy System as an S-LCA instrument?*
Sub-RQ 1) *What are the characteristics of a comprehensive S-LCA methodology?*
Sub-RQ 2) *How well does Oiconomy Pricing align with comprehensive S-LCA criteria?*

This research assesses the comprehensiveness of Oiconomy through a multifaceted approach, including literature, international standards, interviews with and materiality analysis on the Oiconomy Pricing pilot company, expert consultations, and the author's experience as the tool user. Furthermore, a conceptual framework for understanding the comprehensiveness of S-LCA was proposed for systematic analysis. The framework consists of five criteria- Lifecycle thinking, Stakeholder inclusiveness, Impact pathway, Context-specific adaptation, and a set of consensus-based social topics. The combined result indicates that Oiconomy Pricing is a comprehensive methodology by design but neglected to include diverse stakeholder interests associated with social capital, especially value chain governance, and engagement. Three recommendations are given for its future development. This thesis contributes to the literature on knowledge building of S-LCA and

helps business practitioners integrate S-LCA with a plethora of corporate sustainability management tools. Future studies can look at the integration of social justice, the 5Ps of the SDGs: People, Planet, Prosperity, Peace, and Partnership, and intertwined sustainability topics in LCSA.

Preface

A seminar on Social Return on Investment (SROI) in 2017 was the inception of my interest in social impact assessment. The methodology focuses on measuring the social influence of projects or activities. I found it fascinating that practitioners look for "creative" reference points to estimate social impacts, which are often intertwined and subjective. Years later, I was truly excited when I first heard about Oiconomy's philosophy. With my professional background in the manufacturing industry and corporate sustainability reporting, I intimately understand the challenges associated with assessing and quantifying social impacts within complex global supply chains. However, during the time I worked in the Oiconomy team as a student coach, I found it even more challenging to assist Small and Medium-sized Enterprises (SMEs) without established resources and communicate sustainability expertise in easy business language.

This understanding served as the motivation for embarking on my research project into S-LCA. Little did I know then that the field of S-LCA was in such an immature state. Nevertheless, this research experience proved invaluable in providing me with a holistic comprehension of lifecycle-based assessment methodologies and their ongoing challenges. I enjoyed the process of exploring diverse insights and seeing numerous scholars utilize existing knowledge and frameworks to inspire new ideas that can be applied to more complicated situations. I was able to shape my perspectives and apply these perspectives contributing to Oiconomy's development.

Furthermore, it is interesting to witness that Oiconomy has gone through a similar development trajectory with S-LCA. There is always a trade-off between standardization and contextual adaptation, between comprehensiveness and materiality, and between theoretical soundness and empirical feasibility. Once again, I realized there is no correct answer in academia, and even to every question in this world. The real world is too complicated and too amazing to be conceptualized. One of the interviewees from this research asked, "How can I convince my supplier that this tool is not a threat but an opportunity to make the world a little better?" Yet, deep down the question lingering in my mind is "How can I rekindle the human awareness that everything in the universe is connected and remind them to make conscious decisions?" I believe Oiconomy has the potential to catalyze systematic change, and I am proud to be part of this journey.

Acknowledgments

Table of Contents

1.   Introduction

Managing sustainability issues in global value chains (GVCs) ranks as one of the biggest challenges for business entities to meet the 2030 United Nations (UN) Sustainable Development Goals (SDGs) (UN, n.d.; UN Global Compact, n.d.). The complexity arises from a variety of organizations situated across different tiers and geographical regions within value chains, which introduces intricacies in maintaining sustainability practices. While production and consumption activities are dissociated by spatial separation, environmental and societal impacts of these activities extend beyond national borders and affect third parties. The costs and burdens to address these sustainability challenges are "external" to the business actors in the transactions, resulting in inefficiency in resource allocation (Ding et al., 2016). Furthermore, organizations may encounter difficulties in gaining insight into secondary levels of suppliers and confronting issues with suppliers distributed in developing economies characterized by weak environmental and labor regulations or uncertain enforcement (Carter et al., 2015).

Lifecycle-based assessment approach has been recognized as one of the criteria for The UN 10-Year Framework of Programmes on Sustainable Consumption and Production (10YFP) to advance sustainable consumption and production (SCP) (10YFP, n.d.). This methodology enables governments, businesses, and other stakeholders to pinpoint hotspots of environmental and societal risks across product life cycles and construct effective policy bundles to transform consumption and production patterns. So far, Life cycle sustainability assessment (LCSA) is the most comprehensive lifecycle-based framework for assessing both internalities and externalities of products and services (Kloepffer, 2008; Valdivia et al., 2012). It is an overarching sustainability assessment (SA) method that combines and integrates three methodologies- environmental life cycle assessment (E-LCA), life cycle costing (LCC), and social life cycle assessment (S-LCA). It aims to thoroughly assess negative impacts and benefits in all the dimensions of sustainability throughout the product's lifecycle and facilitate decision-making processes towards more sustainable products.

Nonetheless, when compared to the other two methodologies, Social Life Cycle Assessment (S-LCA) is currently situated at an early developmental stage (Huarachi et al., 2020; Pollok et al., 2021). Within the spectrum of the 17 SDGs, a noteworthy 12 of them are linked to social and socio-economic impacts. These dimensions also hold two substantial pillars within the Environmental, Social, and Governance (ESG) paradigm in the realm of corporate sustainability (CS). This alignment underscores the significance of considering

societal factors in managing value chains. The incipient state of S-LCA poses substantial challenges to the comprehensive evaluation of these multi-dimensional impacts. Consequently, an imperative arises for the establishment of a comprehensive and methodically structured assessment framework to effectively navigate these complexities.

Societal Relevance

The significance of S-LCA is on the rise, with the European Commission Joint Research Centre (JRC) actively promoting its application (Sala et al., 2015; Sanyé-Mengual & Sala, 2022). Furthermore, the European Union (EU) Corporate Sustainability Due Diligence (CSDDD) framework has heightened the demand for product transparency, mandating organizations to measure and disclose social risk hotspots (Directive 2019/1937, n.d.). A standardized S-LCA approach can play a pivotal role in aligning with the circular economy policies outlined in the European Green Deal and in fulfilling reporting requirements under the Corporate Sustainability Reporting Directive (CSRD).

Corporate sustainability reporting is increasingly shifting towards a more accounting-centric approach, necessitating greater inclusion of financial data. This shift is evident in the ongoing harmonization efforts within reporting guidelines. The emergence of the International Sustainability Standards Board (ISSB) reflects this trend, as it seeks to integrate various standards, including those from the GRI, the Task Force on Climate-related Financial Disclosures (TCFD), and the International Financial Reporting Standards (IFRS). This alignment will establish a more inclusive and unified framework, enabling the reporting of social impacts in both financial and qualitative terms (IFRS, n.d.).

Additionally, in its Global Green New Deal (GGND), The UN Environment Programme (UNEP) promotes the internalization of environmental and social externalities as one of the necessary paths for achieving sustainability (UNEP, 2009). Bithas (2011) suggests internalizing externalities by reflecting their costs in the market prices of goods and services. Accordingly, the resulting "right prices" will make sustainable products more attractive than their counterparts, increasing allocative efficiency that ensures the environmental and societal welfare of current and future generations. Several scientific and private initiatives are devoting efforts to developing comprehensive SA methods based on life cycle thinking for calculating true prices, such as full-cost accounting. Full-cost accounting determines the total internal and external expenses associated with a product, process, or activity over its entire lifespan, encompassing all costs from acquisition to disposal (Lindgreen & Vermeulen, 2023). Oiconomy Pricing is one of the newly emerged full-

cost accounting methods that aims to monetize sustainability impacts and focuses on addressing externalities in the supply chain (Croes & Vermeulen, 2015). It is considered a path-breaking life cycle impact assessment tool that aims to uncover both the hidden environmental and social externalities of product life cycles by analyzing the costs of preventive action plans. This approach recognizes that the initial purchase price often fails to represent the product's total life cycle costs, making it insufficient as an indicator. Unlike traditional impact-based Life Cycle Assessment (LCA), full-cost accounting enables monetary aggregation and enhances communication, facilitating comparisons within and between value chains (Croes, 2021). However, despite the potential of this methodology to function as a corporate sustainability management tool, there is a lack of empirical evidence demonstrating its applicability in real-world business scenarios for assessing intricate social life cycle impacts.

Scientific Relevance

As of present, a universally standardized methodology for carrying out S-LCA remains absent. Issued by UNEP and The Society of Environmental Toxicology and Chemistry (SETAC), The Guidelines for Social Life Cycle Assessment of Products published (hereafter, the Guidelines or the UNEP/SETAC Guidelines) are widely regarded as the most comprehensive framework for conducting S-LCA (Benoît & Mazijn, 2009; Corona et al., 2017). However, ongoing scientific discussions underscore that these guidelines might not adequately encompass the intricacies of multifaceted social concerns (Baumann et al., 2013; Lehmann et al., 2013; Sureau et al., 2017). A prevailing challenge lies in determining the specific impact categories and corresponding indicators deemed suitable for inclusion in the S-LCA analysis (Jørgensen et al. 2010; Hutchins and Sutherland 2008). Impact categories often operate at a relatively abstract level, requiring an initial classification of inventory data into subcategories. These subcategories are then connected to the relevant impact categories and stakeholder groups. Critics have pointed out that the UNEP/SETAC Guidelines may be deemed incomplete because they do not incorporate performance categories that are considered significant by industries or are supported by empirical studies (Neugebauer et al., 2015; Popovic et al., 2014).

The latitude for interpretation of the Guidelines has engendered a sense of discordance within the realm of S-LCA. This, in turn, can result in challenges when presenting compelling findings and attempting to compare outcomes from distinct assessments (Kühnen & Hahn, 2017). Moreover, the complexity of a plethora of S-LCA methods renders them less accessible to individuals lacking a professional background,

accentuating the divide between conceptual and theoretical principles and their practical implementation (Croes, 2021; Walker et al., 2021). Nonetheless, the establishment of comprehensive S-LCA impact categories and indicators would offer a path to standardization, subsequently enhancing the practical experience and bolstering the evolution of LCSA (Weidema, 2014). A harmonized S-LCA can become imperative to ensure uniform regulations and forestall needless disparities therefore helping facilitate decision-making for addressing externalities and contributing to SCP and SDGs.

Iofrida et al. (2018) emphasized the pressing need for a stronger theoretical foundation in S-LCA. Currently, a consensus on the integral impact categories for S-LCA remains elusive, and there is a lack of established scientific criteria for evaluating the method's comprehensiveness. Dreyer et al. (2006) suggested that S-LCA should incorporate a core set of impact categories applicable across all industries, representing the minimum standards for responsible business conduct. Additionally, as highlighted by Benoît et al., (2010), it's crucial that a universal set of social impact criteria transcends personal, cultural, and political biases, necessitating reference to international conventions, best practices, and legal frameworks.

A review conducted by Messmann et al. (2020) revealed that merely a quarter of S-LCA studies' articles provided a rationale for their indicator selection based on universal norms and standards. Among these, a limited number of international frameworks, such as the Global Reporting Initiative (GRI), ISO 26000, and AA1000, were commonly chosen. However, these frameworks and principles primarily adopt a "top-down" approach focused on societal expectations, and in some cases, the parameters may not align directly with supply chain considerations (Dreyer et al., 2006). A significant knowledge gap exists in understanding how business sectors and pirate initiatives tackle the incorporation of social topics, particularly when viewed from a bottom-up perspective. Notably, ESG (Environmental, Social, and Governance) ratings hold substantial influence as primary reference points for guiding the decisions of corporate leaders and investors in matters of significant financial investments, procurement strategies, and sustainability-focused partnerships. These rating methodologies often derive from a consensus among scholars and key stakeholders, shaping their criteria and assessment frameworks. For instance, EcoVadis stands out as a leading global sustainability rating and assessment tool, widely utilized to evaluate the sustainability performance of businesses and their supply chains (EcoVadis, n.d.). Similarly, S&P Global has developed its corporate sustainability assessment methodology, extensively employed for evaluating portfolios (S&P Global, n.d.).

Additionally, an in-depth analysis conducted by Martínez-Blanco et al. (2015) examined 189 recommended social indicators outlined in the Methodological Sheets for Subcategories by the UNEP/STEAC. This analysis highlighted the difficulties in allocating organizational and product impacts, mainly due to the complexity of identifying suitable social indicators at the product level. It also underscored that social impacts often originate at the organizational level. Despite these insights, the field of S-LCA literature has seen limited discussion on the assessment and integration of corporate governance into S-LCA methodologies. Nonetheless, this integration is crucial as it aligns S-LCA results with effective corporate sustainability reporting, ensures compliance with various corporate sustainability standards, and facilitates well-informed decision-making.

Research Aims and Questions

This research aims to enhance the understanding of the comprehensiveness of S-LCA methodology and fill the gap between the theoretical design and the empirical application. This is achieved two-fold. First, sorting through scientific debates to build a framework for assessing the comprehensiveness of S-LCA. Second, applying the framework through a case study on the Oiconomy Pricing method, to examine whether the conceptual design and designated social impact categories of Oiconomy Pricing are adequate for evaluating social life cycle impacts universally. Oiconomy Pricing is developed to be an open science initiative that enables companies to independently evaluate hidden costs, making it a fitting candidate for a case study. Additionally, in this study, "comprehensiveness" pertains to an S-LCA methodology's ability to evaluate a product or service in diverse contexts, with the potential to deliver exhaustive results.

Thus, the main research question is:
How comprehensive is the Oiconomy Pricing as a Social Life Cycle Assessment instrument?

To answer this research question, two sub-research questions are formulated.
Sub-question 1. What are the characteristics of a comprehensive S-LCA methodology?
Sub-question 2. How well does Oiconomy Pricing perform according to the criteria of a comprehensive S-LCA tool?

Sub-question 1. is explored through an extensive literature review, to formulate consensus-based criteria. The result is organized as a conceptual framework for S-LCA practitioners to easily understand. *Sub-question 2 is* answered by the assessment result through the framework and interview results with participants from the Oiconomy Pricing pilot projects.

Outline of the Report

This thesis follows the following structure. First, an introductory background and traces of the historical evolution of S-LCA are provided, offering insights into existing theoretical foundations and developmental challenges. Second, the research strategy, description of the case study, and discussion of data collection and its associated limitations are outlined. Third, a conceptual framework comprising five criteria to assess the comprehensiveness of S-LCA is constructed, drawing from academic literature and corporate sustainability standards. This framework serves as the analytical basis for investigating Oiconomy Pricing. Fourth, the study presents descriptive findings derived from the analysis of Oiconomy Pricing, insights gleaned from interviews with pilot companies, and a materiality analysis focused on key social issues. Fifth, the results are synthesized to address the main research question. Sixth, this thesis offers recommendations to improve the Oiconomy Pricing methodology based on critical findings and discusses the research's contributions, limitations, and future directions.

2. Conceptual Background

2.1. What Is S-LCA?

S-LCA is a methodology designed to evaluate the social and socio-economic impacts of products or services from cradle to grave. As suggested in the UNEP/SETAC Guidelines, practitioners generally follow the four phases illustrated in the ISO standards 14040 and 14044 for LCA (International Organization for Standardization [ISO], 2006a; 2006b):

1) Goal and scope definition
2) Inventory analysis
3) Impact assessment
4) Interpretation

The assessment is carried out in an iterative manner, with the objectives of the study defined at the beginning. These are often research questions to be answered, such as "What are the social risks associated with a product supply chain?'', or '"What would be the social effects of a certain decision?'' As LCA is a simplified model that aims at evaluating a complex system in reality (Rebitzer et al., 2004), crucial decisions, including target audience, study object (i.e., functional unit), system boundaries, social topics of interest, the identification of social indicators, and the type of the assessment methods, are carefully undertaken to produce a reliable simulation result. Accordingly, relevant data (i.e., inventory) are collected on identified social indicators linked to each process within the system boundary. At the phase of life cycle impact assessment (LCIA), inventory data are translated into social impacts to understand the potential consequences of life cycle activities. This is achieved by calculating and aggregating indicator results (i.e., characterization) and linking inventory results to particular impact categories and/or subcategories (i.e., classification). There are identified two major groups of characterization models (Benoît & Mazijn, 2009; Parent et al. 2010), namely the Performance Reference Points approach (or Type I) and the Impact Pathway approach (or Type II) (see 4.1.3 for further discussion). Finally, the implications of the assessment results are reviewed and analyzed in alignment with the goal and scope for decision-making.

Several fundamental distinctions exist between E-LCA and S-LCA. E-LCA assesses location information by considering physical factors such as geographical features; however,

it does not incorporate site-specific data (Benoît et al., 2010). Impacts are assessed to present the average performances, e.g., raw material acquisition in Brazil and production in China. As such, individual cases and outliers are ignored. In contrast, S-LCA commonly deals with information about the features or qualities of the life cycle process and the supply chain, which can be subjective and sensitive to particular facilities, e.g., the gender pay gap in a specific company. For S-LCA, inventory data can be quantitative, qualitative, or semi-qualitative, typically collected through generic databases, scientific and gray literature publications, audit reports, surveys, interviews, and other sources. Based on the characteristics of the data, it can be classified into several data types such as primary data, secondary data, site-specific data, or generic data. Although some environmental indicators are qualitative, S-LCA utilizes a larger amount of qualitative data compared to ELCA, which in turn brings about added complexities within the assessment process. Furthermore, in contrast to E-LCA, where positive impacts are typically minimal and the emphasis is on reducing negative impacts, S-LCA involves a greater consideration of positive impacts (Di Cesare et al., 2016). Policy interventions stemming from these results frequently strive to establish scenarios that benefit various stakeholders throughout the value chain, often referred to as 'win-win' situations.

While both E-LCA and S-LCA adhere to comparable procedures, E-LCA stands out as a more standardized approach, where each stage is clearly delineated and can be validated by an independent body according to the ISO standards. Conversely, S-LCA is in a state of continuous development, allowing room for diverse interpretations. S-LCA practitioners are confronted with the task of navigating through a range of adaptable methods and addressing numerous ambiguous areas.

2.2.   The Development and Challenges of S-LCA

Since the 1990s, there has been a growing recognition among researchers regarding the imperative to assess the social dimensions of products within the context of the traditional environmentally focused LCA. This recognition has given rise to an integrated approach known as Social and Environmental Life Cycle Assessment (SELCA) (Benoît et al., 2010; O'Brien et al., 1996). Building upon these foundational works, a significant step was taken in 2006 when four distinct frameworks for evaluating the social impacts within the LCA framework were introduced (Dreyer et al. 2006; Hunkeler 2006; Norris 2006; Weidema 2006). Subsequent to this pivotal moment, a proliferation of studies dedicated to exploring the principles and methodologies of social LCA has occurred. In response to the escalating demand for effective methodologies, the UNEP/SETAC Life Cycle initiative responded by

producing a comprehensive framework that offers guidance through the intricate landscape of social LCA (Benoît & Mazijn, 2009). The publication of the Guidelines stands as a significant milestone in the evolution of this field and has provided a foundation for academic research (Huarachi et al., 2020). The initiative has underscored 15 issues that remain ripe for further investigation. These encompass an array of domains including the formulation of robust methodological frameworks, the establishment of comprehensive databases, and empirical case studies aimed at knowledge enhancement (Benoît et al., 2010). With the acknowledgment of S-LCA as a crucial tool within the broader LCSA paradigm, an influx of studies has been propelled to improve S-LCA methodologies. These studies continue to yield novel frameworks and indicators for S-LCA, with many closely aligning with the Guidelines and others endeavoring to refine them (Pollok et al., 2021).

However, despite their significant contributions, the Guidelines have not escaped criticism. A primary concern revolves around the challenge of translating these guidelines into real-world practices with confidence. This skepticism stems from the initiative's inability to foster agreement on the methodology and indicators for impact assessment (Kühnen and Hahn, 2017). The limited applicability of the guiding framework has provided a weak foundation for empirical studies to "prove it works" (Baumann et al., 2013; Jørgensen, 2013). The choice of social indicators often leans towards intuitive reasoning rather than empirical knowledge, resulting in inherent variability across different studies. Practitioners may choose indicators relevant to their understanding of a company's sustainability stance, stakeholder expectations, geographical location, and industry sectors.

Kühnen and Hahn (2017) further noted that during the period spanning 2003 to 2015, the quantity of quantitative studies was approximately four times greater than that of qualitative studies. Given the inherently qualitative nature of S-LCA, they voiced concerns regarding the potential disregard for qualitative research due to the comparatively simpler data collection and result aggregation processes. This, consequently, has contributed to a weakened establishment of the theoretical underpinnings of the field. The challenges associated with data availability have also resulted in incomplete and biased exploration of impact categories. As of now, the conceptualizations and frameworks for measuring social performance predominantly center around worker-related health and safety (Jørgensen et al., 2008; Macombe et al., 2013). This narrow focus runs the risk of overlooking impacts on a multitude of other stakeholders.

