Chapter 16
Social Life Cycle Assessment: An Introduction

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Abstract An expansion of the LCA framework has been going on through the development of 'social life cycle assessment'—S-LCA. The methodology, still in its infancy, has the goal of assessing social impacts related to a product's life cycle. This chapter introduces S-LCA framework area and the related challenges. It outlines the main conceptual differences between LCA and S-LCA and discusses the barriers in terms of methodological development and potential application. Three case studies are presented applying S-LCA in different contexts and using varying methods. In the light of the outlined differences, perspectives for the future development of S-LCA are discussed.

Learning Objectives
After studying this chapter, the reader should be able to:

- Understand the methodological phases of S-LCA.
- Explain the main differences between LCA and S-LCA; the related challenges and implications.
- Explain how social impacts are often defined in the SLCA literature.
- Explain how social impacts depend on the conduct of the company rather than the nature of the process.
- Demonstrate an overview of S-LCA applications in different contexts and using different methods.
- Give examples where the use of SLCA for decision support may not benefit stakeholders in the product life cycle.
- Discuss the perspectives for the future development of S-LCA.

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16.1 Introduction

Since the 60s, there has been increasing awareness that constant growth in consumption and production within the limits of the finite planet is not viable for humans andecosystems. This realisation has led to a vision forsustainable development. The key term "sustainability" is defined in Chap. 5 as "the ability for meeting present human needs without compromising future generations" after the commonly referenced *Brundtland Report* from 1987 (WCED 1987). The chapter also discusses that the goal of sustainable development was one of the motivations behind the development of LCA, which aims to support environmental protection.

However, beyond the environmental concerns sustainability is also related to social aspects. The concerns on the social aspect of sustainability reflects in today'spolicy frameworks such as United Nations' Sustainable Development Goals, in various national and international initiatives focusing on sustainability of supply chains, and in standardisation frameworks of social nature such as the ISO 26000's Guidance on Social Responsibility (ISO 2010; UN 2010; UNDP 2015). In this context, to be able to give a more comprehensive assessment of a product's or system's contribution to sustainability, an expansion of the LCA framework to also include the impacts on social entities (e.g. workers, consumers, communities) has been going on since the early years of this millennium. This expansion of LCA is known as the 'social life cycle assessment'—S-LCA.

The ambition for S-LCA is to be a methodology, in other words a system of methods with corresponding procedural steps, which if followed will lead to an assessment of the social impacts of a product over its life cycle. The initial development of S-LCA was strongly influenced by LCA, with the scientific community assuming that S-LCA can assess social impacts in the same way that LCA can assess environmental ones. Its methodological phases are thus similar to the ones discussed in Chaps. 7–12:

- *Goal definition* addresses what is to be assessed and why the assessment is performed.
- *Scope definition* addresses the choices made in order to perform the assessment and the limitations of the assessment.
- *Inventory analysis* has the purpose of collecting the data outlined through the goal and scope definition.
- *Impact assessment* uses models to translate inventory data into impacts.
- *Interpretation* analyses the outcome of the previous phases in accordance with the goal of the study and tries to answer the question posed in the goal definition.

16.1.1 Status of S-LCA

As described in Chap. 5, (environmental) LCA has been standardised, e.g. in the ISO 14000 series standards and in theEuropean Commission'sILCD guideline (ISO 2006a, b; EC-JRC 2010), and is broadly acknowledged and applied in publicpolicymaking and private initiatives (see Part III of this book for examples of applications). In contrast, S-LCA is still in its infancy. The existing S-LCA literature thus presents a broad variety of approaches for the above methodological phases. Therefore, to characterise it as a consistent and consensual methodology will be misleading. Rather, one could probably speak of bits and pieces of methodological suggestions with the overall goal of assessingsocial impacts related to a product's life cycle.

To date the most important step towards thestandardisation of S-LCA has been the development of the "Guidelines to S-LCA" under the UNEP-SETACLife Cycle Initiative (Benoît and Mazijn 2009). This was the result of a consensus process involving researchers working on S-LCA, mainly fromEurope and North America. The process, which lasted several years, was the first step towards bridging the differences present in the S-LCA community at the time of publishing. Yet, since a limited amount of research had been published prior to the "Guidelines for S-LCA", this publication, rather than a definitive guide, can be considered as a first rough map, a skeleton for the future work on S-LCA. This was also emphasised by the main authors of the guidelines and has become evident in the later work on S-LCA where significant methodological problems have been revealed.

16.1.2 Focus of Chapter

The intention of this chapter is to give an introduction to the S-LCA area and the related challenges rather than to analyse its methodological aspects in detail or to give a stepwise description of how one *could* perform an S-LCA (for this we refer to the "Guidelines for S-LCA" which is more a "how to" guide).

We outline the main conceptual differences between LCA and S-LCA drawing on the background knowledge of the LCA framework that you will obtain by reading Chaps. 7–12. The chapter further discusses the barriers that these differences set in relation to using the methodological framework of LCA for assessing social impacts. By "barrier" is meant anything that could impede the *ease of use*, the *accuracy*, or the *meaningfulness* of the assessment. These observations are of key importance for the applicability and trustworthiness of S-LCA.