To enhance clarity and operational effectiveness, the initiative issued Methodological Sheets for Subcategories- an official document that defines impact subcategories and

suggests inventory indicators as fundamental elements for creating inventories (Benoit-Norris et al., 2011). The subsequent revisions of the guidelines in 2020 and methodological sheets in 2021 sought to address academic critiques as much as possible (UNEP, 2020; (UNEP, 2021)). While these updates incorporate a diverse range of methodologies suggested by researchers and instructions for choosing the appropriate method under different circumstances, the field still grapples with the absence of a standardized approach, perpetuating an aura of uncertainty.

Huarache et al., (2020) summarized that the development of S-LCA has gone through three stages: the first steps toward S-LCA (1996–2009), the uncertainty years (2009–2012), and the development years (2013–2016). They refer from 2017 to date to the phase of "'searching for standardization". They contend that true standardization can be achieved through the utilization and advancement of databases, along with the application of SLCIA methodologies and quantification frameworks. Databases offer established reference scales; hence, the imperative for database development, exemplified by well-established resources like the Social Hotspots Database (SHDB) (Benoît Norris, 2013) and the Product Social Impact Life Cycle Assessment (PSILCA) database (Ciroth and Eisfeldt, 2016), is becoming increasingly pronounced. However, it remains essential to address concerns about the comprehensiveness of database deployment, an aspect explored in further detail in section 8.1.4. At the time of writing this thesis, ISO has commenced the preparation of ISO 14075 Principles and Framework for Social Life Cycle Assessment (ISO, n.d.). While this process might entail some duration, it holds the substantial potential to serve as a pivotal advancement in propelling the standardization of S-LCA.

3.   Method

3.1.   Research Approach

This study employs a mixed methodology that incorporates both systematic literature review and single case study methodologies. By combining both quantitative and qualitative analyses, this approach strives to attain a holistic understanding of the subject matter. The findings derived from the literature review play a pivotal role in addressing sub-RQ 1, as they inform the development of an assessment framework. The subsequent application of this assessment framework addresses sub-RQ 2 which leads to the discussion of the main research question. Figure 1 presents the research strategy of this thesis.

Given that the theoretical foundation of S-LCA is not yet well-constructed, the initial step of the study involved an extensive literature review to establish a holistic understanding of the field. Through this in-depth review, a set of criteria was formulated intended to evaluate the comprehensiveness of S-LCA methods. These criteria were distilled from a diverse range of perspectives prevalent in academic literature. In the next phase, the study conducted a comparative analysis of existing corporate sustainability standards to understand how they assess social impacts. This involved scrutinizing the themes and methods these tools use to categorize social factors. By merging and summarizing the results from both stages, a broadly applicable framework for assessing the comprehensiveness of the S-LCA methodology is built.

The next step entails applying the conceptual framework to the Oiconomy Pricing. Given that Oiconomy Pricing is designed as a sustainability assessment tool encompassing all three pillars, this study specifically evaluates its social and profit dimensions. To gain diverse insights, a sequence of semi-structured interviews is conducted concurrently with the developers and the companies engaged in the pilot phase. Furthermore, a materiality analysis is conducted in cooperation with the pilot participants, focusing on the core social topics outlined in the assessment framework. This collaborative effort provides subjective insights into the prominent social concerns spanning various industries. Finally, the combined findings from these two sub-questions contribute to addressing the main research question.

Figure 1

Research strategy
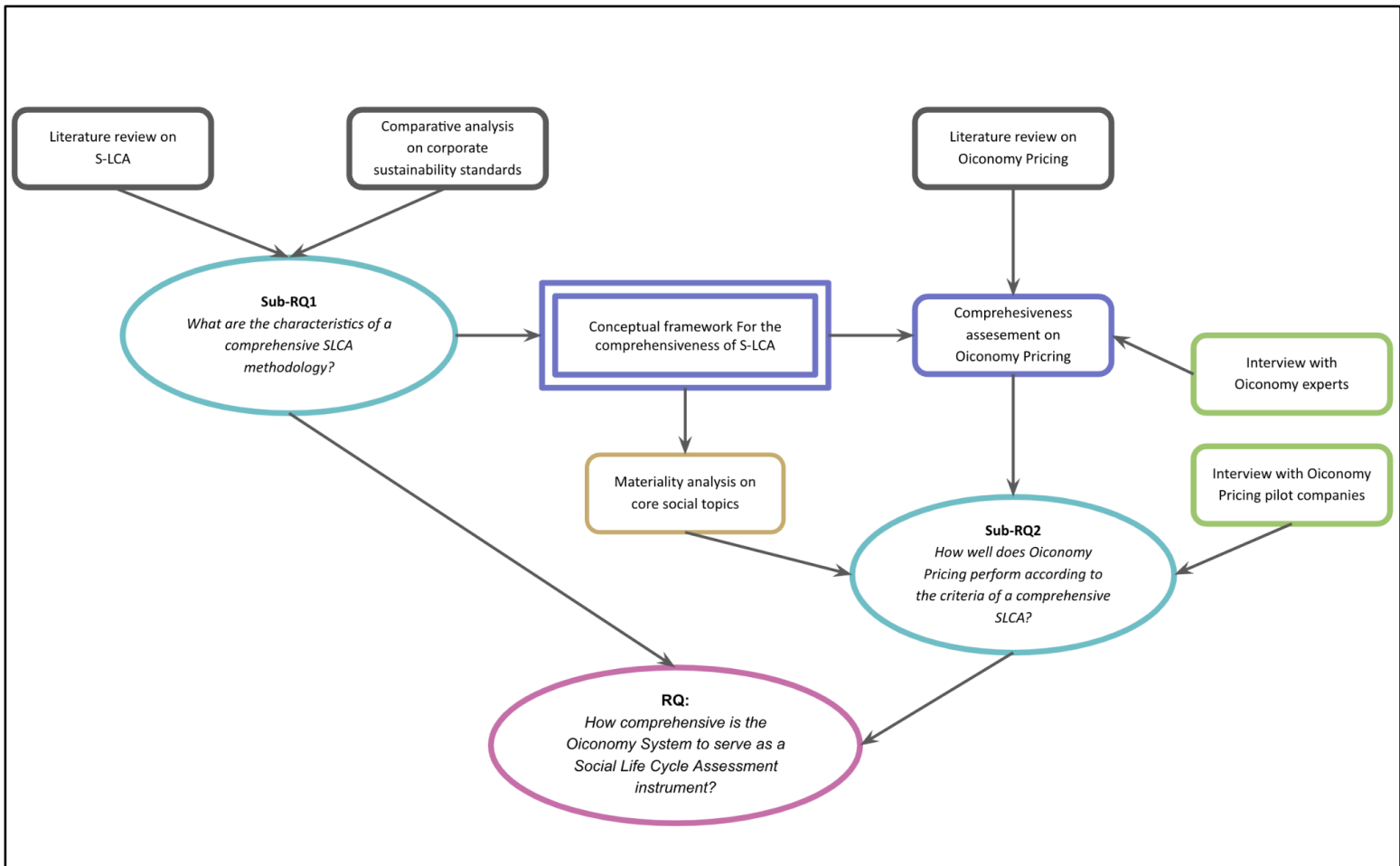
3.2.   Data Collection and Analysis

Literature review

The literature review was conducted using a mixed approach of keyword searching and snowballing. Keywords such as "Social life cycle assessment," "SLCA," "S-LCA," and "Comprehensive Social LCA" were used in the search on Google Scholar, employing the Boolean operator OR. An initial set of four state-of-the-art articles on S-LCA resulted in a pool of 475 articles including duplicates. The review then expanded by tracing both references and citations of these papers, prioritizing the articles cited over 20 times. This process led to a total of 82 articles being included in the review. Additionally, gray literature, primarily international standards, was sourced directly from official organization websites. The collected literature was organized and managed using Google Sheets, with key insights noted and arguments compared and contrasted for analysis.

Case study

The case study on Oiconomy Pricing involves both desk research and interviews. The desk research begins with a review of eight scientific articles on Oiconomy Pricing. Additionally, a Ph.D. thesis published by the developer is included because it revises and expands upon some contents of Croes & Vermeulen (2015), such as the inclusion of SDGs. Furthermore, the assessment tool, Oiconomy Pricing version 2.4 (Excel spreadsheet), is obtained directly from the developer.

Subsequently, six semi-structured open interviews were conducted with pilot companies and experts. Table 1 presents the list of interviewees. There are two interviewees from Arte Groep because they were involved in different tasks in the pilot - the CEO participated in scoping and communication, while the sustainability specialist provided data. Moreover, the author served as the Oiconomy coach in the same company, thus having access to more personnel. All interviews were recorded and transcribed afterward. Company interview transcriptions underwent analysis in NVivo 14, utilizing a predefined list of keywords for coding relevant comments. The analysis comprises three key sections: the interviewee's background information, the pilot project experience, and opinions on Oiconomy assessed against criteria of comprehensiveness. The coding results are illustrated in Figure 2.

The interview results with firms are presented in section 5.2, and consultations with experts were used for assessing the design of Oiconomy in section 5.1. When information is derived from the interviews mentioned in this report, the interviewee will be specified and denoted at the end of the sentence to differentiate it from the scientific citation, e.g., (*Interviewee A*).

Table 1

Lists of interviewees

Name	Affiliation	Title / Position
Interviewee A	Arte Groep	CEO
Interviewee B	Arte Groep	Quality, Safety, Health and Sustainability Coordinator
Interviewee C	Verstegen Spices & Sauces	Sustainable Supply Chain Developer
Interviewee D	Tradin Organic Agriculture	Sustainability Manager
Interviewee E	Oiconomy Pricing Foundation	Developer of Oiconomy pricing; Co-founder of Oiconomy Pricing Foundation
Interviewee F	Oiconomy Pricing Foundation	Sustainable Supply Chain Expert; Co-founder of Oiconomy Pricing Foundation

Figure 2

Analysis Result of Company Interviews in NVivo 14

Name	Files	References
∨ ○ Pilot projects	0	0
○ Motivation	4	16
○ Feedback	4	26
○ Experience	4	32
∨ ○ Criteria for comprehensiveness	0	0
○ Stakeholer inclusiveness	4	25
○ Life cycle thinking	4	16
○ Impact pathway	4	13
○ Core social topics	4	14
○ Context-specific adaptation	4	17
∨ ○ Background	0	0
○ Supply chain practices	4	55
○ Interviewee	4	6

Materiality analysis

A materiality analysis is conducted in the form of an online questionnaire created with Google Forms. This process is utilized in sustainability reporting, where organizations identify and prioritize the most significant sustainability issues relevant to their stakeholders and business operations (Whitehead, 2016). The questionnaires were distributed to four interviewees from the pilot companies (Interviewees A to D), and all of them responded. These interviewees were tasked with rating 39 social topics proposed in this study on a scale of 1 to 5, reflecting the relevance and/or importance of these topics to their supply chain. The quantitative data is subsequently analyzed using Google Sheets.

3.3.   Case Study Description

Oiconomy Pricing represents a full cost accounting method rooted in LCA principles. This method offers a standardized framework for the comprehensive evaluation of product sustainability. Therefore, there exists a compelling rationale to investigate the encompassed social and socio-economic facets to assess the method's depth and breadth. The following section delineates the methodology, introduces the pilot companies chosen for interview participation, and provides additional justification for the selection of Oiconomy Pricing for the case study.

3.3.1.   Oiconomy Pricing

Oiconomy Pricing, referred to as Oiconomy hereafter, is an innovative assessment method for pricing goods and services in alignment with the principles of life cycle assessment (Croes & Vermeulen, 2015). It is a full cost accounting method designed to tackle externalities through the systematic internalization of external costs. It takes a holistic approach to evaluating externalities, covering all three dimensions of sustainability – People, Planet, and Prosperity (PPP) (Croes, 2015). Additionally, it targets hidden costs that arise within global supply chains, making it applicable for assessing value chains across various industries and geographical regions. This methodology strives to present a more precise depiction of the genuine value associated with products and services. As a result, Oiconomy fosters responsible consumption and production behaviors while promoting sustainability.

Oiconomy calculates a product's full costs by uncovering the hidden expenses tied to unsustainable life cycle activities. These encompass various issues such as excessive resource depletion, the use of child labor, and irresponsible disposal of hazardous materials. The methodology arises from the realization that conventional pricing methodologies frequently neglect to capture the long-term negative impacts of economic activities on both the environment and society. These indirect costs are invariably shifted downstream, affecting third-party entities across the value chain. At its core, Oiconomy confronts this challenge by calculating the" cost distance to sustainability", or in other words, "the price gap between the current and the sustainable version" (Croes & Vermeulen, 2015), by monetizing the expenses incurred in preventing unsustainable behaviors and the resulting negative consequences in a unified virtual monetary unit, Eco Social Cost Units (ESCU). The philosophy is inspired by the international food safety system, Hazard Analysis, and Critical Control Points (HACCP) (*Interviewee E*). The system targets avoiding hazards in the food

supply chain by setting verification and auditable procedures for identifying and reducing safety risks (HACCP, n.d.). While the cost distance to sustainability can also be measured through the pressures of impact, or ''damage costs', as most impact-based LCA studies assess, impacts are difficult to evaluate because of their complex and unpredictable nature (Weidema et al. 2009). On the other hand, the costs of prevention, or 'abatement costs' can be measured in the present moment and are more tangible to business decision-makers (Croes, 2021).

Fundamentally, the implementation of Oiconomy's full costs will need to be incorporated into the transactional prices between buyers and suppliers within the value chain and result in a higher selling price (Vermeulen et al., 2023). This allows consumers to shape their purchasing choices by considering the authentic price that encompasses both environmental and societal externalities. This bottom-up approach facilitates the operation of Adam Smith's "invisible hand," the mechanism of the free market, to assume control and gradually eliminate unsustainable products or services (Smith & Rogers, 1776). This progression allows society to attain the equilibrium of the free market, known as "Pareto efficiency" (Pareto, 1972), a state denoting the optimal economic condition where resource allocation cannot enhance one individual's situation without negatively affecting another's. Ultimately, this process addresses the inherent flaws in the economy that contribute to an unsustainable future (*Interviewee E*).

Oiconomy differentiates itself from other true cost assessment methods by adopting a preventative cost-based system. The hidden costs are calculated and aggregated via an EcoCost ratio system first developed by Vogtländer et al. (2001). The system computes the marginal cost associated with implementing a preventive measure to mitigate damages to a target level. This calculation is carried out using a prevention curve, identifying the point at which mitigation efforts reach a marginal threshold to achieve a "negligible-risk level." This approach is based on the premise that when multiple solutions are required to address a sustainability challenge, the most effective measures tend to become costlier and are often implemented at a later stage as technology advances. The performance target within Oiconomy is determined through three approaches. Firstly, it hinges on whether the value chain entity holds international certification according to established standards or meets thresholds defined in international conventions. Secondly, in the absence of clearly defined international agreements addressing a specific issue, the consideration is given to either achieving an 80% reduction in detrimental impacts relative to a predetermined baseline or adhering to a benchmark of the top 20% best practices. Thirdly, for non-regulated issue areas, proximity to "perfect governance" is assessed using governance-level scoring sheets

based on the Deming cycle (Plan-Do-Check-Act, PDCA) (Deming, 1982; Oiconomy Pricing Foundation, n.d.).

The same 80/20 principle is also employed when scoping each evaluated product, where 80% of the physical weight and value addition are considered, focusing on essential lifecycle activities to streamline the process. Building on this framework, an assessment tool was developed. All participants within the value chain are required to carry out annual self-assessments and transmit the outcomes (total ESCU) downstream for aggregation by end-producers. Performance evaluation involves foreground and/or background data. "Foreground data" refers to product-specific data acquired directly from the supply chain. On the other hand, "background" data consists of averages obtained from sources outside the specific supply chain (JRC, 2010). In cases where value chain participants are unable to provide foreground data showcasing their efforts to meet the preventative targets, the system assigns default values for prevention costs. These defaults are typically higher than the actual precautionary expenses necessary for damage prevention.

Within each sustainability pillar, a predefined set of categories is required, some of which are further subdivided into subcategories. An overview of these considered categories is provided in Figure 3. Additionally, alongside negative hidden costs, positive costs are aggregated within the bonus ESCU category. These positive costs do not offset or combine with the negative costs to yield a net value. Positive costs, within the context of Oiconomy, pertain to favorable externalities that extend beyond the seller-buyer transaction impacting third parties or unforeseen extra benefits linked to products or services. Furthermore, these externalities shall serve as mechanisms for enhancing the capacity of stakeholder groups to address their requirements and make progress towards SDGs (Vermeulen et al., 2023).

Expanding beyond EcoCost's initial environmental focus, Oiconomy extends the value system to encompass the societal dimension. Its primary objective is to address existing challenges within S-LCA qualification by offering an objective, transparent, and standardized qualitative assessment methodology that ensures comparability of outcomes. The framework embraces all six social and socioeconomic categories, i.e., *Human Health, Labor, Various Social Factors, Economic Responsibility, Corruption and Conflict,* and *Various Social Aspects*. According to the developers, Oiconomy takes into consideration the entirety of the SDGs, GRI standards, and ISO 26000 guidelines (*Interviewee E*). Being an open science initiative centered on self-assessment by business practitioners, the Oiconomy assessment tool operates under predefined assessment categories that practitioners cannot modify. Furthermore, the project's overarching ambition is to ensure a comprehensive

evaluation. Consequently, it becomes paramount to examine whether the inclusion of social and socio-economic factors (people and prosperity) is truly exhaustive, as originally claimed, and possesses the flexibility to cater to diverse supply chain contexts.

Figure 3

Overview of Oiconomy Sustainability Categories

| Category | ESCU's | | | | | | | | | | Total |
| | Planet | | | | | People | | | Prosperity | | |
	Pollution	Depletion	Land	Biodiversity	Waste	Public Health	Labor	Various Social Aspects	Economic	Corruption	Total
Suppliers	Purchase-Pollution	Purchase-Depletion	Purchase-Land	Purchase-Biodiversity	Purchase-Waste	Purchase-Public Health	Purchase-Labor	Purchase-Various Social	Purchase-Economic	Purchase-Corruption	ESCU - Purchase
Gate to Gate	Gate to gate-Pollution	Gate to gate-Depletion	Gate to gate-Land	Gate to gate-Biodiversity	Gate to gate-Waste	Gate to gate-Third Parties' Health	Gate to gate-Labor	Gate to gate-Various Social	Gate to gate-Economic	Gate to gate-Corruption	ESCU - Gate to Gate
Product use	Use-Pollution	Use-Depletion			Use-Waste	Use-Public Health		Use-Social Responsibility			ESCU - Use
End of Life	End of Life-Pollution				End of Life-Waste						ESCU - End of Life
Bonus	Bonus-Pollution		Bonus-Land	Bonus-Biodiversity	Bonus-Waste	Bonus-Public Health	Bonus-Labor	Bonus-Various Social	Bonus-Economic		ESCU - Bonus
Total	Total-Pollution	Total-Depletion	Total-Land	Total-Biodiversity	Total-Waste	Total-Public Health	Total-Labor	Total-Various Social	Total-Economic	Total-Corruption	ESCU - Total

Note. *Adapted from Croes (2021)*

3.3.2.   Pilot Projects

From 2021, Oiconomy embarked on pilot projects supported by The Netherlands Enterprise Agency (RVO) to test its practicality and to gather real-world data for potential enhancements. The initial pilot project, conducted over six months, involved evaluating three Dutch companies. The results of this pilot have demonstrated the feasibility of Oiconomy's underlying philosophy, showcasing its capacity to stimulate communication among various value chain participants to improve unsustainable practices (Vermeulen et al., 2023).

This research conducted interviews with three company participants from the second phase of the pilot project- Arte, Verstegen, and Tradin Organic. This second pilot initiative was conducted between September 2022 and August 2023 and engaged four Dutch

enterprises. The pilot process involved project scoping, data collection, input data into the assessment tool, interpretation, and communication of results. The pilot projects were facilitated by researchers from the Copernicus Institute at Utrecht University, with additional support from student ambassadors who served as on-site coach trainees, assisting the participating companies throughout the assessment process. An overview of the pilot companies and their assessed products is presented in Table 2.

Both Arte and Verstegen have been consistent participants since the program's first pilot. In the second pilot, all four participants share certain key attributes. Firstly, they are industry leaders who have established sustainable practices and exhibit strong supply chain management. Secondly, they engage in global material sourcing and collaborate extensively with supply chain partners worldwide. Among the companies, Arte and Moyee are Small and Medium-sized Enterprises (SMEs), defined by the European Commission as businesses with fewer than 250 employees (EU, 2020). This shows their capacity to attain impressive outcomes within a more streamlined framework and acts as a sample group to assess whether Oiconomy is applicable to smaller-sized organizations. While Moyee Coffee's participation was unfortunately not feasible, this study has gathered perspectives and insights from other participants within the agricultural industry. A more detailed depiction of their supply chain practices is presented in 5.2.1.

Table 2

Information on the 2nd pilot participant companies

Company	Industry	Assessed product	Assessed supply chain description	Introduction
Arte Groep (Arte)	Kitchen furniture manifacturing	1 m2 of stone kitchen countertop	Raw materials sourced from two European countries are processed in Spain and then further processed in the Netherlands.	A Dutch kitchen countertop manufacturer specializing in high-quality natural stone, composite, and ceramic products. With a production facility in Helmond, they serve local customers and over 200 stores, committed to creating positive supply chain impacts.
Verstegen Spices & Sauces (Verstegen)	Food	1 jar of cinnamon sticks	Raw materials from Indonesia and Germany are used to produce the final product in the Netherlands.	A premium brand known for its high-quality spices and sauces. They source diverse global ingredients, expertly blended for culinary excellence, while also emphasizing sustainability and responsible sourcing.
Tradin Organic Agriculture (Tradin Organic)	Organic and sustainable agriculture	1 liquid bulk, 25kg, of cocoa liquor	Raw materials from Sierra Leone are processed in the Netherlands.	Tradin Organic specializes in high-quality organic ingredients, collaborating with farmers in 60+ countries to promote sustainable agriculture, biodiversity, and ethical sourcing. They offer various organic products and prioritize fair trade and community development.
Moyee Coffee	Organic coffee	1 kilogram of roasted coffee beans	Coffee cherries are harvested, roasted, and packed in Ethiopia before being shipped to the Netherlands.	A Dutch coffee brand prioritizing quality and social impact, they collaborate directly with coffee farmers through FairChain for fairness and sustainability. Their diverse coffee beans highlight responsible sourcing and exceptional taste.

3.4.   Data Ethics Validation and Limitations

In the process of collecting interview data, strict adherence to GDPR guidelines is maintained. Interviewees are provided with detailed information and consent forms to ensure privacy and voluntary participation in the study. This study upholds the principle of anonymity for all interview participants. Information about the pilot companies is publicly accessible on the official Oiconomy pricing website and is thus acknowledged within this study.

To validate the data gathered, this study relies on credible public sources for scientific and gray literature. Information pertaining to Oiconomy Pricing is further corroborated through interviews with its developers, adding a layer of reliability to the findings. Additionally, validation of details about pilot participants is achieved through their official reports available on their respective websites.

It is important to acknowledge that certain documents under review may undergo changes in the future, especially considering the ongoing development of Oiconomy Pricing and CSRD. In this thesis, we analyze the drafts and sets of data available, recognizing that further developments may impact the data analysis and restrain the conclusion.

4. Result for Sub-RQ1- Developing a Conceptual Framework

This section presents a three-step progression in constructing a conceptual framework aimed at assessing the comprehensiveness of S-LCA. Step 1 involves an in-depth examination of academic literature to discern the diverse criteria influencing comprehensiveness, underpinned in scientific perspectives. Additionally, as the theoretical foundation of S-LCA is not solid yet, the author endeavors to approach these concepts through varying theoretical lenses and scholarly viewpoints. Moving to Step 2, the analysis delves into 11 distinct CS tools, assessing their focus and coverage of social themes. This preliminary phase lays the groundwork for generating a comprehensive consensus-based list of social impact categories. Finally, in Step 3, the insights gleaned from the preceding two phases are synthesized to forge a cohesive conceptual framework.

4.1. The Characteristics of Comprehensive S-LCA Methodology

4.1.1. Life Cycle Thinking

The concept of lifecycle thinking (LCT) emerged along with the development of LCA techniques and forms the fundamental principle of S-LCA (Dreyer et al., 2006). It considers all the steps that a product goes through, including raw material extraction and processing, manufacturing, distribution, utilization, reuse, maintenance, recycling, and ultimate disposal, spanning from its creation to its eventual elimination.

From a system theory perspective, a product's supply chain can be seen as a complex system (Li et al., 2004), where each element within the system interacts with one another, and the performances and behaviors of components shape the dynamic as a whole. These components can be tangible entities such as materials or value-chain actors, or intangible entities such as organizational culture or information flows. Life cycle thinking examines a product system beyond the limited focus on the input or output of a single process and recognizes the interdependencies between social, economic, and environmental variables present at every stage of the life cycle. This recognition provides a foundation for understanding the cause-effect relationships within the supply chains and implies that decisions made at one stage of the lifecycle can have significant consequences at other stages.

The social network theory also recognizes that the social impacts of a product extend beyond the boundaries of a single company (Varsei et al., 2014). In the traditional

perspective of supply chain management, emphasis is often on the sourcing and production activities of a single company, which is commonly referred to as the focal company that governs the supply chain. Conversely, adopting life cycle thinking allows focal entities to look beyond manufacturing processes and production facilities and pay attention to the broader social and socio-economic impacts arising during both the consumption phase and the end-of-use phase.

S-LCA is considered more comprehensive than comparable tools as it integrates social considerations throughout a product's lifecycle. However, it is crucial to acknowledge that most S-LCA focuses on the social impacts of what is currently implemented (ISO, 2006). Jørgensen (2013) argues that to achieve a truly comprehensive assessment, it is essential to also consider the social impact of alternative scenarios. This means evaluating the social consequences of different design choices, material sourcing options, production methods, and consumption patterns. For instance, phasing out a multinational company's production line in a developing country could cause potentially severe repercussions that outweigh the benefits of preventing child labor situations. Nevertheless, the former is usually not being assessed.

Life cycle thinking sheds light on the complex feedback loops and unsustainable interplays inherent in supply chains (McCabe & Halog, 2016). In this capacity, it functions as a lens that scrutinizes the transfer of negative impacts across the varied phases of the lifecycle and geographical areas (Benoît & Mazijn, 2009). As highlighted in the introduction, the broader perspective opens the door to identifying externalities that may exist within complex global supply chains. This enables decision-makers to have a holistic and long-term outlook to identify potential hotspots for social risks and opportunities for remediations.

4.1.2. Stakeholder Inclusiveness

Addressing diverse demands from various stakeholder groups is at the core of sustainable supply chain management (Wood, 1991). Businesses are accountable for including a wide range of stakeholders in the decision-making processes by recognizing and addressing different expectations and interests in the operations and practices of their supply chains. Stakeholder groups commonly include but are not limited to investors, customers, local communities, government authorities, and non-governmental organizations (NGOs) (Gualandris et al., 2015). In the context of supply chain management, workers in the upper or downstream are also taken into account.

Stakeholder inclusivity is equally a crucial aspect of social life cycle assessment. Social impacts in supply chains are not solely determined by the nature of the process itself but are strongly influenced by the conduct and behavior of the companies involved (Dreyer et al. 2006; Jørgensen 2013). This means that stakeholders experience direct and indirect social impacts, both positive and negative, that result from actions, policies, and practices of businesses throughout the supply chain. As stakeholders provide valuable insights and feedback on the effects of corporate activities on individuals and communities, engaging stakeholders from different categories and ensuring their perspectives are taken into account is crucial for comprehensive social impact assessment and management.

Currently, there is a general consensus in the S-LCA community that the categorization of social impacts should be divided into two parts, based on the stakeholder approach and impact categories (Reitinger et al., 2011). The classification aims to gain a holistic understanding of the social implications on all affected parties across the entire product lifecycle. The Task Force of the UNEP/SETAC Life Cycle Initiative originally proposed four universal stakeholder groups, which are Workforce (Workers/Employees), Local Community, Consumers (concerning only the use stage), and Society (national/global), while allowing for flexibility in additional groups and subgroups (Grießhammer et al., 2006). The UNEP/STEAC guidelines later included Value chain actors in 2009 and added Children in its 2020 revision to represent future generations, with the aim to "guarantee the same welfare and wellbeing to the future generation as to the present generation" (UNEP 2009; UNEP, 2020). Nonetheless, Vermeulen (2018) raises a pertinent question about the appropriateness of categorizing "Society" as an independent stakeholder category. Often, this category encompasses various other stakeholders in different contexts, and it tends to serve as a "trash bin" for everything outside the business entity. In light of this, Vermeulen proposes "socio-economic institutions" to represent organizations at the macro-level, emphasizing their role in promoting equitable development and addressing critical issues like anti-corruption and fair competition.

Stakeholder inclusiveness, as defined by Eskerod et al. (2015), pertains to the consideration of all parties' interests to ensure that they are not "negatively surprised" by a company's decisions. Intriguingly, it aligns with the concept of externalities can be seen as those unexpected, undesirable, or overlooked impacts experienced by third parties (Dahlman, 1979). This highlights the vital role of inclusivity in sustainable consumption and production practices. Nevertheless, in practical application, the stakeholders included can vary significantly across different S-LCA studies and at various stages of the value chain (Benoît & Mazijn, 2009). Furthermore, the stakeholder salience theory suggests that the

legitimacy of an organization or an entire supply chain can be threatened when influential stakeholders leverage their own legitimacy to argue that certain concerns should be prioritized (Freeman et al., 2004). Consequently, when conducting an S-LCA, efforts must be taken to ensure the representation and participation of various stakeholder groups and define indicators that are appropriate for their situation and comprehension. Chhipi-Shrestha et al. (2015) identified that there is no scientific consensus on cut-off criteria for determining essential stakeholders and impact categories. They also noted that in certain studies, generic outcomes were presented without accounting for location-specific effects, and often, the criteria used to determine the scope of these assessments were left undefined. The UNEP/STEAC (2020) recommends using "social significance" as a cut-off criterion but advises against its use unless resource limitations necessitate it; otherwise, "ALL RELEVANT stakeholders and impact categories should be considered in an S-LCA study".

To better assess social impacts, there is also a growing recognition of the need to include subjective perceptual impacts, such as stakeholder satisfaction (Kühnen and Hahn, 2017). Existing S-LCA studies primarily focus on objective and verifiable situational attributes because these indicators are often quantifiable and easier to assess. However, Jørgensen et al. (2010) maintain that stakeholders' inner perceptions and interpretations are more valid in determining whether an impact is favorable or detrimental. A balanced approach of both quantitative research and qualitative approaches is hence necessary for conducting an S-LCA

4.1.3.   Impact Pathway

Understanding the cause-effect relationship between various activities and their consequences in a social life cycle analysis is essential, as it allows practitioners to grasp how actions and choices resonate throughout the system, influencing diverse aspects of society, the environment, and individual well-being (Benoît & Mazijn, 2009). By recognizing the causal chain, decision-makers are able to identify the root causes of problems to design targeted interventions that address complex societal challenges. Here, the term social impact encompasses ideas related to effect, consequences, processes of social change, and the presence of social attributes. The described process is referred to as the establishment of impact pathways (Hunkeler, 2006; Weidema, 2006).

Currently, causal models within the realm of social sciences remain in a state of limited development (Benoît & Mazijn, 2009). Defining impact pathways in social science proves challenging due to the intricate interplay of human behaviors and the unpredictable nature of

socioeconomic interactions in complex social systems. Nonlinear relationships and contextual dependencies further complicate establishing clear cause-and-effect connections. This is particularly evident in the domain of S-LCA, where the two most applied characterization models Type I and Type II approach the relationship-building between variables differently. Figure 4 illustrates the classification process of the two models. The two approaches overlap to some extent and are both not theoretically well-developed. As a result, variations in definition and implementation often arise among researchers and practitioners engaged in S-LCA.

Figure 4

The mechanisms of two types of social life cycle impact assessment characterization model, modified from Chhipi-Shrestha et al. (2015)
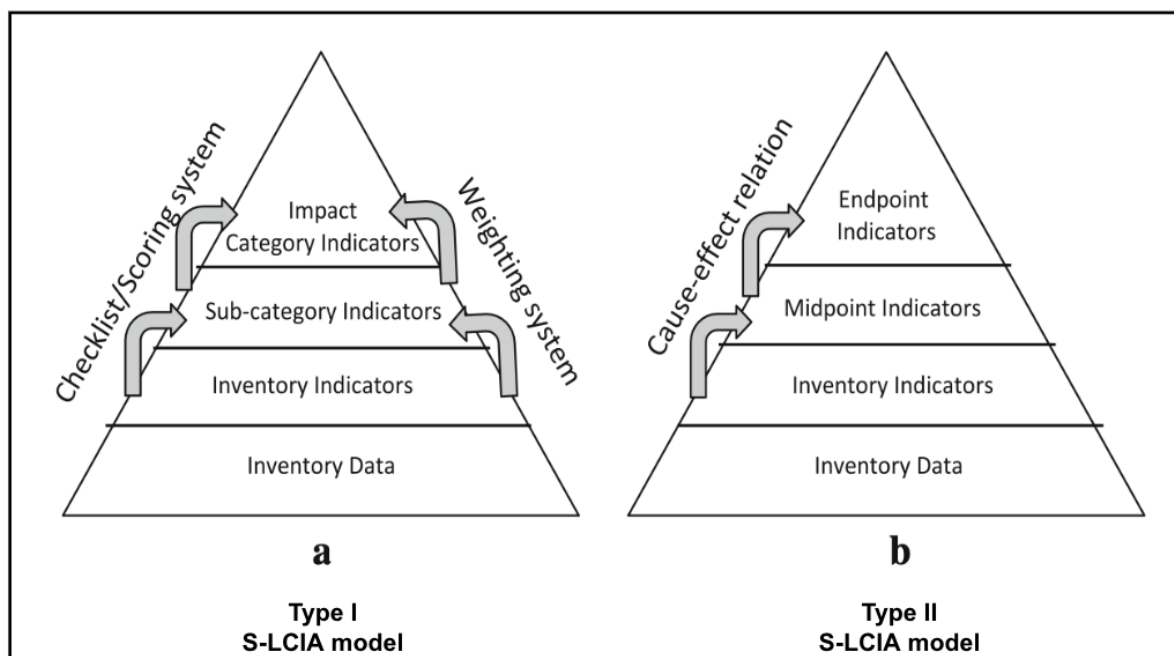
Type I uses a checklist or a scoring system to assess social performance based on universal thresholds, targets, norms, or real-world best practices (Chhipi-Shrestha et al., 2015). The qualitative and/or quantitative inventory results are aggregated into subcategories (or into a single score with an optional choice of weighting), which should be further logically linked to impact categories under a stakeholder group. Casual-effect chain is not particularly examined under these methods because "cause-effect relationships are not simple enough or not known with enough precision to allow quantitative cause-effect modeling" (Benoît & Mazijn, 2009). Jørgensen (2009) elucidated that whether it is explicitly stated or not, the primary aim of most S-LCA studies is to safeguard or enhance specific social dimensions. These dimensions are referred to as Areas of Protection (AoP), a

terminology initially rooted in environmental LCA denoting specific aspects that hold value for a particular society (Benoît & Mazijn, 2009). To elaborate, when we examine the sustainability aspect related to child labor, we emphasize the significant importance of human rights as a critical concern both within the supply chain and within society at large. In the most recent revision, the UNEP/SETAC Guidelines have redefined the depiction of Type I methodologies as involving "relations between activity and potential social impact are assumed" (UNEP, 2020).

On the other hand, Type II establishes impact pathways that outline the cause-and-effect connections between indicators and the AoP. The existing relationships can be proven both qualitatively and quantitatively, but most studies tend to focus on the latter (UNEP, 2020). The analysis sorts out inventory data following a cause-effect chain to midpoint impact categories and subsequently to endpoint impact categories. Midpoint indicators reflect the intermediate social effects of a variable while endpoint indicators relate the levels of social consequences on the AoP. For instance, job creation indirectly enhances family health by increasing income, serving as a midpoint indicator, while health conditions serve as the endpoint indicator, linked through an impact pathway describing the cause-and-effect relationship (Jørgensen et al., 2008). Type II method does not have a strong focus on stakeholder groups as ''the stakeholder relations of a company are very specific and can be quite complex, which makes it difficult to make a general people impact model based on them." (Dreyer et al., 2006).

Feschet et al. (2013) highlight the importance of bridging the gap between the two methods by establishing a causal link between social activities undertaken by stakeholders to the subsequent changes and effects. Chhipi-Shrestha et al. (2015) and Sureau et al. (2020) echo this argument and suggest combining the two methods to achieve a more comprehensive assessment by associating stakeholder groups to midpoint and endpoint impact categories, and further to the AoP. Currently, there is a consensus that the AoP in S-LCA is to maximize human well-being (UNEP, 2020; Weidema; 2006). Jørgensen et al. (2009) provide a thorough review that under this ultimate objective, it can be divided into two types- "individual AoP: and "societal AoP". Most scholars believe that individual AoP is related to subjective "inner qualities", such as happiness and life satisfaction, while societal AoP pertains to social capital for productivity development of the society (Benoît & Mazijn, 2009; Dreyer et al., 2006; Nazarkina and Le Bocq, 2006; Weidema, 2006). The societal AoP often is also referred to as enhancing "social capital", derived from the World Bank's 'four capitals approach' (Nazarkina and Le Bocq, 2006; Schmidt et al., 2004; UNEP, 2020; World Bank 1997). Social capital encompasses social networks, social conditions, institutions

united by common norms, and trust-based relationships, serving as critical foundations for economic and social development. In certain contexts, social capital is considered synonymous with social sustainability.

Several studies have also linked social indicators to the SDGs (Vermeulen, 2018; Wulf et al., 2018, Almanza & Corona, 2020), as the shared objective of the UN SDGs to advance human well-being (UN, 2022). This alignment allows information gathered through S-LCA to be effectively integrated into an organization's sustainability strategies, providing a consolidated measure for assessing progress and facilitating actions aligned with the SDGs agenda. Furthermore, this enables practitioners to construct a holistic picture of how a life cycle activity can affect society.

4.1.4. Context-specific Adaptation

Social and socio-economic impacts are shaped by the context in which they occur. Various factors such as culture, economics, politics, local variations, industry types, business size, and the complexity of value chains significantly influence S-LCA studies (Ekener et al., 2016). Moreover, S-LCA utilizes site-specific data collected across the value chain's various stages. Data is drawn from multiple tiers, encompassing enterprise-level labor practices and the national regulatory framework enveloping the organization. This contextual information distinctly molds assessment outcomes. Thus, the meticulous choice of indicators and the facilitation of context-specific adaptations hold utmost significance in S-LCA methodology, ensuring a comprehensive understanding of social impacts and informed decision-making.

Nevertheless, Popovic et al. (2014) point out that assessment frameworks commonly used for measuring social sustainability tend to heavily rely on generic indicators. In other words, these indicators are not tailored to the unique characteristics of individual systems. This approach carries the inherent risk of overlooking unique challenges that different industries or countries face in social sustainability, which could potentially lead to the exclusion of crucial considerations on the impacts. Norris (2006) also emphasized the significance of considering context-specific evaluations of life cycle attributes instead of relying solely on conventional inventory data when conducting an S-LCA analysis. For instance, he illustrates that economic growth does not always serve as an appropriate indicator for poverty, as evidence shows that income gained from economic growth often benefits the wealthy, leading to income inequality. Hence, relying solely on aggregate measures such as total income or average life expectancy might not accurately represent benefit distribution. Poverty shall be seen as a multi-faceted concept influenced by elements

related to health, politics, and culture, beyond income.

The Type I characterization approach typically assesses organizational social performance based on best practices, socioeconomic and geographical context, or contextual compliance (Ramirez et al., 2014). It aims to determine if an organization meets fundamental requirements in a standardized manner. However, the judgment of whether these requirements are met requires careful scrutiny to avoid subjectivity. Additionally, there are challenges related to weighting different indicators without considering their significance may vary to different value chains. Meanwhile, databases such as SHDB and PSILCA include country-specific sectors (CSS); however, such regional characterization fails to consider individual company behavior (Chhipi-Shrestha et al., 2015) and tends to produce generic results.

To address such challenges, corporate sustainability reporting frameworks such as the GRI create sector-specific guidelines that cover material topics aligned with stakeholders' expectations in different industries. On the other hand, the UNEP/STEAC Guidelines, while not offering sector-specific guidance, offer practitioners the flexibility to incorporate indicators that are deemed important by their stakeholders. For instance, in a study on wastewater treatment facilities, Popovic et al. (2014) proposed using "social compatibility" as an indicator of social equality, by examining financial accessibility to the service and the billing methods employed. However, this flexibility creates challenges due to the absence of standardized criteria for comparing results.

Dreyer et al., (2006) suggest S-LCA studies using two sets of indicators, obligatory and optional. The obligatory set encompasses normative and consensus-driven parameters, setting forth the minimal standards for responsible business practices. In contrast, the optional set is self-determined and context-specific, allowing organizations to address their unique interests not already covered by predefined impact categories. This approach balances both standard foundation and contextual adaptation to meet individual company's needs. To help practitioners decide what should be included in the assessment scope, Dreyer et al., (2006) also introduce the concept of the sphere of fluence to decipher direct (inner sphere) and indirect impacts (outer layers) on stakeholder groups. Additionally, participatory approaches such as stakeholder consultation (Mathe,2014), private sector consultation, and expert consultation (Jørgensen et al., 2008) are gaining acceptance to serve as the basis for determining tailored-made impact indicators (Pollok et al., 2021; Sureau et al., 2018).

4.1.5. Core Social Topics

Following the discussion on Dreyer et al., (2006), this section attempts to build a consensus-based list of core social topics to contribute to the formulation of the obligatory sets of social indicators. The UNEP/STEAC has identified six main types of references and instruments as relevant to social sustainability assessment: International Policy Frameworks (e.g., SDGs); Sustainability Reporting Frameworks (e.g., GRI); Sustainability Implementation Guidelines (e.g., ISO 26000); Auditing and Monitoring Frameworks (e.g., product certifications); Codes of Conduct and Principles and Financial Indices (UNEP, 2020). Among these, the discussion on financial indices is absent in S-LCA literature. This study compares eleven international corporate sustainability standards and tools, including two S-LCA frameworks, three sustainability reporting frameworks, three voluntary sustainability standards (VSS), and three ESG ratings (see Table 3). Choices for selecting target standards are made based on the frequency discussed in the literature.

The selection of consensus-based social topics involves a four-step process (Fontes et al., 2018). First, 11 standards were identified, and 257 social topics were categorized into stakeholder groups based on their significance. Second, these topics were then consolidated within the same stakeholder groups, and redundancies were eliminated to avoid duplication. Third, a thorough examination of topics mentioned only once to assess their relevance to social life cycle impacts. Finally, this process yielded 39 core social topics at the sub-category level. The list of social topics and further discussion is in 4.2.

Among these tools, only the two S-LCA frameworks focus on assessing product-related aspects while other standards and tools encompass all dimensions related to organizational performance including operational activities related to a business including value chain activities. As aforementioned the UNEP/SETAC Guidelines remain the most comprehensive guiding framework and the landmark in the field. Another leading framework, The Handbook for Product Social Impact Assessment (PSIA) is produced by The Roundtable for Product Social Metrics (Roundtable for Product Social Metrics, 2020). The aim of PSIA was to enhance the UNEP/SETAC guidelines and establish a more consistent assessment approach, which involved refining definitions of social topics and performance indicators, incorporating reference values and assessment scales, and providing case studies to ease adoption (Fontes et al. in 2018). Likewise, PSIA structures around the ISO 14040 standard for environmental LCA and evaluates both positive and negative social effects of products and services on four key stakeholder groups. Both S-LCA frameworks are developed by interactive and collaborative process workshops with stakeholders and

experts, supported by empirical case studies. However, PSIA has taken more practical insights from the business sector into consideration, helping businesses make decisions closely connected to their everyday operations.

Additional findings include:

- Assessment Approaches: All references employ a mixed approach for assessing social impacts, encompassing quantitative, qualitative, and semi-qualitative indicators, as well as the use of questionnaires and certification. Notably, except for ISO 26000, all other standards have developed sector-specific sections or guidelines.

- Social AoP Alignment: Non-product-oriented references do not explicitly define the AoP for social impacts. However, given that all standards align with the SDGs, it can be assumed that their AoP aligns with the ultimate goals of human well-being set by the SDGs.

- Consistent Focus on Labor and Health: Labor and health-related issues continue to be of paramount importance across all references.

- Differing Emphases:

  - In contrast to the UNEP/SETAC Guidelines, other standards do not assess indirect impacts out of the control of value chains such as poverty and decolonization.
  - Besides the two S-LCA frameworks, other references place a strong emphasis on evaluating the quality of corporate governance and a company's potential for striving, e.g., innovation management and risk management.
  - EU-originated standards prioritize circular economy prospects, such as CSRD, CSR performance ladder, and PSIA, while others allocate less attention to this aspect.

Table 3

Overview of selected references for building core social topics

Standards	Type of Tool	Social Impact Categories	No. of Social Topics	AoP/SDGs
Guidelines for Social Life Cycle Assessment of Products and Organisations 2020	S-LCA framework	● Worker ● Local community ● Value chain actors ● Consumer ● Society ● Children	39	Social or Human Well-Being
The Handbook for Product Social Impact Assessment (PSIA)	S-LCA framework	● Worker ● Local community ● Small-scale entrepreneurs ● Users	24	Human well-being (Five capitals) SDGs
GRI Standards	Reporting standards	● Social (GRI 400 series) ● Economics (GRI 200 series)	24	SDGs
The Sustainability Accounting Standards Board (SASB) Standards	Reporting standards	● Social Capital ● Human Capital ● Business Model & Innovation ● Leadership & Governance	15	SDGs
CSRD European Sustainability Reporting Standards (ESRS)	Reporting standards	● Own workforce ● Workers in the value chain ● Affected communities ● Customers and end-users	12	SDGs

ISO 26000	VSS	• Human rights • Labor practices • Community involvement and development • Consumer issues • Fair operating practices	32	SDGs
EcoVadis Sustainability Ratings	VSS	• Labor & human rights, ethics, sustainable procurements, products	15	SDGs
CSR Performance Ladder	VSS	• Organizational governance • Labor practices • Human rights • Fair operating practices • Consumer issues • Societal involvement and development	25	SDGs
MSCI ESG Ratings	ESG ratings	• Social pillar • Governance pillar	20	SDGs
S&P Global ESG Scores	ESG ratings	• Social Dimensions Criteria Topics • Governance &Economic Criteria Topics	43	SDGs
Ftse Russell ESG Scores	ESG ratings	• Social pillar • Governance pillar • Product quality and effectiveness • Risk management • Innovation management • Responsible political involvement	8	SDGs

4.2. Presenting the Conceptual Framework

Based on the preceding discussion, the author proposes a conceptual framework for assessing the comprehensiveness of an S-LCA methodology to be used in various settings. This framework is comprised of five key criteria: Life Cycle Thinking (LCT), *Stakeholder Inclusiveness*, *Impact Pathways*, *Context-Specific Adjustments*, *and Core Social Topics.* These five criteria are interconnected and mutually influential. Figure 5 illustrates how these criteria position in relation to the four assessment phases. Life Cycle Thinking serves as the foundation, recognizing the interplay and interdependence among elements within the social system, acknowledging the uniqueness of each value chain, and emphasizing the necessity of contextual adaptations. Within this framework, stakeholder inclusiveness plays a significant role, ensuring that the interests of all relevant stakeholder groups are accounted for and incorporated into impact pathways leading toward sustainability. The core social topics serve as the fundamental basis for these pathways. This framework functions as a checklist, facilitating the evaluation of the comprehensiveness of S-LCA assessments. It is recommended to employ performance indicators using a traffic light system, as demonstrated through examples in the following case study.

Figure 5

Conceptual framework for the assessment comprehensiveness of S-LCA
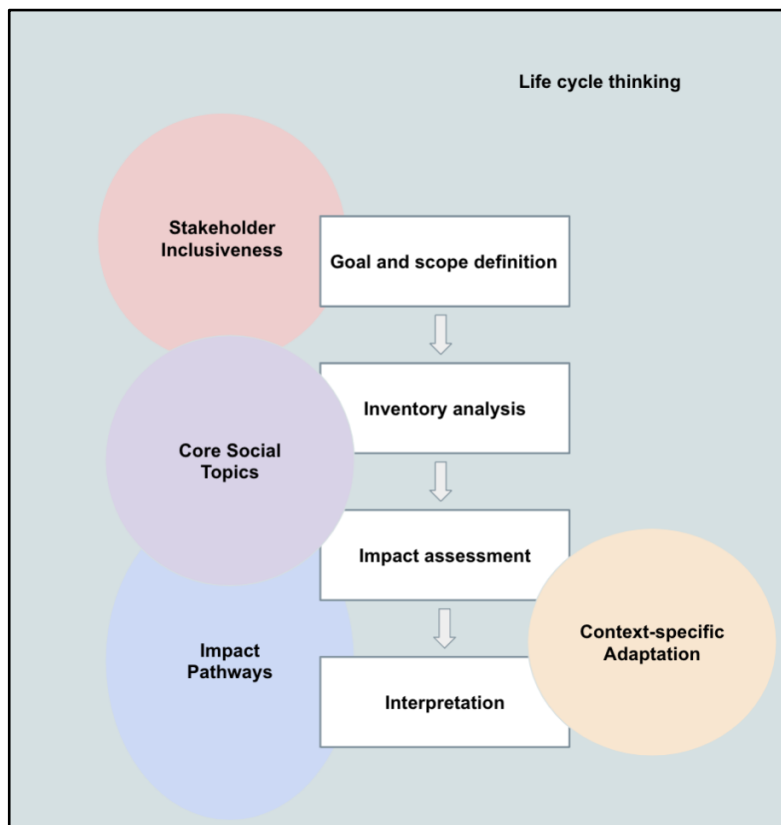
Figure 6

Core social topics and the impact pathways
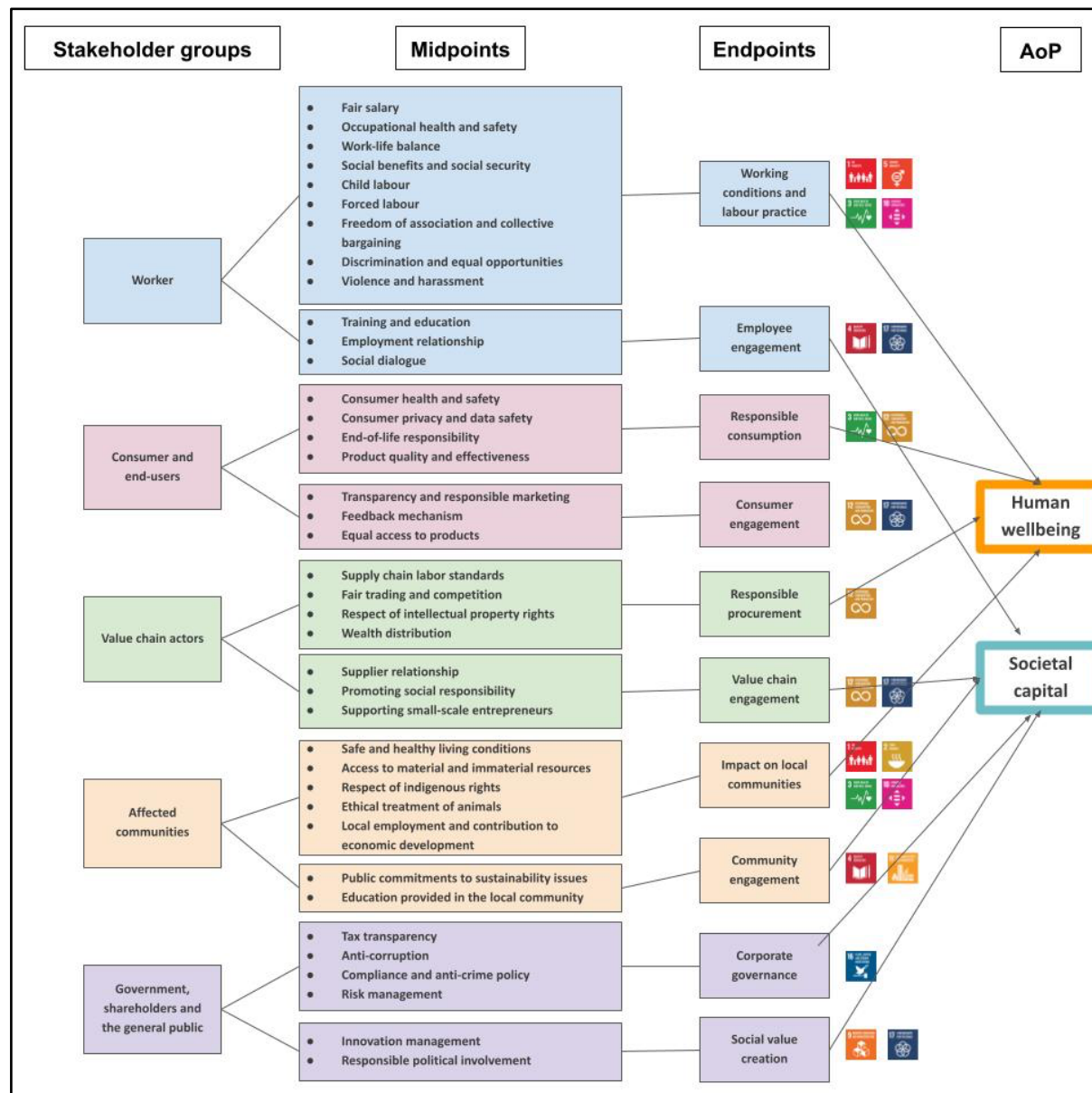
Based on the findings from comparing different corporate sustainability standards, 39 core social topics based on consensus are identified. Figure 6 presents the core social topics and their impact pathways. These are grouped under five stakeholder groups, midpoints, and endpoints to form impact pathways that align with AoPs and SDGs. Five stakeholder groups are Workers; Consumers and end-users; supply chain partners; affected communities; Government, shareholders, and the general public. This categorization has four differences from the ones in the UNEP/STEAC guidelines.

First, the term "Consumer and end-users" is utilized, referring to CSRD and PSIA, highlighting the significance of considering various types of product users. PSIA further distinguishes between consumer users and professional users. The latter category encompasses workers or small-scale entrepreneurs who employ the product in a professional context, as it directly affects their working conditions. For instance, a painter who uses paint containing potentially hazardous chemicals represents a professional user, while the family residing in a house painted with such paint would be considered consumer users. Alternatively, users can be categorized as direct or indirect users of a product, such as bus drivers and passengers.

Secondly, "Affected communities" is employed instead of "local communities." This terminology is also adopted from CSRD to distinguish from local societies not directly impacted by operational and product social impacts, extending the concept beyond the sphere of influence by Dreyer et al. (2006). Thirdly, "Government, shareholders, and the general public" is used to replace "society," aiming to eliminate ambiguity and encompass shareholders/investors, government institutions, and other indirectly affected local/global communities. In contrast to "Socio-economic institutions" proposed by Vermeulen (2018), this classification places more emphasis on how internal corporate governance can influence investors' decisions and their interactions with the government and media, potentially resulting in effects that indirectly affect the general public. This perspective aligns more closely with the ESG paradigm, which revolves around ESG ratings and corporate sustainability reporting.

Lastly, the category "Children" is removed because they can overlap with other stakeholder groups, as children can be assessed as customers and local community residents. This can lead to issues with double counting. Furthermore, the UN System Common Principles on Future Generations clearly defines future generations as "all those generations that do not yet exist, are yet to come, and who will eventually inherit this planet." The principles state that "Children and youth are oftentimes referred to as future decision-makers or future leaders, but they alone should not bear the burden of representing future generations" (UN, 2023).

Under each stakeholder category, two endpoint categories are identified. The first category encompasses aspects related to compliance, meeting basic human needs, upholding human rights and dignity, and preventing damages. The second category involves variables associated with societal capital, such as inclusion, engagement, and the

management of intangible assets. These two endpoints are linked to the AoP of human well-being and societal capital, respectively. Additionally, as most corporate sustainability standards are aligned with the SDGs, it is recommended to align impact pathways with the SDGs to facilitate decision-making and integration with other sustainability tools. Furthermore, it is advisable to connect with the 5Ps paradigm - People, Planet, Prosperity, Peace, and Partnership - promoted by the UN, as it underscores the importance of social capital aspects (UN, n.d.).

When we compare the core social topics with the UNEP/STEAC S-LCA Guidelines, it's clear that the Guidelines serve as the most comprehensive framework related to sustainable consumption and production. Nonetheless, there are notable differences between them. Table 4 presents a comparison summary between the suggested core social topics and the UNEP/STEAC S-LCA Guidelines from 2020.

Table 4

Summary of differences between the core social topics and the UNEP/STEAC Guidelines

	Social Topics	**Description**
Added	● Product quality and effectiveness ● Risk management ● Innovation management ● Responsible political involvement	These topics are considered important in other consensus-based references but overlooked in the Guidelines.
Removed	● Poverty alleviation ● Delocalization and migration ● Children-related topics	Intertwined issues out of the direct control of the supply chain and should be addressed at the national level, at the macro/national (endpoint) level.
Regrouped	● Cultural heritage → Innovation management ● Working hours → Work-life balance	To encompass its broader definitions.

5.   Result for Sub-RQ2

This section provides a three-part analysis aimed at evaluating the comprehensiveness of the Oiconomy methodology. Firstly, it offers a qualitative descriptive assessment based on the criteria established in *Section 4* of the conceptual framework. This analysis sheds light on the theoretical underpinnings and foundation of Oiconomy. Secondly, it incorporates insights from interviews conducted with pilot companies, focusing on the alignment of the theoretical foundation with the practical application of the assessment tool in real-life scenarios. Lastly, representatives from the pilot companies are asked to provide ratings for the core social topics to measure their relevance within the respective companies' supply chains. These collective results will be examined together in the concluding *Section 6* to address the main research question.

5.1.   Framework Assessment Results- Oiconomy Pricing

This analysis assesses the comprehensiveness of Oiconomy according to the five criteria established in the conceptual framework. The assessment draws from an examination of scientific literature, insights gained through interviews with Oiconomy Pricing experts (Interview E and F), and the author's practical experience as a user during the pilot project. By bringing together different perspectives, this analysis aims to give a complete view of Oiconomy's overall functionality and potential areas for refinement.

Life Cycle Thinking

Oiconomy is built upon the principles of life cycle thinking. Although it is common practice in global value chains to demand production certifications like Rainforest Alliance from distant suppliers, these standards mainly originated within OECD member states and have limitations in evaluating impacts associated with life cycle stages beyond production, such as transportation and the user phase within developed nations (*Interviewee F*). In response, Oiconomy aims to encompass the entire supply chain and takes a more holistic approach by integrating circular perspectives and aligning seamlessly with SDGs. This strategy acts as a strong framework to discover cases of problem-shifting in the intricate network of global value chains.

Oiconomy assessment tool takes a comprehensive examination of a product's life cycle, from material sourcing, manufacturing, sales, transportation, and use until end-of-life.

While not explicitly stated, the assessment process closely aligns with the four phases outlined in ISO standards 14040. The project's inception involves defining its goals and scope (Goal and Scope), followed by businesses collecting inventory data based on predefined questions and indicators within each category (Inventory analysis). Subsequently, the gathered data is input into the Oiconomy assessment tool, which then calculates and aggregates ECSU, using either primary data or generic background data (Impact assessment). Finally, the assessment delves into unearthing negative hidden costs, which enable companies to initiate internal and external discussion and formulate risk mitigation strategies in collaboration with value chain partners (Interpretation).

As discussed, traditional LCA studies center around evaluating the implementation of established practices, often overlooking the crucial aspect of comparing alternative approaches. Similarly, corporate sustainability reporting guidelines tend to emphasize accomplished actions rather than identifying necessary future steps. In this context, Oiconomy's preventative costs measure emerges as a potent tool that adeptly scrutinizes both the current status quo ("Where we are at") and potential alternative scenarios ("What is the cost-distance to the sustainable version"). This positions Oiconomy as a fitting tool to assess a product's sustainability from cradle to grave, and even back to cradle.

Stakeholder Inclusiveness

A primary objective of Oiconomy lies in its capacity to empower companies to initiate meaningful conversations with partners across their value chains, aimed at addressing the root cause of negative externalities within the supply network (Croes & Vermeulen, 2015). By doing so, it amplifies companies' interactions with value chain partners across multiple tiers, which might otherwise remain distant or unnoticed. Nonetheless, the prioritization of engagement extends less to other stakeholder groups and consumer-oriented communications (Vermeulen et al., 2023). The engagement with other stakeholder groups is somewhat restricted due to the absence of an explicit stakeholder consultation process in the design of the system (*Interviewee F*). This is based on the rationale that connecting with its international value chain networks is the company's operational activities and responsibilities. Therefore, while workers and local community members receive attention through meticulous analysis of sustainability concerns aligned with their interests, this approach is characterized by an emphasis on objective performance rather than subjective experience when estimating social impacts.

In the envisioned trajectory, the Oiconomy system will evolve into a non-profit entity responsible for overseeing and administering the Oiconomy certification standards. Enterprises will autonomously undertake self-assessments and organize stakeholder consultation sessions with their stakeholder groups to identify and implement progressive enhancements. Simultaneously, on the Oiconomy side, periodic open stakeholder consultations will occur every few years, fostering a collaborative platform for discussing the efficacy of the process, categories, indicators, and thematic areas (*Interviewee F*). This iterative dialogue will serve to refine and elevate the Oiconomy standards, ensuring their ongoing relevance and alignment with evolving sustainability objectives.

The objective of Oiconomy is to establish itself as a standardized and third party-verified system, immune to individual practitioner biases; therefore, value choices for designing the system, such as monetization methods, the 80/20 rules, transfer of data through the supply chain, and considered issue areas, play an important role (Croes, 2021). While the assessment does encompass relevant social topics to account for stakeholders' interests, current involvement primarily centers around value chain participants utilizing assessment tools. The exclusion of specific social factors outlined in the framework leads to the oversight of certain interests. Consequently, further discussion linked to the core social topic criteria is necessary. This also prompts another fundamental question: Will and can the Oiconomy methodology effectively incorporate stakeholder subjective perceptions and translate them into a standardized monetary unit?

Impact pathway

The majority of indicators and performance targets within Oiconomy are derived from international frameworks. While the initial proposal for Oiconomy in 2015 did not specify stakeholder groups and AoP (Croes & Vermeulen, 2015), later developments introduced an impact pathway (see Figure 7). In terms of the societal aspect, five stakeholder groups were defined, following the categorization outlined by Vermeulen (2018). Additionally, 18 midpoints were established, further grouped into four social endpoints: *Worker well-being*, *Community livelihood*, *Fairness in the economic system*, and *Societal stability*. All of these aspects converge towards a single area of social protection, *Human well-being*, which, in conjunction with the environmental AoP, represents the ultimate goal of Oiconomy—to contribute to *Current and Future Human well-being*. Furthermore, Figure 8 illustrates the alignment of these social categories with the 11 SDGs. Although compared to the proposed framework, shareholders' interests, and corporate governance (the G in ESG) are less emphasized, Oiconomy boasts a comprehensive impact pathway that extends from the

stakeholder level to the AoP, aligning with international sustainability frameworks.

The PDCA cycle, a widely recognized framework within quality control and corporate sustainability initiatives, serves as a fundamental principle of Oiconomy. Interviewee E highlights that businesses are primarily interested in understanding cause-effect pathways specific to their cases, along with the associated preventative measures and related costs. In the context of preventative cost-based S-LCA, once an impact has been identified as an externality, the key focus becomes how to measure and effectively mitigate it at a reasonable cost. Interviewee F further underscores that as more industry frontrunners embrace Oiconomy and disclose their hidden costs, it is expected to stimulate competitors to follow suit by implementing effective and cost-efficient preventive measures to reduce their own hidden costs. This collective effort ultimately propels society closer to achieving the SDGs, illustrating the significant role Oiconomy plays in advancing sustainability practices.

Figure 7

Oiconomy Impact Pathways
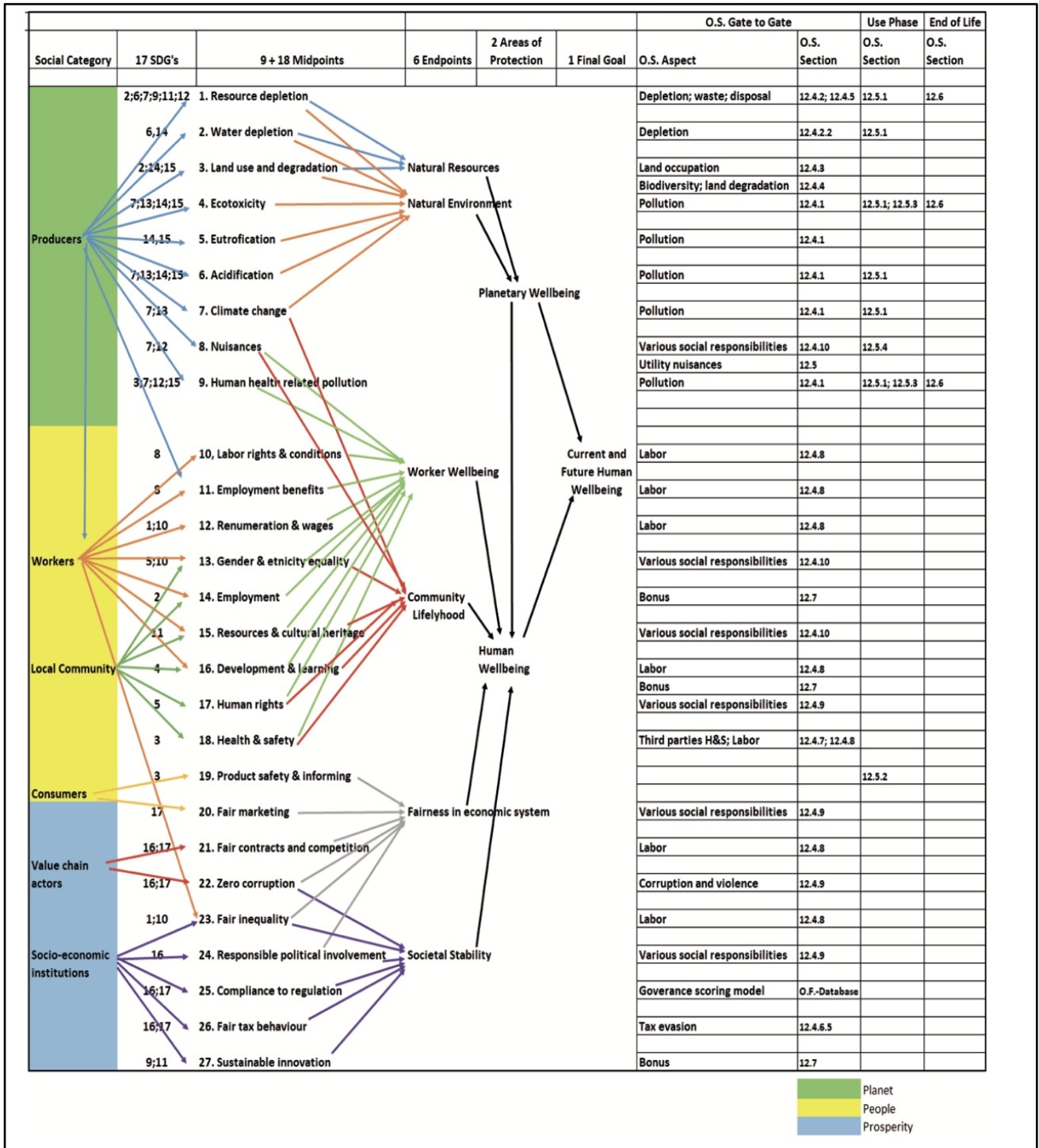
Figure 8

Oiconomy categories and alignment with SDGs (adopted from Croes, 2021)

SDG nr.	Sustainable Development Goal	Pillar	Midpoints	O.S. Aspects	O.S. Sections
1	No poverty	People	12	Labor - wages; fair transaction; child labor;	12.4.8.1; 12.4.6.1; 12.4.8.4
2	Zero hunger	People	1,3,14	Pollution; Depletion; land occupation; biodiversity land/water; bonus	12.4.1; 12.4.2; 12.4.3; 12.4.4; 12.7
3	Good health and wellbeing	People	18,19	Pollution; health and safety 2x (public and occupational); product safety	12.4.1; 12.4.7; 12.4.8.4; 12.5.2
4	Quality education	People	16	Labor conditions	12.4.8.1
5	Gender equality	People	13,17	Labor conditions; various social responsibilities	12.4.8.3; 12.4.10
6	Clean water and sanitation	Planet	2	Depletion; health 2x (public and occupational)	12.4.2.2
7	Affordable and clean energy	Planet	1,4,6,7,8,9	Pollution; depletion; land occupation	12.4.1; 12.4.2; 12.4.3; 12.5.3
8	Decent work and economic growth	Prosperity	10,11	Labor; various social responsibilities	12.4.8; 12.4.10
9	Industry, innovation and infrastructure	Prosperity	27	Bonus	12.7
10	Reduced inequalities	People	12,13,23	Labor; various social responsibilities	12.4.8.3; 12.4.10
11	Sustainable cities and communities	People	27	Various social responsibilities	12.4.10; 12.7
12	Responsible consumption and production	Planet	1,8,9	Depletion; land occupation; biodiversity land/water; waste prod/use/end of life; product life; various economic responsibilities	12.4.2; 12.4.3; 12.4.4; 12.4.5; 12.5.3; 12.5.4; 12.6; 12.4.6.4; 12.4.6.6
13	Climate action	Planet	4,6,7	Pollution; energy	12.4.1
14	Life below water	Planet	2,3,4,5,6	Biodiversity water systems	12.4.4
15	Life on land	Planet	3,4,5,6,9	Biodiversity land systems	12.4.4
16	Peace, justice and strong institutions	Prosperity	21,22	Economic responsibility; corruption and violence	12.4.6; 12.4.9; 12.5.4
17	Partnership for the goals	Prosperity	All	Oiconomy system	All sections

Context-specific adaptation

The Oiconomy assessment tool places a strong emphasis on country-specific and geographical adjustments. For indicators lacking international standards or conventions, it selects the top-performing 20% of benchmark countries as targets and assigns default ESCU values for adjustments. This approach considers varying risk factors, such as corruption and child labor, in different countries. Organizations in high-risk countries may face higher preventative costs if they fail to demonstrate effective preventative measures. The tool also recognizes distinctions between developed and developing countries based on social and socioeconomic factors within its generic database.

Conversely, Oiconomy does not draw significant distinctions among sectors or industries. While some governance-level questionnaire items indirectly address potentially harmful industries such as tobacco, the tool adopts a flexible "applicable or non-applicable approach." All organizations receive the same assessment indicators and can select the standards most relevant to their supply chain or analysis scope. In terms of the size of organizations, experience drawn from the pilot project has prompted Oiconomy to simplify the questionnaires for evaluating the quality of governance for SMEs, which may not be able to provide detailed required data (Vermeulen et al., 2023).

Nevertheless, insights from the two interviewees highlight different concerns. Interviewee F emphasized the importance of a standardized approach, suggesting that some details from individual companies must be streamlined to facilitate comparisons. Allowing too much flexibility for businesses to determine what to measure may result in a narrow focus on limited issues driven by stakeholder consultation or prevailing "hot topics" such as climate change and child labor. The adoption of an 80/20 rule, along with a list of potential high-impact hazards, helps ensure that the most crucial aspects are addressed and facilitates the comparison of assessment results. Interviewee E also stressed the necessity for standards in a certification system to gain approval and acceptance from key stakeholders. To encompass all aspects of SDGs, transdisciplinary expertise is crucial. However, Oiconomy, in its early stages, lacks the necessary resources and capacity to tackle this complexity comprehensively. Therefore, its current strategy remains science-based and aligned with international conventions. In the future, as Oiconomy accumulates empirical data and develops a robust database, companies will be able to compare their practices with industry peers and make adjustments accordingly.

Core social topics

Oiconomy encompasses five distinct social categories that pertain to aspects related to people and prosperity. To assess whether Oiconomy adequately addresses the essential social topics outlined in the conceptual framework, a comprehensive cross-matching analysis has been undertaken. This analysis meticulously examines each sub-category and the posed questions; hence the midpoints and endpoints differ from those proposed by Croes (2021). Notably, taking a closer look, the latest version of the Oiconomy assessment tool comprises eight sections dedicated to measuring societal performance, including the Bonus category. These sections can be further disaggregated into 19 sub-sections, each encompassing multiple indicators. The classification may not currently adhere to a consistent organizational structure; however, it is worth noting that the tool is still evolving. An overarching overview of the sections related to societal aspects is provided in Table 5.

Table 5

Overview of societal-related sections in the Oiconomy assessment tool

Sections	Sub-sections
Human Health and Safety Risks	-
Labor	- Remuneration - Inequality - Overtime wages - Health Insurance Plans - Personnel Development - Employment contract time - Various Labor Related aspects - Occupational Health and Safety - Labor Conditions - Child Labor
Various Social Aspects and Animal Welfare	27 Various Social Issues with 4 sections - Discrimination, equality, violence, and harassment (5 indicators) - The use and respect for property rights (7 indicators) - Responsible advertising, communication, and privacy (11 indicators) - Damage to human health and cultural heritage, and lobbying on sustainable development (4 indicators) - Animal Welfare
Prosperity (Economic) Criteria	- Fair Transactions - Transparency - Finance Related Criteria - Taxes - Subsidies
Corruption and Conflict	-
Use-Human Health Risks	-
Use-Social Responsibility	- Instructions for use - Product Warranties
Bonus	18 out of 33 indicators are societal-related aspects

The outcome of the cross-check analysis is summarized in Table 6, where Oiconomy's alignment with core social topics is assessed across three levels: *Sufficient* (Green), *Low sufficiency* (Yellow), and *Insufficient* (Red). The analysis reveals that 28 social topics are categorized as sufficient (72%), while 8 exhibits low sufficiency (20%), and 3 topics are deemed insufficient (8%). The designation of "sufficient" is assigned when a section or sub-section addresses the topic adequately, or when questions related to the topic are covered in multiple sections, indicating a well-rounded consideration, as seen in areas such as fair salary and child labor. Conversely, "low sufficiency" is applied when there is some coverage but with room for improvement, suggesting that certain aspects could be more comprehensively addressed. Furthermore, the grouping of various social aspects within a single category has the potential to result in disparities. These disparities can be classified into two primary types:

Firstly, some indicators in Oiconomy do not fully align with the definitions of social topics found in other international standards. Certain social topics are simplified to yes/no questions in the governance level sheet, lacking robust evaluation through strong indicators. For instance, within the category of various social issues, there's a question related to lobbying's impact on sustainable development. While relevant, this single indicator falls short of completely addressing the topic of Responsible political involvement, as ISO 26000 assigns equal importance to political contributions within this category. Another instance is the treatment of risk management: SASB and S&P Global standards also consider system risks, whereas Oiconomy primarily focuses on financial risk.

Secondly, some aspects are "implied" rather than explicitly assessed in the Oiconomy process. For example, while the assessment process promotes the value and improvement of supplier relationships by engaging value chain partners, there is no specific indicator evaluating the quality of managing these supplier relationships.

Lastly, "Insufficient" is assigned when social topics are entirely absent from Oiconomy; these include *Equal access to products, Wealth distribution*, and *Supporting small-scale entrepreneurs*. The outcomes highlight Oiconomy's limitations in tackling social topics linked to social capital endpoints and its absence of indicators for assessing the quality and equity in supply chain governance. This discovery is unexpected given that Oiconomy's primary goal is to enhance collaboration within the value chain.

Table 6

Cross-matching Oiconomy Indicators and Core Social Topics

Stakeholder group	Endpoints	Midpoints	Sufficient level	Oiconomy sections
Worker	Working conditions and labour practice	Fair salary	Sufficient	Remuneration (wages), Inequality
		Occupational health and safety	Sufficient	Occupational Health and Safety (OHS)
		Work-life balance	Sufficient	Overtime wages, Employment contract time
		Social benefits and social security	Sufficient	Health Insurance Plans, Bonus
		Child labor	Sufficient	Child Labor
		Forced labor	Sufficient	Various Labor Related aspects
		Freedom of association and collective bargaining	Sufficient	Various Labor Related aspects
		Discrimination and equal opportunities	Sufficient	Various social Issues & Various Labor Related aspects
		Violence and harassment	Sufficient	Various social Issues & Various Labor Related aspects
	Employee engagement	Employment relationship	Low sufficiency	Labor condition governance level sheet
		Training and education	Sufficient	Personnel Development & Bonus
		Social dialogue	Low sufficiency	Labor condition governance level sheet
Consumer and end-users	Responsible consumption	Consumer health and safety	Sufficient	Use-Human Health Risks
		Consumer privacy and data safety	Sufficient	Various social issues
		End-of-life responsibility	Sufficient	EoL governance-level
		Product quality and effectiveness	Sufficient	Product Warranties
		Equal access to products	Insufficient	
	Consumer engagement	Transparency and responsible marketing	Sufficient	Instructions for use, Transparency, Various social issues
		Feedback mechanism	Sufficient	Various social issues
Value chain actors	Responsible procurement	Supply chain labor standards	Sufficient	Oiconomy assessment involvement
		Fair trading and competition	Sufficient	Fair Transactions
		Respect of intellectual property rights	Sufficient	Various social issues
		Wealth distribution	Insufficient	
	Value chain engagement	Supplier relationship	Low sufficiency	Oiconomy final results consulation
		Promoting social responsibility	Sufficient	Oiconomy assessment involvement
		Supporting small-scale entrepreneurs	Insufficient	
Affected communities	Impact on local communities	Safe and healthy living conditions	Low sufficiency	Bonus
		Access to material and immaterial	Low sufficiency	Bonus
		Respect of indigenous rights	Sufficient	Various social Issues & Bonus
		Ethical treatment of animals	Sufficient	Animal walfare
		Local employment and contribution to economic development	Sufficient	Bonus
	Community engagement	Public commitments to sustainability issues	Sufficient	Bonus
		Education provided in the local community	Sufficient	Bonus
Government, shareholders and the general public	Corporate governance	Tax transparency	Sufficient	Taxes, Subsidies
		Anti-corruption	Sufficient	Corruption and Conflict
		Compliance and anti-crime policy	Sufficient	Corruption and Conflict governance level sheet
		Risk management	Low sufficiency	Finance Related Criteria
	Social value creation	Innovation management	Low sufficiency	Bonus
		Responsible political involvement	Low sufficiency	Various social issues

5.2.   Interview results- Pilot Companies

5.2.1.   Pilot Companies

To gain a better understanding of the applicability and comprehensiveness of the Oiconomy assessment tool empirically, three out of four pilot companies are invited for interviews. The following section presents summaries of the interviews conducted with representatives from the three pilot companies. Finally, the concluding section provides a synthesis of key findings and any unexpected insights that emerged from the interviews.

Notably, for Arte Groep, an overview is constructed by combining insights from interviews A and B. The interview process involves several targeted inquiries. These encompass their supply chain practices and how they perceive Oiconomy as an assessment instrument for measuring social impact within the supply chain, based on five proposed criteria. Furthermore, interviewees are prompted to share their motivations for participating in Oiconomy, their anticipated and realized outcomes, overall experiences, and constructive feedback for future enhancements.

To help business participants grasp the concept of comprehensiveness criteria, questions are formulated using business-oriented language. For instance, under the impact pathways session, questions are framed as follows: "Is it straightforward to understand Oiconomy's rationale for incorporating these social subjects? How does this alignment aid in connecting your supply chain challenges to SDGs and your sustainability strategies?" The complete interview guide can be found in the attached appendix.

5.2.2.   Arte Groep

With the majority of its materials being sourced from natural stone, Arte places a strong emphasis on responsible procurement practices that positively influence the sourcing regions. The company values its suppliers as partners and follows effective supply chain practices, such as annual supplier audits to maintain quality. Arte communicates regularly with suppliers at different levels and keeps track of materials' origins using a product passport system. Following international guidelines and private standards such as CSRD, OECD Guidelines for Multinational Enterprises, and The CSR performance Ladder certificate, Arte has established EMBO (CSR) guidelines that cover issue areas including labor conditions, waste management, and avoiding child labor. Additionally, in dealings with new suppliers, Arte extends the practice of requiring first-tier suppliers to commit to a code of

conduct for purchasing. This code encompasses stipulations that are also applicable to suppliers in subsequent tiers. Recently, Arte started an E-LCA to measure the environmental impact of their products. This reflects their dedication to sustainability practices.

Arte's participation in the Oiconomy pilot project stemmed from its commitment to maximize sustainability. By scrutinizing materials and supply chain intricacies, it intended to uncover concealed negative costs and opportunities for improvement. The previous pilot highlighted the challenge of engaging suppliers due to the voluntary nature of participation. In response, Arte refined the assessment scope for a more precise evaluation of the true product cost. Through Oiconomy, Arte aims to facilitate an open and forthright dialogue with its suppliers.

Considering the design of Oiconomy, the lifecycle approach effectively covers all stages of Arte's product life cycle. However, in terms of stakeholder inclusiveness, both interviewees recognized that while the assessment offers valuable insights into Arte's influence on stakeholders, there are limitations to this aspect. The process of stakeholder dialogue and analysis remains distinct within their original supply chain practices. During the assessment, the primary emphasis was directed towards internal processes, with limited engagement of external stakeholders other than suppliers (*Interviewee B*). Arte does share Oiconomy findings with both its employees and clients. However, the effectiveness of this communication is also limited by difficulties in securing cooperation from their primary supplier to disclose confidential data. This hesitance could be attributed to ''worries about potential competition", especially for materials lacking patent protection (*Interviewee A*). While their primary suppliers managed to provide an Environmental Product Declaration (EPD) report, it offered only a "broad estimate for the assessment's purposes (*Interviewee B*).

Both interviewees share the view that Oiconomy adequately covers relevant social topics, leaving no obvious gaps for inclusion. This argument is substantiated by their response to questions regarding context-specific criteria: significant concerns pertaining to Arte's supply chain are already addressed through Oiconomy. Arte sources materials globally including from India and Zimbabwe, where confront challenges such as child labor and fair wage disparities within local communities. To address this, Arte established the True Stone Foundation, adopting its own approach to estimating progress in reducing child labor—a quantification based on daily school attendance. Conversely, the labor workforce within Arte's Spanish supply chain experiences more favorable treatment due to the country's higher affluence, resulting in fewer necessary interventions from Arte.

Regarding the impact pathway, Oiconomy serves as a confirmation of the challenges that the company is facing (*Interview A*). The challenges were already recognized, and the outcomes from Oiconomy align with their expected critical areas. Efforts have been made to integrate these findings into their strategies by engaging with suppliers. However, this remains a work in progress due to the time required for effective collaboration. In some aspects, Oiconomy didn't introduce novel information necessitating immediate integration into actions. This is because actions are already based on SDGs or certain risk-mitigation projects have been ongoing for a considerable duration, such as those related to occupational safety.

Overall, Arte acknowledges that while it has gained a better understanding of the principles of Oiconomy, comprehending the methodology entirely and conducting self-assessment without support from the Oiconomy team remain challenging. Arte anticipates the Oiconomy Pricing Foundation could provide clear explanations to convince its supplier that the full cost method is "not a threat but rather an opportunity to contribute positively to the world." (*Interviewee A*).

5.2.3.   Verstegen Spices & Sauces

Verstegen offers spicy seasonings and single spices, sauces, and related products in the European market. Spices and natural ingredients are sourced from diverse corners of the globe, including Indonesia and India. The company undertakes several supply chain management initiatives, one of which involves a vendor assurance scheme aimed at evaluating food safety and quality. Ensuring social sustainability criteria are met, the company investigates its suppliers regarding a range of matters that encompass diverse factors such as human rights, working hours, remuneration, health and safety, etc. The company manages a complex network of suppliers across multiple tiers. For smaller transactions, direct management occurs between suppliers and traders due to minimal land impact. However, for crucial materials with significant purchase volumes, transparency is maintained by tracking back to the collector level. In some cases, detailed farmer data is also mapped. The company's current focus is on regenerative agriculture, involving the evaluation of supplier's adherence to standards and the identification of naturally regenerative spices.

Verstegen partnered with Oiconomy to explore the concept of true pricing, a relevant topic in its industry. Additionally, due to its longstanding collaborations with farmer groups on

social projects, the company aims to quantify the impact of its actions within the supply chain. Verstegen's commitment to quality is evident in its practice of maintaining stable suppliers rather than frequently switching for lower costs. Oiconomy's true price method provides a suitable tool for Verstegen to transparently communicate to its customers why prices might be higher, aligning with the company's priority of maintaining excellent product quality.

Based on the insights drawn from participating in two pilot projects, Verstegen concurs that Oiconomy's life cycle approach effectively encompasses their product value chains and its causal-effect rationale aids in seamlessly integrating PDCA into Verstegen's sustainability initiatives. Additionally, Oiconomy's guidance shed light on the requisite data for appraising social impact according to international standards, along with an evaluation of the organization's accessibility to such data. Notably, Verstegen encountered a surprise when the negative costs of certain social facets contributed significantly to the total hidden costs, exemplified by the wage gap between the CEO and employees of one of its suppliers. This revelation led to the suggestion that a review of the weighting methodology for social aspects might be beneficial.

Given Interviewee C's involvement in the data input process using the assessment tool, the interview naturally revolved around discussions regarding data and indicators. According to Interviewee C, the tool's complexity and the manner in which questions are presented pose challenges, with the complexity often exceeding practical levels. As data collection, processing, and storage are difficult in any supply chain, guiding questions concerning indicators in the Oiconomy assessment tool indeed help companies collect internal data. However, Interviewee C notes that at times, there are too many questions under an issue category. As a suggestion, Interviewee C proposes that Oiconomy consider refining its approach by prioritizing focused indicators, while potentially excluding certain smaller or more complex items to prevent overwhelming organizations.

In terms of stakeholder inclusiveness, communication, and discussion are constrained to supply chain partners. Within its expansive value chain, Verstegen engages numerous suppliers, a significant portion of whom operate in developing countries. Verstegen acknowledges that certain suppliers might lack available data or be hesitant to share it. This situation leads to the selection of data-sharing-capable suppliers for pilot projects. In this context, Verstegen looks forward to Oiconomy's provision of comprehensive guidelines for organizations in developing countries, aimed at enhancing data collection practices and ensuring data quality.

Regarding the social topics addressed by Oiconomy, Interviewee C recommends that indicators and required items should focus initially on essential core aspects to reduce the workload on data collection, gradually expanding to include additional data and details. As Oiconomy aims to establish a certification system, allowing verification of entries as Oiconomy suppliers, multiple certification tiers are advised. These levels include basic and advanced tiers; the former covering mandatory topics that give an overview of the hidden costs, while the latter would offer a deeper understanding of hidden costs associated with specific aspects, allowing for the implementation of PDCA cycles. Interviewee C also suggests that a sector-specific approach might be advantageous, particularly for smallholders with limited data availability.

5.2.4.   Tradin Organic Agriculture

Tradin Organic is involved in sourcing, processing, and selling organic ingredients. It has developed a comprehensive due diligence system in line with OECD Guidelines for Multinational Enterprises to integrate various sustainable supply chain initiatives. Their system encompasses policies related to diverse themes including deforestation, human rights, and ethical sourcing. Suppliers are required to adhere to a code of conduct derived from these policies. Reassessment of suppliers takes place every three years through questionnaires, data analysis, or product certifications such as FairTrade. Managing suppliers across 60 countries, the company employs a risk indicator approach to prioritize areas needing further attention. Collaborative projects with value chain partners, such as a child protection program in Sierra Leone, are undertaken for risk mitigation and remediation.

Tradin Organic joined Oiconomy to provide customers with ingredient transparency and insight into their impact on the food system. After a successful small project with a consultant to assess ingredient costs, Tradin Organic is eager for a deeper exploration. Positive results from Oiconomy's pilot projects amplified their interest in participation.

In broad terms, Oiconomy's life cycle design addresses Tradin Organic's entire value chain. Yet, given Tradin Organic's primary engagement in B2B transactions, achieving comprehensiveness down to the end consumer's final product proves intricate. Consider the example of sourcing cocoa beans, processing them into semi-products like cocoa liquor and cocoa powder, and selling these to customers who, in turn, create chocolate milk or bars. The ultimate product includes additional components such as sugar and milk. As such, this assessment outcome doesn't provide a complete view of the consumer product's impact on

the end user.

Hence, Tradin Organic aspires to engage Oiconomy in collaboration with its customers. However, it recognizes that transparency might not be comfortable or feasible for downstream value chain partners due to potential data constraints. Uncertainties also arise concerning the definitiveness and accuracy of stakeholder impacts due to their perceived vagueness. Beyond data collection, stakeholder engagement plays a limited role in the assessment process. Tradin Organic currently conducts limited stakeholder engagement and a materiality assessment as part of reporting obligations. Interviewee D added that integrating or aligning this process with Oiconomy could be potentially beneficial.

Interview D finds the Oiconomy methodology to be highly comprehensive, even more so than other tools he/she has encountered. Unlike Tradin Organic's internal system that groups some topics together, Oiconomy breaks them down further. After comparing it to GRI, the company affirmed Oiconomy's thoroughness. There were overlaps with GRI, CSRD, SASB, and PSIA. Additionally, Oiconomy helps Tradin Organic outline impact pathways by using numbers to support their narratives of supply chain practices.

While sector-specific adjustments are common in various corporate sustainability tools, Interview D believes that this might not be the optimal direction for Oiconomy. Expanding categories and increasing complexity could pose challenges in management. Instead, Interview D suggests focusing on a limited set of core categories for social aspects. Universal themes such as human rights, for instance, remain relevant across industries. Tradin Organic's experience has highlighted that measuring social impacts is more intricate than environmental ones. Rather than striving for exhaustive and extremely detailed coverage, a pragmatic approach would involve robustly measuring fundamental aspects. This would allow organizations to invest resources where they matter most. The expansion into other areas can be pursued as the methodology matures over time.

Interviewee D also highlighted the merit of Oiconomy's adoption of two data options, foreground, and background, as a precautionary measure in cases where primary data might be unavailable. During the assessment, an instance of unusually high emissions data that seemed discrepant compared to other companies was identified by the Oiconomy developer. Interviewee D emphasized the importance of using verified primary data or a generic database to prevent errors. He/she added that given this perspective, Oiconomy's vision as an accreditation body to verify supply chain data and product full costs while mitigating the risk of subjective estimations begins to make sense

Interviewee D's feedback on Oiconomy's implementation highlights the challenge of transitioning from academia to the business sphere, where attention spans are short, time is precious, and business reputation matters greatly. The concept of preventative and bonus costs resonates well within the business world. Moreover, a user-friendly online dashboard for tracking progress and obtaining a comprehensive overview is also appreciated. Finally, recognizing Oiconomy as a newer player in the full cost accounting field compared to True Price (True Price Foundation, n.d.), there's an acknowledged need for further promotion and methodological comparisons to gain visibility in the market and the public eye.

5.3.   Key Findings and Other Findings

Figure 9 presents how representatives from the three companies perceive the degree to which Oiconomy aligns with the five criteria of comprehensiveness. Furthermore, key findings from the interviews are summarized as follows:

- The reasons to participate in the Oiconomy pilot include "enable storytelling about the source of our products" and "interest in full cost accounting method".

- All interviewees acknowledge that Oiconomy encompasses all stages of their products. However, for companies engaged in B-to-B transactions, assessing the impact until the end-users phase is either not considered or difficult to measure.

- All interviewees indicated that they possess a deeper understanding of their influence on stakeholders. However, it's challenging to verify the accuracy of this comprehension as their engagement was restricted to supplier partners who took part in the assessment.

- All participants agree that the Oiconomy assessment results align with their expectations regarding social hotspots in their industry. However, it may be surprising to see that certain topics can result in high hidden costs, which raises questions about the weighting method. Interviewee C also emphasizes the need for further adaptation for their small-holder suppliers in developing countries, as they may face challenges in data collection.

- Oiconomy covers a wide range of social topics. Both interviewees from Arte believe the coverage is extensive, and they cannot think of more critical social topics at this

time. Conversely, interviewees B and C both suggest the need to formulate a simpler, core set of social topics, as collecting data in the business setting might otherwise become too labor-intensive.

- All participants concur that Oiconomy provides clear impact pathways. The assessment results assist them in connecting preventive actions to sustainability strategies and goals.

Figure 9

Interviewees' perspectives on the comprehensiveness of Oiconomy based on the five criteria

	Life cycle thinking	Stakeholder inclusiveness	Impact pathway	Context-specific adaptation	Core social topics
Arte Groep	Sufficient ▼	Low sufficiency ▼	Sufficient ▼	Sufficient ▼	Sufficient ▼
Verstegen Spices & Sauces	Sufficient ▼	Low sufficiency ▼	Sufficient ▼	Low sufficiency ▼	Sufficient ▼
Tradin Organic Agriculture	Low sufficiency ▼	Low sufficiency ▼	Sufficient ▼	Sufficient ▼	Sufficient ▼

The open-ended interviews yielded additional noteworthy findings.

- All interviewees brought up the tool's complexity. This complexity could potentially obscure their ability to accurately assess the comprehensiveness and effectiveness of the Oiconomy assessment tool. Moreover, without support from the Oiconomy team, these companies currently lack the capacity and resources required to conduct self-assessments.

- The effectiveness of the assessment results may be compromised because suppliers may not always provide honest or open responses. Suppliers may be aware of potential negative findings and, consequently, may be hesitant to cooperate. This situation is regarded as "a missed opportunity," as issues of transparency and data availability can significantly impact the comprehensiveness of the assessment.

5.4. Materiality Analysis of Core Social Topics

Figure 10 presents the outcomes of the materiality analysis conducted on the core social topics outlined in the conceptual framework. In this analysis, interviewees from the pilot companies were asked to provide ratings on a scale of 1 to 5, ranging from "not relevant/important" to "very relevant/important," with a score of 3 or higher indicating relevance. The results for Arte represent the average scores from interviewees A and B. On the whole, participants reached a consensus that 95% of the core social topics hold relevance within their respective supply chains. However, Tradin Organic identified two topics, namely *Consumer privacy and data safety* and *End-of-life responsibility*, as not important or relevant. Additionally, Verstegen found *Equal access to product* and *Employee relationships* to be of lesser relevance or importance.

Figure 11 illustrates the average scores of these social topics, assessed by all four interviewees, categorized into 10 endpoint categories. Evidently, all the social topics are perceived as relevant or important, with standout importance attributed to *Working conditions and labor practices* and *Value chain engagement* among them.

Figure 10

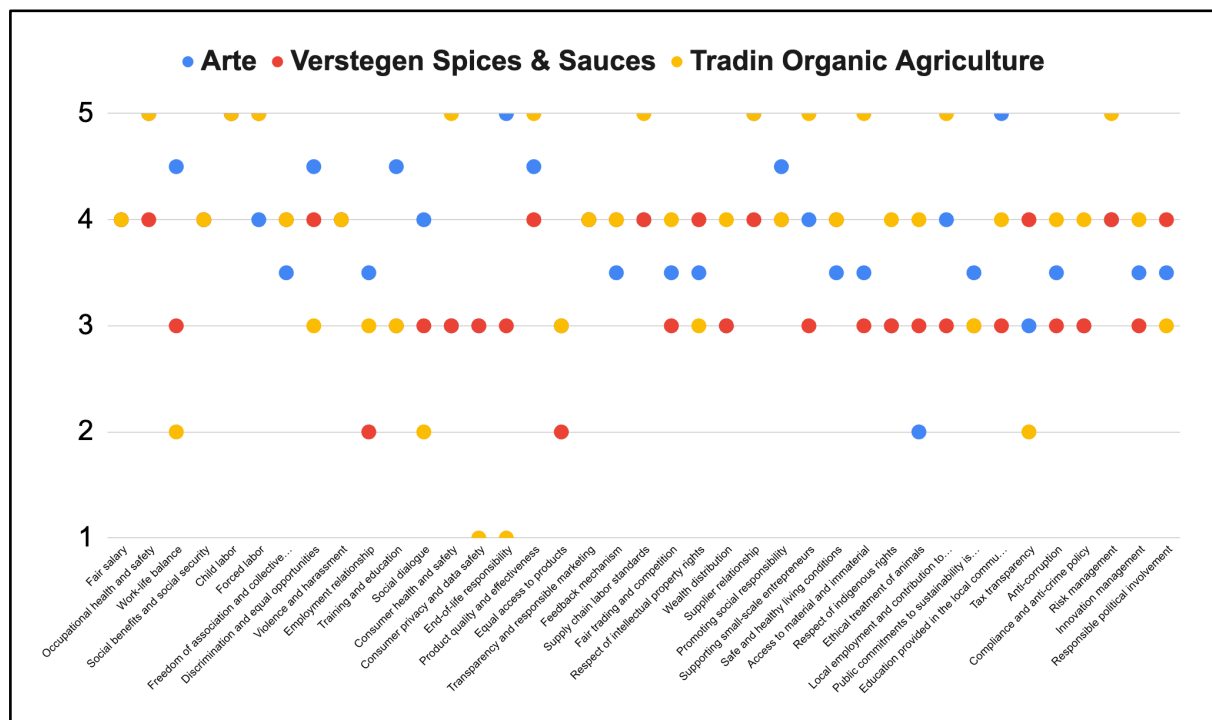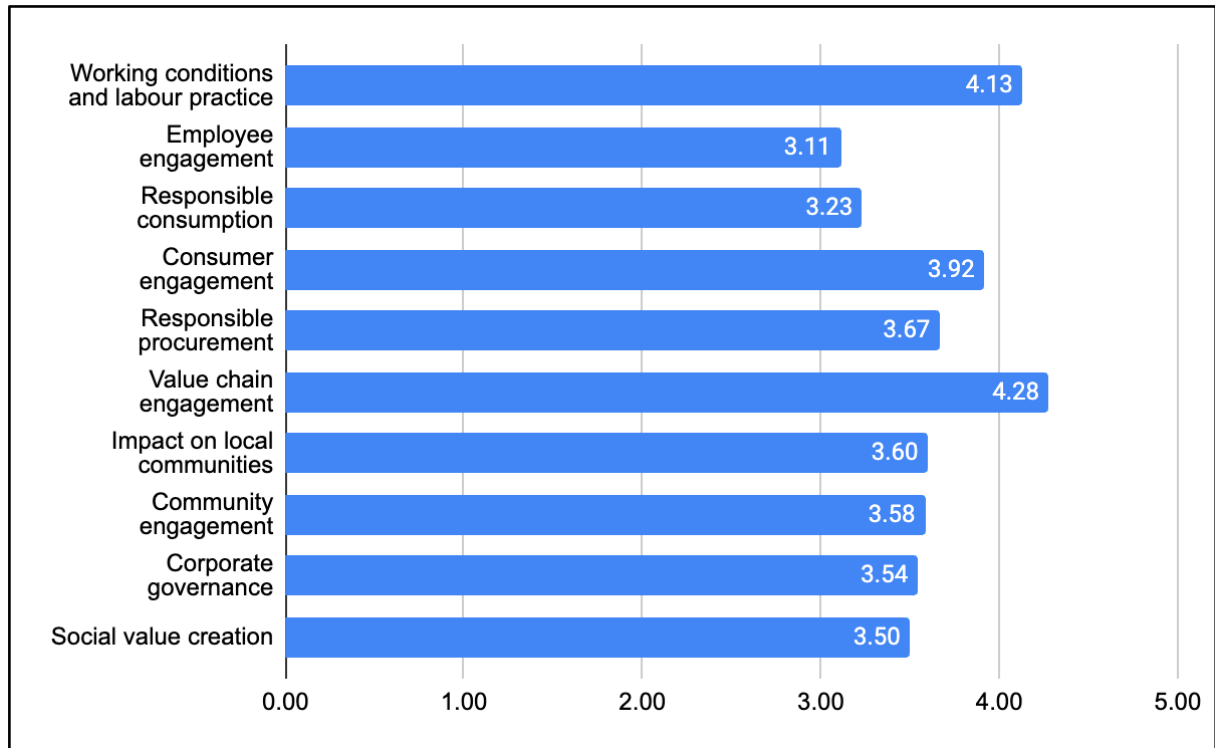*Overview of Materiality analysis results for all three pilot companies*

Figure 11

Average materiality scores for each endpoint category

6. Conclusion- Answering the RQ

By systematically synthesizing the results discussed in sub-research question 2, a conclusion is arrived at for the main research question, shedding light on the overall comprehensiveness of Oiconomy.

Oiconomy is designed as a comprehensive full cost accounting method, grounded in the product life cycle perspective. Consequently, the life cycle thinking criteria are considered adequate within the system design to address externalities effectively. Unlike conventional S-LCA, which typically concentrates solely on implemented solutions, Oiconomy's preventative cost approach proves valuable in evaluating the costs associated with various alternative scenarios, enabling decision-makers to make informed choices regarding cost-effective improvement initiatives and accelerate progress toward sustainability objectives. Additionally, Oiconomy offers clear impact pathways for organizations to identify affected stakeholders and align preventative actions with the SDG framework. However, empirical feedback raises questions about how the Oiconomy assessment process can be applied in cases where focal companies exclusively produce semi-products and engage in B2B transactions, with impacts on downstream partners and consumer markets being relatively uncertain.

A comparison of the conceptual framework assessment results and the insights gathered from interviews reveals a notable contradiction. The cross-matching analysis indicates that Oiconomy encompasses 72% of the consensus-based integral social topics, a comprehensiveness unanimously acknowledged by the pilot companies during interviews. However, the materiality analysis highlights that the remaining 28% of social themes, which receive less attention or are entirely overlooked in Oiconomy, remain relevant to assessing these companies' supply chains. It's noteworthy that these gaps are primarily concentrated within the social capital endpoint categories. Furthermore, another contradiction arises from the fact that, despite its role as a supply chain assessment tool, Oiconomy lacks indicators for evaluating the quality of supply chain governance and engagement. Intriguingly, the materiality analysis reveals that value chain enga*gement* holds the highest average significance, further underscoring this inconsistency.

Examining the coverage of social themes takes on added significance due to the limited stakeholder involvement in the design of Oiconomy. Oiconomy's primary aim is to promote collaboration within the value chain to mitigate external impacts, while stakeholder consultation remains a separate process organized by individual companies. Consequently, aside from the value chain actors directly involved in the assessment process, other stakeholders are not actively engaged or incorporated into the evaluation process. As a result, certain stakeholder interests may not be adequately accounted for if some of the proposed social topics within the framework are overlooked. This, in turn, results in a lower level of stakeholder inclusiveness in the Oiconomy assessment.

Regarding contextual adjustments, both Oiconomy experts and business interviewees concur that there is currently no need for industry-specific guidelines. This is preferred as creating such guidelines would be labor-intensive and time-consuming, potentially resulting in challenges when comparing results. However, it is acknowledged that SMEs, especially those in developing nations, may require some form of support or adaptation due to limitations in capacity and data availability. Another point of discussion centers around the weighting of factors and materiality. The pilot project revealed that participants were concerned about less significant issues contributing to disproportionately high hidden costs. Nevertheless, it lies in Oiconomy's philosophy to employ a monetizing aggregation method to avoid weighting and ensure that each factor is given equal importance, aiming at addressing the bias limitation often associated with traditional LCA.

Additional findings indicate that the complexity of the assessment tool and the lack of available data also pose challenges to its applicability and the feasibility of achieving a comprehensive assessment. In summary, Oiconomy Pricing demonstrates a comprehensive approach to product social life cycle assessment in theoretical design. However, it falls short of fully encompassing stakeholder interests and their associated indicators when compared to established international corporate sustainability standards. This limitation undermines its effectiveness in thoroughly uncovering hidden costs. Additionally, the comprehensiveness of individual assessments may be influenced by project scoping and the specific context of the assessed value chain. Recommendations for refinement will be provided in the following section.

7. Discussion

7.1. Recommendations

By communicating preventative costs throughout the supply chain, Oiconomy supports the identification of the most efficient route to sustainability. Hence, the improvement of the Oiconomy methodology can help facilitate standardization of the complex S-LCA field. The following three recommendations for improving Oiconomy are given based on the findings in this study.

First, there is a need for a reexamination of selected social categories and sub-categories. As Oiconomy aims to evolve as a private standard, it is crucial to ensure democratic legitimacy through the participation of stakeholder groups beyond just value chain actors (Fuchs and Kalfagianni, 2010). Currently, Oiconomy does not require stakeholder consultation during the assessment process. Therefore, the predetermined categories play a pivotal role in determining the inclusiveness of the interests of affected stakeholders. It is recommended to re-evaluate key stakeholder groups, including social aspects and impact pathways, in reference to the framework proposed in this thesis. Moreover, following the suggestions from pilot companies and Dreyer et al. (2006), an integral, mandatory set of social topics should be defined to reduce complexity. This obligatory set of indicators can serve as the baseline for certification, covering topics related to compliance and upholding human rights within the framework. Conversely, topics associated with sector-specific positive impacts and social capital can be ranked at a higher certificate level for industry leaders. For example, EcoVadis has established four medal levels based on percentile performance: Platinum (top 1%), Gold (top 5%), Silver (top 25%), and Bronze (top 50%) (EcoVadis, n.d.). By doing so, core social topics are addressed, and companies are encouraged to make step-by-step continuous improvements without feeling overwhelmed by the assessment process.

Second, it is essential to explore the feasibility of the monetarization of subjective opinions. This is again related to democratic legitimacy and stakeholder inclusivity. To initiate this process, Oiconomy can begin by incorporating quantitative data, such as stakeholder satisfaction, into consideration. Common business operational practices already utilize metrics like customer and employee satisfaction to measure such performance. Additionally, there are social certification bodies such as EDGE Certification that employ questionnaires and employee surveys to evaluate workers' perspectives on workplace gender equality (EDGE Certified Foundation, n.d.), highlighting the growing importance of capturing and valuing subjective viewpoints in standardized certification systems.

Lastly, the need for publishing clear guidelines for instructions becomes apparent. Feedback from interviews underscores the prevalent hesitancy among most value chain partners to engage in the assessment process due to concerns about revealing hidden costs. Furthermore, it is essential to acknowledge that SMEs in developing countries may face limitations in data collection capabilities, necessitating the provision of simplified instructions. Official guidelines can play an important role in guiding participants, reassuring them that embracing full cost accounting is not a threat to their reputation but rather an opportunity to foster long-term positive changes within the value chain. Looking forward, there is potential for offering consulting services that focus on strategies for mitigating negative impacts, sharing industry best practices, and outlining preventive measures adopted by leaders in the field. This supporting approach will empower participants to navigate the assessment process confidently, fostering sustainability improvements throughout the value chain.

7.2.   Limitations and Contribution of the Research

The conclusion of this study is limited for several reasons. To begin with, this study focuses on evaluating the comprehensiveness of methodological design until the impact sub-category level, while social data is collected at the indicators level. There exists an inherent uncertainty between achieving comprehensiveness and the availability of data. Even when a methodology encompasses all core impact categories and has the potential for a comprehensive assessment, the actual quality and comprehensiveness of the results heavily rely on data availability and the selection of appropriate data indicators and characterization models. Moreover, the comprehensiveness level, while significant, doesn't inherently guarantee more thorough decisions but empowers decision-makers to make well-informed choices that closely simulate real-world systems. Ultimately, LCA and other complex system analyses represent the "best available science" (Benoît et al., 2010).

Furthermore, it's essential to note that the sample data used for establishing a universally applicable set of social themes is relatively limited. The analysis relies on data from 11 standards and materiality assessments conducted within three specific companies. This sample size may not fully capture the diversity of standards and opinions prevalent across various industries, company sizes, and geographical locations. Lastly, this research centers on assessing the comprehensiveness of Oiconomy Pricing. However, it's worth noting that the allocated working period of 30EC may be insufficient for the in-depth development of a comprehensive conceptual framework. Consequently, the comparative

analysis among various corporate sustainability tools is curtailed. The construction of the impact pathway is based on qualitative reasoning without additional scientific evidence.

Despite the limitations, this study makes three primary contributions. First, it adds to the existing scientific literature by advancing the theoretical foundation of S-LCA. It introduces a conceptual framework comprising five criteria, addressing the existing knowledge gap related to the comprehensiveness of the S-LCA methodology. This framework has the potential to facilitate the standardization of S-LCA practices. Secondly, this study acts as a bridge between the theoretical framework of the S-LCA methodology and its practical implementation. It achieves this by introducing a novel categorization for 39 core social topics and corresponding endpoint categories. This categorization is grounded in a consensus reached between the researcher and industry experts. Academic critics of the UNEP/STEAC guidelines are addressed by redefining the stakeholder group e.g., *Society,* and excluding social themes that cannot be directly influenced by supply chains e.g., poverty. This classification ensures the coverage of the interests of five distinct stakeholder groups, provides pathways for assessing impacts that align with SDGs, and helps business practitioners integrate S-LCA with other corporate sustainability practices. Moreover, this list of core social themes can simplify the scoping process, making it more accessible to practitioners without extensive S-LCA expertise. Finally, through a case study, this research examines the emerging full cost accounting method of Oiconomy and identifies areas in need of improvement while offering recommendations for enhancement. The insights derived from the analysis, coupled with empirical findings from interviews, contribute to the ongoing development of the field of full-costing accounting.

7.3. Future Research Direction

As discussed within the limitations of this study, ensuring the applicability of consensus-based social themes to companies across diverse contexts necessitates a more comprehensive examination, drawing from a wider array of standards and empirical insights. One avenue for improvement involves a clearer definition of the midpoint categories, such as the example of the EU Forced Labor Ordinance incorporating child labor under the forced labor category. Additionally, there is a question regarding the necessity of treating gender equality as an independent midpoint category. While gender equality is one of the SDGs, it is also part of the broader spectrum of diversity factors along with race and age, etc., which are already under the banner of "Discrimination and equal opportunities." Notably, the PSAI includes "Women's empowerment" within the "Small-scale entrepreneurs" category, while

other standards reviewed in this study do not specify gender issues. Ultimately, when there arises a need to emphasize the rights and equality of specific groups, it brings forth a nuanced debate about potential discrimination to some extent. Further exploration of this issue can be undertaken from the perspective of social justice. Another example to consider is child labor. According to the International Labour Organization (ILO), child labor involves work that harms a child's well-being and disrupts their education and overall development. However, some opponents argue that child labor can sometimes contribute to a child's well-being by providing additional income for their diet and health, or by teaching them responsibility and discipline through work (Pollok et al., 2021).

Future studies can also look at topics that overlap between environmental and social issues, contributing to the development of LSCA. Social sustainability concerns are intricate and challenging to analyze in isolation. Take, for example, the experiences of indigenous women, who often confront multiple forms of discrimination, limited access to education and healthcare, and a higher risk of violence, particularly in contexts involving domestic abuse, human trafficking, and armed conflicts (International Labour Organization, 2012). Additionally, poverty and social roles could make them more vulnerable to climate risks (UN Women, n.d.). Failing to address the interconnectedness of worker equality and the well-being of indigenous communities or neglecting critical social factors can introduce ambiguity and uncertainty when assessing the social impacts within supply chains. To comprehensively evaluate and address these complexities, a holistic approach that considers the interplay of various social aspects is essential. Further exploration can dive into the integration of the 5Ps framework into LSCA, which would enhance the focus on aspects such as social justice and inclusivity.

8. Reference

10YFP. (n.d.). UNDESA- Division for Sustainable Development. Retrieved August 1, 2023,

from

https://sustainabledevelopment.un.org/content/documents/1444HLPF_10YFP2.pdf

Almanza, A. H., & 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

Arcese, G., Lucchetti, M. C., Nanni, O., & Valente, C. (2016). State of the art in S-LCA:

integrating literature review and automatic text analysis. *International Journal of Life

Cycle Assessment*, *23*(3), 394–405. https://doi.org/10.1007/s11367-016-1082-0

Arcese, G., Lucchetti, M. C., Nanni, O., & Valente, C. (2018). State of the art in S-LCA:

integrating literature review and automatic text analysis. *International Journal of Life

Cycle Assessment*, *23*(3), 394–405. https://doi.org/10.1007/s11367-016-1082-0

Baitz, M., Albrecht, S., Brauner, E., Broadbent, C., Castellan, G., Conrath, P., Fava, J. A.,

Finkbeiner, M., Fischer, M., Fullana-I-Palmer, P., Krinke, S., Leroy, C., Loebel, O.,

McKeown, P., Mersiowsky, I., Möginger, B., Pfaadt, M., Rebitzer, G., Rother, E., . . .

Tikana, L. (2012). LCA's theory and practice: like ebony and ivory living in perfect

harmony? *International Journal of Life Cycle Assessment*, *18*(1), 5–13.

https://doi.org/10.1007/s11367-012-0476-x

Baumann, H., Arvidsson, R., Tong, H., & Wang, Y. (2013). Does the Production of an Airbag

Injure more People than the Airbag Saves in Traffic? *Journal of Industrial Ecology*,

17(4), 517–527. https://doi.org/10.1111/jiec.12016

Benoît, C., & Mazijn, B. (Eds.). (2009). *Guidelines for Social Life Cycle Assessment of

Products: Social and Socio-economic LCA Guidelines Complementing Environmental*

LCA and Life Cycle Costing, Contributing to the Full Assessment of Goods and Services Within the Context of Sustainable Development. UNEP/SETAC.

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

Benoît Norris, C. (2013). Data for social LCA. *International Journal of Life Cycle Assessment*, *19*(2), 261–265. https://doi.org/10.1007/s11367-013-0644-7

Benoit-Norris, C., Vickery-Niederman, G., Valdivia, S., Franze, J., Traverso, M., Ciroth, A., & Mazijn, B. (2011). Introducing the UNEP/SETAC methodological sheets for subcategories of social LCA. *International Journal of Life Cycle Assessment*, *16*(7), 682–690. https://doi.org/10.1007/s11367-011-0301-y

Bithas, K. (2011). Sustainability and externalities: Is the internalization of externalities a sufficient condition for sustainability? *Ecological Economics*, *70*(10), 1703–1706. https://doi.org/10.1016/j.ecolecon.2011.05.014

Bouillass, G., Blanc, I., & Perez-Lopez, P. (2021). Step-by-step social life cycle assessment framework: a participatory approach for the identification and prioritization of impact subcategories applied to mobility scenarios. *International Journal of Life Cycle Assessment*, *26*(12), 2408–2435. https://doi.org/10.1007/s11367-021-01988-w

Carter, C. R., Rogers, D. S., & Choi, T. Y. (2015). Toward the theory of the supply chain. *Journal of Supply Chain Management*, *51*(2), 89–97. https://doi.org/10.1111/jscm.12073

Chhipi-Shrestha, G., 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., & Eisfeldt, F. (2016). *PSILCA – A Product Social Impact Life Cycle Assessment database*.

Corona, B., Bozhilova-Kisheva, K. P., Olsen, S. I., & Miguel, G. S. (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

Costa, D. C., Quinteiro, P., & Dias, A. (2019). A systematic review of life cycle sustainability assessment: Current state, methodological challenges, and implementation issues. *Science of the Total Environment*, *686*, 774–787. https://doi.org/10.1016/j.scitotenv.2019.05.435

Croes, P. (2021). *An assessment methodology as first step to a sustainable and responsible true price economy: "Oiconomy."*

Croes, P. R., & Vermeulen, W. J. (2015a). Comprehensive life cycle assessment by transferring of preventative costs in the supply chain of products. A first draft of the Oiconomy system. *Journal of Cleaner Production*, *102*, 177–187. https://doi.org/10.1016/j.jclepro.2015.04.040

Croes, P. R., & Vermeulen, W. J. (2016). In search of income reference points for SLCA using a country level sustainability benchmark (part 2): fair minimum wage. A contribution to the Oiconomy project. *International Journal of Life Cycle Assessment*, *21*(3), 363–377. https://doi.org/10.1007/s11367-015-1017-1

Croes, P. R., & Vermeulen, W. J. (2018). Quantification of corruption in preventative cost-based S-LCA: a contribution to the Oiconomy project. *International Journal of Life Cycle Assessment*, *24*(1), 142–159. https://doi.org/10.1007/s11367-018-1507-z

Croes, P. R., & Vermeulen, W. J. (2020). The assessment of positive impacts in LCA of products. *International Journal of Life Cycle Assessment*, *26*(1), 143–156. https://doi.org/10.1007/s11367-020-01820-x

CSR Performance Ladder. (n.d.). *What is the CSR Performance Ladder? - MVO Prestatieladder*. MVO Prestatieladder. https://www.mvoprestatieladder.nl/en/what-is-csr-performance-ladder/

Dahlman, C. J. (1979). The problem of externality. *The Journal of Law and Economics*.

Deming, W. E. (1982). *Out of the crisis*. http://ci.nii.ac.jp/ncid/BA10269119

D'Eusanio, M., Serreli, M., Zamagni, A., & Petti, L. (2018). Assessment of social dimension
of a jar of honey: A methodological outline. *Journal of Cleaner Production*, *199*, 503–
517. https://doi.org/10.1016/j.jclepro.2018.07.157

Di Cesare, S., Silveri, F., Sala, S., & Petti, L. (2016). Positive impacts in social life cycle
assessment: state of the art and the way forward. *International Journal of Life Cycle
Assessment*, *23*(3), 406–421. https://doi.org/10.1007/s11367-016-1169-7

Ding, H., Liu, Q., & Zheng, L. (2016). Assessing the economic performance of an
environmental sustainable supply chain in reducing environmental externalities.
European Journal of Operational Research, *255*(2), 463–480.
https://doi.org/10.1016/j.ejor.2016.05.003

Directive (EU) 2019/1937 on Corporate Sustainability Due Diligence and amending. (n.d.).
https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52022PC0071

Dreyer, L. C., Hauschild, M. Z., & Schierbeck, J. (2006). A Framework for Social Life Cycle
Impact Assessment (10 pp). *International Journal of Life Cycle Assessment*, *11*(2),
88–97. https://doi.org/10.1065/lca2005.08.223

EcoVadis. (n.d.). *EcoVadis CSR Rating Methodology: Scoring Principles*. EcoVadis CSR
Rating Methodology: Scoring Principles. https://resources.ecovadis.com/ecovadis-
solution-materials/csr-rating-methodology-scoring-principles

EDGE Certified Foundation. (n.d.). EDGE Certification | Achieve workplace gender and
Intersectional Equity. *EDGE Certified Foundation*. https://www.edge-cert.org/

EFRAG. (n.d.). *First Set of draft ESRS - EFRAG*. https://www.efrag.org/lab6

Ekener, E., Hansson, J., & Gustavsson, M. (2016). Addressing positive impacts in social
LCA—discussing current and new approaches exemplified by the case of vehicle
fuels. *International Journal of Life Cycle Assessment*, *23*(3), 556–568.
https://doi.org/10.1007/s11367-016-1058-0

Eskerod, P., Huemann, M., & Ringhofer, C. (2015). Stakeholder Inclusiveness: Enriching
Project Management with General Stakeholder Theory1. *Project Management
Journal*, *46*(6), 42–53. https://doi.org/10.1002/pmj.21546

Esposito, F., Corazza, A., & Cutugno, F. (2016). Topic Modelling with Word Embeddings. In *Accademia University Press eBooks* (pp. 129–134). https://doi.org/10.4000/books.aaccademia.1767

Esteves, A. P., Franks, D. M., & 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

EU. (2020). *User guide to the SME Definition*.

Feschet, P., Macombe, C., Garrabé, M., Loeillet, D., Saez, A., & Benhmad, F. (2013). Social impact assessment in LCA using the Preston pathway. *The International Journal of Life Cycle Assessment*, *18*(2), 490–503. https://doi.org/10.1007/s11367-012-0490-z

Fontes, J. L. I., Tarne, P., Traverso, M., & Bernstein, P. (2018). Product social impact assessment. *International Journal of Life Cycle Assessment*, *23*(3), 547–555. https://doi.org/10.1007/s11367-016-1125-6

Freeman, R. R., Wicks, A. C., & Parmar, B. L. (2004). Stakeholder Theory and "The Corporate Objective Revisited." *Organization Science*, *15*(3), 364–369. https://doi.org/10.1287/orsc.1040.0066

Ftse Russell. (n.d.). FTSE Russell. https://www.ftserussell.com/data/sustainability-and-esg-data/esg-ratings

Fuchs, D., & Kalfagianni, A. (2011). The challenges of Global Business Authority: Democratic Renewal, Stalemate, or Decay? In *The challenges of global business authority: democratic renewal, stalemate of decay?* (pp. 88–188). SUNY Press.

Gauthier, C. (2005). Measuring Corporate Social and Environmental Performance: The Extended Life-Cycle Assessment. *Journal of Business Ethics*, *59*(1–2), 199–206. https://doi.org/10.1007/s10551-005-3416-x

Germani, M., Gregori, F., Luzi, A., & Mengarelli, M. (2015). Assessing Social Sustainability of Products: An Improved S-LCA Method. *IFIP Advances in Information and Communication Technology*. https://doi.org/10.1007/978-3-319-33111-9_48

Gualandris, J., Klassen, R. D., Vachon, S., & Kalchschmidt, M. G. M. (2015). Sustainable

   evaluation and verification in supply chains: Aligning and leveraging accountability to

   stakeholders. *Journal of Operations Management*, *38*(1), 1–13.

   https://doi.org/10.1016/j.jom.2015.06.002

HACCP. (n.d.). *Certification of food safe equipment, materials and services*. HACCP

   International. https://haccp-international.com/services/certification-of-food-safe-

   equipment-materials-and-services/

Hannouf, M., Assefa, G., Hannouf, M. B., & Gates, I. D. (2021). Cause-effect chains in S-

   LCA based on DPSIR framework using Markov healthcare model: an application to

   "working hours" in Canada. *International Journal of Life Cycle Assessment*, *26*(5),

   936–949. https://doi.org/10.1007/s11367-021-01900-6

Huarachi, D. R. G., Piekarski, C. M., Puglieri, F. N., & De Francisco, A. C. (2020). Past and

   future of Social Life Cycle Assessment: Historical evolution and research trends.

   Journal of Cleaner Production, *264*, 121506.

   https://doi.org/10.1016/j.jclepro.2020.121506

Huijbregts, M. a. J., Steinmann, Z. J. N., Elshout, P. M. F., Stam, G., Verones, F., Vieira, M.,

   Mc, Z., Hollander, A., & Van Zelm, R. (2016). ReCiPe2016: a harmonised life cycle

   impact assessment method at midpoint and endpoint level. *International Journal of

   Life Cycle Assessment*, *22*(2), 138–147. https://doi.org/10.1007/s11367-016-1246-y

Hunkeler, D. (2006). Societal LCA Methodology and Case Study (12 pp). *International

   Journal of Life Cycle Assessment*, *11*(6), 371–382.

   https://doi.org/10.1065/lca2006.08.261

*IFRS - IFRS S1 General requirements for Disclosure of sustainability-related Financial

   information*. (n.d.). https://www.ifrs.org/issued-standards/ifrs-sustainability-standards-

   navigator/ifrs-s1-general-requirements/

International Labour Office. (2012). *Indigenous women workers With case studies from

   Bangladesh, Nepal and the Americas*. https://www.ilo.org/wcmsp5/groups/public/---

   dgreports/---gender/documents/publication/wcms_173293.pdf

Iofrida, N., De Luca, A. I., Strano, A., & Gulisano, G. (2018). Can social research paradigms justify the diversity of approaches to social life cycle assessment? *International Journal of Life Cycle Assessment*, *23*(3), 464–480. https://doi.org/10.1007/s11367-016-1206-6

ISO. (n.d.). *ISO/CD 14075 Principles and Framework for Social Life Cycle Assessment*. https://www.iso.org/standard/61118.html

ISO. (2006a). *International Standard ISO 14040: Environmental Management - Life Cycle Assessment- Principles and Framework*.

ISO. (2006b). *ISO 14044: Environmental Management - Life Cycle Assessment - Requirements and Guidelines*.

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

Jørgensen, A., Bocq, A. L., Nazarkina, L., & Hauschild, M. Z. (2008). Methodologies for social life cycle assessment. *International Journal of Life Cycle Assessment*, *13*(2), 96–103. https://doi.org/10.1065/lca2007.11.367

Jørgensen, A., Lai, L. C., & Hauschild, M. Z. (2009). Assessing the validity of impact pathways for child labour and well-being in social life cycle assessment. *International Journal of Life Cycle Assessment*, *15*(1), 5–16. https://doi.org/10.1007/s11367-009-0131-3

Joint Research Centre, Institute for Environment and Sustainability, (2010). General guide for Life Cycle Assessment: provisions and action steps, Publications Office. https://data.europa.eu/doi/10.2788/94987

Kalfagianni, A., & Fuchs, D. (2012). The Global G.A.P.: usiness Regulation and Non-State Actors: Whose Standards? Whose Development? In *Business regulation and Non-State Actors Whose Standards? Whose Development?* (pp. 160–172). Routledge.

Kloepffer, W. (2008). Life cycle sustainability assessment of products. *International Journal of Life Cycle Assessment*, *13*(2), 89–95. https://doi.org/10.1065/lca2008.02.376

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., Russi, D., Bala, A., Finkbeiner, M., & Fullana-I-Palmer, P. (2011). Integration of Social Aspects in Decision Support, Based on Life Cycle Thinking. *Sustainability*, *3*(4), 562–577. https://doi.org/10.3390/su3040562

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

Li, J., Zhang, J., Ge, W., & Liu, X. (2004). Multi-scale methodology for complex systems. *Chemical Engineering Science*, *59*(8–9), 1687–1700. https://doi.org/10.1016/j.ces.2004.01.025

Likert, R. (1932). *A technique for the measurement of attitudes*. https://psycnet.apa.org/record/1933-01885-001

Lindgreen, E. R., & Vermeulen, W. J. (2023). In search for ground rules for product-oriented full cost accounting methods: Ensuring construct validity. *Environmental and Sustainability Indicators*, *19*, 100275. https://doi.org/10.1016/j.indic.2023.100275

Macombe, C., Leskinen, P., Feschet, P., & Antikainen, R. (2013). Social life cycle assessment of biodiesel production at three levels: a literature review and development needs. *Journal of Cleaner Production*, *52*, 205–216. https://doi.org/10.1016/j.jclepro.2013.03.026

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

Martínez-Blanco, J., Lehmann, A., Chang, Y., & 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

Mathe, S. (2014). Integrating participatory approaches into social life cycle assessment: the SLCA participatory approach. *International Journal of Life Cycle Assessment*, *19*(8), 1506–1514. https://doi.org/10.1007/s11367-014-0758-6

Matos, S., & Hall, J. (2007). Integrating sustainable development in the supply chain: The case of life cycle assessment in oil and gas and agricultural biotechnology. *Journal of Operations Management*, *25*(6), 1083–1102. https://doi.org/10.1016/j.jom.2007.01.013

McCabe, A., & Halog, A. (2016). Exploring the potential of participatory systems thinking techniques in progressing SLCA. *International Journal of Life Cycle Assessment*, *23*(3), 739–750. https://doi.org/10.1007/s11367-016-1143-4

Messmann, L., Zender, V., Thorenz, A., & Tuma, A. (2020). How to quantify social impacts in strategic supply chain optimization: State of the art. *Journal of Cleaner Production*, *257*, 120459. https://doi.org/10.1016/j.jclepro.2020.120459

Morali, O., & Searcy, C. (2012). A Review of Sustainable Supply Chain Management Practices in Canada. *Journal of Business Ethics*, *117*(3), 635–658. https://doi.org/10.1007/s10551-012-1539-4

MSCI. (n.d.). *ESG Ratings Methodology*. https://www.msci.com/esg-and-climate-methodologies

Muiña, F. E. G., Medina-Salgado, M., González-Sánchez, R., Huertas-Valdivia, I., Ferrari, A. M., & Settembre-Blundo, D. (2022). Social Organizational Life Cycle Assessment (SO-LCA) and Organization 4.0: An easy-to-implement method. *MethodsX*, *9*, 101692. https://doi.org/10.1016/j.mex.2022.101692

Nazarkina, L., & Le Bocq, A. (2006). Social Aspects of Sustainability Assessment: Feasibility of Social Life Cycle Assessment (S-LCA). *EDF, Moret-sur-Loing, France*.

Neugebauer, S., Martínez-Blanco, J., Scheumann, R., & Finkbeiner, M. (2015). Enhancing the practical implementation of life cycle sustainability assessment – proposal of a

Tiered approach. *Journal of Cleaner Production*, *102*, 165–176.

https://doi.org/10.1016/j.jclepro.2015.04.053

Neugebauer, S., Traverso, M., Scheumann, R., Chang, Y., Wolf, K., & Finkbeiner, M. (2014). Impact Pathways to Address Social Well-Being and Social Justice in SLCA—Fair wage and level of education. *Sustainability*, *6*(8), 4839–4857. https://doi.org/10.3390/su6084839

Norris, G. A. (2006). Social Impacts in product life cycles - towards life cycle Attribute assessment. *International Journal of Life Cycle Assessment*, *11*(S1), 97–104. https://doi.org/10.1065/lca2006.04.017

O'Brien, M., Doig, A., & Clift, R. (1996). Social and environmental life cycle assessment (SELCA). *International Journal of Life Cycle Assessment*, *1*(4), 231–237. https://doi.org/10.1007/bf02978703

Oiconomy Pricing Foundation. (n.d.). *Oiconomy Pricing Assessment Tool*. Retrieved August 1, 2023, from https://oiconomy.geo.uu.nl/tool/

Parent, J., Cucuzzella, C., & Revéret, J. (2010). Impact assessment in SLCA: sorting the sLCIA methods according to their outcomes. *The International Journal of Life Cycle Assessment*, *15*(2), 164–171. https://doi.org/10.1007/s11367-009-0146-9

Pareto, V. (1972). Vilfredo Pareto, Manual of Political Economy. Trans. Ann S. Schwier, ed. Ann S. Schwier and Alfred N. Page. New York: Augustus M. Kelley, 1971, pp. xii, 504. *Canadian Journal of Political Science*, *5*(4), 599–600. https://doi.org/10.1017/s000842390003729x

Pizzol, M., Weidema, B. P., Brandão, M., & Osset, P. (2015). Monetary valuation in Life Cycle Assessment: a review. *Journal of Cleaner Production*, *86*, 170–179. https://doi.org/10.1016/j.jclepro.2014.08.007

Pollok, L., Spierling, S., Endres, H., & Grote, U. (2021a). Social Life Cycle Assessments: a review on past development, advances and methodological challenges. *Sustainability*, *13*(18), 10286. https://doi.org/10.3390/su131810286

Popović, T., & Kraslawski, A. (2015). Social Sustainability of Complex Systems. *Elsevier eBooks*, 605–614. https://doi.org/10.1016/b978-0-444-63472-6.00024-0

Popovic, T., Kraslawski, A., Heiduschke, R., & Repke, J. (2014). Indicators of social sustainability for wastewater treatment processes. In *Computer-aided chemical engineering* (pp. 723–728). https://doi.org/10.1016/b978-0-444-63433-7.50105-x

Programme, U. N. E., & Andrews, E. S. (2009). *Guidelines for Social Life Cycle Assessment of Products: Social and Socio-economic LCA Guidelines Complementing Environmental LCA and Life Cycle Costing, Contributing to the Full Assessment of Goods and Services Within the Context of Sustainable Development*. UNEP/Earthprint.

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

Rebitzer, G., Ekvall, T., Frischknecht, R., Hunkeler, D., Norris, G. A., Rydberg, T., Schmidt, W., Suh, S., Weidema, B. P., & Pennington, D. (2004). Life cycle assessment. *Environment International*, *30*(5), 701–720. https://doi.org/10.1016/j.envint.2003.11.005

Reitinger, C., Dumke, M., Barosevcic, M., & Hillerbrand, R. (2011). A conceptual framework for impact assessment within SLCA. *International Journal of Life Cycle Assessment*, *16*(4), 380–388. https://doi.org/10.1007/s11367-011-0265-y

Roundtable for Product Social Metrics. (2020). *The Handbook for Product Social Impact Assessment (PSIA)*.

Sala, S., Alessandro, V., Mancini, L., Dewulf, J., & Eckehard, R. (2015). Social Life Cycle Assessment: State of the art and challenges for supporting product policies. *Publications Office of the European Union*. https://doi.org/10.2788/53485

Sala, S., Farioli, F., & Zamagni, A. (2012). Life cycle sustainability assessment in the context

of sustainability science progress (part 2). *International Journal of Life Cycle*

Assessment, *18*(9), 1686–1697. https://doi.org/10.1007/s11367-012-0509-5

Sanyé-Mengual, E., & Sala, S. (2022). Life Cycle Assessment support to environmental

ambitions of EU policies and the Sustainable Development Goals. *Integrated*

Environmental Assessment and Management, *18*(5), 1221–1232.

https://doi.org/10.1002/ieam.4586

SASB. (n.d.). SASB. https://sasb.org/

Scapparone, P. (2017). *Manual of Political Economy*, A Critical and Variorum, edited by

Vilfredo Pareto. *European Journal of the History of Economic Thought*, *24*(2), 399–

402. https://doi.org/10.1080/09672567.2017.1285118

Schmidt, I., Meurer, M., Saling, P., Kicherer, A., W, R., & Gensch, C. (2004). SEEBalance.

Greener Management International, *2004*(45), 78–94.

https://doi.org/10.9774/gleaf.3062.2004.sp.00007

Seuring, S., Koplin, J., Behrens, T., & Schneidewind, U. (2003). Sustainability assessment in

the German detergent industry: from stakeholder involvement to sustainability

indicators. *Sustainable Development*, *11*(4), 199–212. https://doi.org/10.1002/sd.216

Smith, A., & Rogers, J. E. T. (1776). An Inquiry into the Nature and Causes of the Wealth of

Nations. In *Oxford University Press eBooks*.

https://doi.org/10.1093/oseo/instance.00043218

Smulders, S. (2012). An arrow in the Achilles' heel of sustainability and wealth accounting.

Environment and Development Economics, *17*(3), 368–372.

https://doi.org/10.1017/s1355770x12000174

S&P Global. (n.d.). *Sustainable1 Solutions: ESG Scores | S&P Global*.

https://www.spglobal.com/esg/solutions/data-intelligence-esg-scores

Sureau, S., Mazijn, B., Garrido, S. R., & Achten, W. (2017). Social life-cycle assessment

frameworks: a review of criteria and indicators proposed to assess social and

socioeconomic impacts. *International Journal of Life Cycle Assessment*, *23*(4), 904–920. https://doi.org/10.1007/s11367-017-1336-5

Sureau, S., Mazijn, B., Garrido, S. R., & Achten, W. (2018). Social life-cycle assessment frameworks: a review of criteria and indicators proposed to assess social and socioeconomic impacts. *International Journal of Life Cycle Assessment*, *23*(4), 904–920. https://doi.org/10.1007/s11367-017-1336-5

Sureau, S., Neugebauer, S., & Achten, W. (2020). Different paths in social life cycle impact assessment (S-LCIA)—a classification of type II impact pathway approaches. *International Journal of Life Cycle Assessment*, *25*(2), 382–393. https://doi.org/10.1007/s11367-019-01693-9

Swarr, T. E., Hunkeler, D., Klöpffer, W., Pesonen, H., Ciroth, A., Brent, A. C., & Pagan, R. J. (2011). Environmental life-cycle costing: a code of practice. *International Journal of Life Cycle Assessment*, *16*(5), 389–391. https://doi.org/10.1007/s11367-011-0287-5

True Price Foundation. (n.d.). We Create Standards for the Adoption of True Prices. Retrieved August 1, 2023, from https://www.truepricefoundation.org/

Umair, S., Björklund, A., & Petersen, E. E. (2015). Social impact assessment of informal recycling of electronic ICT waste in Pakistan using UNEP SETAC guidelines. *Resources Conservation and Recycling*, *95*, 46–57. https://doi.org/10.1016/j.resconrec.2014.11.008

UN. (n.d.). *THE 17 GOALS | Sustainable Development*. https://sdgs.un.org/goals

UN. (2023). *United Nations System Common Principles on Future Generations*. https://unsceb.org/sites/default/files/2023-05/Advance%20Unedited%20-%20United%20Nations%20System%20Common%20Principles%20on%20Future%20Generations.pdf

UN Women. (n.d.). Explainer: How gender inequality and climate change are interconnected | UN Women – Headquarters. UN Women – Headquarters. https://www.unwomen.org/en/news-stories/explainer/2022/02/explainer-how-gender-inequality-and-climate-change-are-interconnected

UN Global Compact. (n.d.). *Supply Chain Sustainability | UN Global Compact*. Retrieved

    August 1, 2023, from https://unglobalcompact.org/what-is-gc/our-work/supply-chain

UNEP. (2009). *Global Green New Deal Policy Brief*.

    https://wedocs.unep.org/bitstream/handle/20.500.11822/7903/A_Global_Green_New

    _Deal_Policy_Brief.pdf?sequence=3&amp%3BisAllowed=

UNEP. (2020). *Guidelines for Social Life Cycle Assessment of Products and Organisations

    2020*. https://wedocs.unep.org/20.500.11822/34554.

UNEP. (2021). *Methodological Sheets for Subcategories in Social Life Cycle Assessment

    (S-LCA) 2021*.

UNEP/SETAC Life Cycle Initiative. (2011). *Towards a Life Cycle Sustainability Assessment*.

    https://www.lifecycleinitiative.org/wp-content/uploads/2012/12/2011%20-

    %20Towards%20LCSA.pdf

United Nations Global Compact. (2019). *Making Global Goals Local Business*.

    https://d306pr3pise04h.cloudfront.net/docs/publications%2FMGGLB+Brochure+2019

    .pdf

Valdivia, S., Ugaya, C. M. L., Hildenbrand, J., Traverso, M., Mazijn, B., & Sonnemann, G.

    (2012). A UNEP/SETAC approach towards a life cycle sustainability assessment—

    our contribution to Rio+20. *International Journal of Life Cycle Assessment*, *18*(9),

    1673–1685. https://doi.org/10.1007/s11367-012-0529-1

Vanclay, F. (2003). International Principles For Social Impact Assessment. *Impact

    Assessment and Project Appraisal*, *21*(1), 5–12.

    https://doi.org/10.3152/147154603781766491

Varsei, M., Soosay, C., Fahimnia, B., & Sarkis, J. (2014). Framing sustainability performance

    of supply chains with multidimensional indicators. *Supply Chain Management*, *19*(3),

    242–257. https://doi.org/10.1108/scm-12-2013-0436

Vermeulen, W. J. (2013). Self-Governance for Sustainable Global Supply Chains: Can it

    Deliver the Impacts Needed? *Business Strategy and the Environment*, *24*(2), 73–85.

    https://doi.org/10.1002/bse.1804

Vermeulen, W. J. (2018). Substantiating the rough consensus on the concept of sustainable development as a point of departure for indicator development. In *Routledge eBooks* (pp. 59–92). https://doi.org/10.4324/9781315561103-4

Vermeulen, W. J., Croes, P. R., & Van Der Feen, L. (2023). Piloting Oiconomy Pricing: First experiences of producers applying full cost sustainability assessment of products. *Business Strategy and the Environment*. https://doi.org/10.1002/bse.3400

Vogtländer, J. G., Brezet, H., & Hendriks, C. F. (2001). The virtual eco-costs '99 A single LCA-based indicator for sustainability and the eco-costs-value ratio (EVR) model for economic allocation. *International Journal of Life Cycle Assessment*, *6*(3), 157–166. https://doi.org/10.1007/bf02978734

Walker, A. M., Opferkuch, K., Lindgreen, E. R., Simboli, A., Vermeulen, W. J., & Raggi, A. (2021). Assessing the social sustainability of circular economy practices: Industry perspectives from Italy and the Netherlands. *Sustainable Production and Consumption*, *27*, 831–844. https://doi.org/10.1016/j.spc.2021.01.030

Weidema, B. P. (2006). The integration of economic and social aspects in life cycle impact assessment. *International Journal of Life Cycle Assessment*, *11*(S1), 89–96. https://doi.org/10.1065/lca2006.04.016

Weidema, B. P. (2009). Guidelines for application of deepened and broadened LCA. *CALCAS*. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=8be59252f6790032 8a6360d506df522de78bbce4c

Weidema, B. P. (2014). Has ISO 14040/44 failed its role as a standard for life cycle assessment? *Journal of Industrial Ecology*, *18*(3), 324–326. https://doi.org/10.1111/jiec.12139

Whitehead, J. (2016). Prioritizing sustainability indicators: Using materiality analysis to guide sustainability assessment and strategy. *Business Strategy and the Environment*, *26*(3), 399–412. https://doi.org/10.1002/bse.1928

Wood, D. J. (1991). Corporate Social Performance Revisited. *The Academy of Management Review*, *16*, 691–718.

World Bank. (1997). *Expanding the measure of wealth: Indicators of Environmentally Sustainable Development*. World Bank Publications.

Wu, R., Yang, D., & Chen, J. (2014). Social life cycle assessment revisited. *Sustainability*, *6*(7), 4200–4226. https://doi.org/10.3390/su6074200

Wu, S. R., Chen, J., Apul, D., Fan, P., Yan, Y., Fan, Y., & Zhou, P. (2015). Causality in social life cycle impact assessment (SLCIA). *The International Journal of Life Cycle Assessment*, *20*(9), 1312–1323. https://doi.org/10.1007/s11367-015-0915-6

Wulf, C., Werker, J., Zapp, P., Schreiber, A., Schlör, H., & Kuckshinrichs, W. (2018). Sustainable Development Goals as a guideline for indicator selection in Life cycle Sustainability Assessment. *Procedia CIRP*, *69*, 59–65. https://doi.org/10.1016/j.procir.2017.11.144

Zamagni, A., Pesonen, H., & Swarr, T. E. (2013). From LCA to Life Cycle Sustainability Assessment: concept, practice, and future directions. *International Journal of Life Cycle Assessment*, *18*(9), 1637–1641. https://doi.org/10.1007/s11367-013-0648-3

Appendix- Interview Guide with Pilot Project Companies

- **Background**

    1. Please briefly introduce your job title and function.
    2. Please briefly elaborate on the supply chain management policy of your organization (how many tiers… etc.). What is your role in supply chain management at your organization?
    3. How do you integrate sustainability into your supply chain management practices?

- **Oiconomy pilot project**

    4. Why and how did your organization decide to participate in the Oiconomy project? What benefits or added values do you expect from the participation?
    5. How involved you are in the Oiconomy pilot project? (Purpose, process, assessment methods…etc.)
    6. Please elaborate on your general experience and impression of participating in the pilot project. What were the difficulties?
    7. How well/comprehensive do you think the Oiconomy is to evaluate the social performance of your companies and your suppliers? (Impact categories)
    8. Do you think the required data and indicators are suitable for assessing the social performance of your supply chain?

- **S-LCA criteria**

    9. In your opinion, do you think Oiconomy has considered covering every lifecycle stage of your product?
    10. How well do you think Oiconomy evaluates your stakeholders' objective data and collects their subjective opinions? Do you learn more about your impact on stakeholders or opinions after the assessment? (Stakeholder engagement).
    11. Is it easy for you to comprehend why Oiconomy assesses these social aspects? Does the assessment result could help you link actions to the SDGs or the sustainability strategies of your company? (Impact pathways)
    12. What are the major social issues in your industries or your supply chain that are not assessed? (Context-specific indicators)
    13. What are the other methods you can think of to assess social impact in your supply chain?
    14. Your general advice or recommendations for improving the Oiconomy methodology or the assessment process.