The chapter's structure follows the methodological phases outlined earlier in this section, however, as the interpretation of S-LCA does not differ from the LCA, this phase is not described. The methodological overview is followed by a summary, discussing the implications of the differences between S-LCA and LCA. After this, a short presentation of three case studies applying S-LCA in different contexts and

using varying methods is given to illustrate real applications of S-LCA. Finally, in the light of the outlined differences, perspectives for the future development of S-LCA are discussed.

16.2 Overview of S-LCA Methodology

16.2.1 Goal Definition

S-LCA assesses "social impacts" rather than environmental impacts as done in the LCA. But what is meant by "assessing social impacts"? There is a general consensus in the S-LCA community that the ultimate purpose of an S-LCA is to assess how human well-being is affected by products or systems throughout their life cycle (Weidema 2006; Dreyer et al. 2006; Jørgensen et al. 2010b). Using the LCA terms, well-being can thereby be considered as the Area of Protection in S-LCA, i.e. the concept that S-LCA is most fundamentally attempting to assess impacts on in order to ensuresustainability. This also implies that S-LCA should provide a methodology not only for identifying the social changes caused by a product or system but also for characterising them and evaluating them in relation to how they contribute to some overall human well-being.

S-LCA is to assess impacts on well-being, but well-being of whom? In principle, any affected human is considered a stakeholder in S-LCA, implying that if the well-being of a person is affected by some activity in the product life cycle, it should be included in the assessment. Prevailing stakeholder groups (see also Table 16.1) considered in S-LCA are the workers across the life cycle (who have gained the largest attention in S-LCA research); the local or regional communities affected by the product life cycle stages; and the product users (Jørgensen et al. 2008). Additionally, S-LCA may consider other stakeholders who can affect or can be affected by decisions taken across the product life cycle, e.g. shareholders, company owners and other decision-makers (Benoît and Mazijn 2009).

16.2.2 Scope Definition

Impact Categories in S-LCA

The goal of S-LCA is to assess impacts from the product life cycle on stakeholders' well-being. However, before assessing how it is *affected* we first need to define what well-being *is*. Despite being at the foundation of S-LCA, "well-being" has been discussed to a rather limited extent by the S-LCA community (Jørgensen et al. 2010b). The concept goes beyond physical health, i.e. psychological aspects play a central role in its essence. Furthermore, well-being in S-LCA is a concept commonly related to a personal (and thus subjective) experience. Thus, objectively

Table 16.1 An overview of social impacts included in S-LCA approaches

Worker related issues
Non-discrimination
Freedom of association and collective bargaining
Child labour, including hazardous child labour
Forced and compulsory labour
Level and regularity of wages and benefits
Physical working conditions
Psychological working conditions
Training and education of employees
Society-related issues
Corruption
Development support and investments in society
Local community acceptance of company
Company commitment to sustainability issues
Product user-related issues
Integration of costumer health and safety concerns in product
Availability of product information to product users
Ethical guidelines for advertisements of product

observable living conditions, such as income, physical health, housing, etc. are necessary but not sufficient to gauge well-being.

In S-LCA, well-being is mainly understood in a descriptive way, meaning that S-LCA methodology developers have attempted to identify those social themes that contribute to human well-being and hence form the basis for the definition of impact categories for S-LCA. Indicatively in the "Guidelines for S-LCA", there are more than 30 themes. Table 16.1 summarises some of these per stakeholder group:

The social themes in Table 16.1 have been identified following three different approaches of which the first has been the dominant one.

(i) *Normative compliance*: Most of the themes related to employees and workers have been based on international conventions relating to working conditions, namely conventions from the International Labour Organisation (ILO 2016). This is a UN organisation working to establish a set of universal worker rights. Although ILO conventions have been adopted by most countries, their enforcement is often weak. Other less authoritative standards such as the ones made by the Global Reporting Initiative (GRI 2016) have also been used to identify relevant social aspects for S-LCA.

Normative requirements are undoubtedly useful for monitoringsocial impacts. Nonetheless, they should be perceived as the outcome of long political negotiations and compromises to reach international consensus rather than as scientifically valid instruments for assessing human well-being. Therefore, while the limits they set can be a reference for S-LCA, they are not absolute standards aiming to safeguard well-being and their direct adoption in S-LCA can be problematic.

(ii) *Social theory interpretation*: A second approach, less commonly used in the S-LCA literature, is to use social theories about human well-being and from these derive the social themes relevant to include in S-LCA (Jørgensen et al. 2010b). Yet, it remains a challenge to establish theoretically valid and to some extent mechanistic causal pathways (as also known from the environmental impact assessment in LCA) between various events in the product life cycle and well-being. Figure 16.1 shows an example of an impact pathway for child labour.

(iii) *Co-creation*: A third approach, which is more discussed in literature than actually carried out (Dreyer et al. 2006; Kruse et al. 2009), is to identify the social impacts relevant to include in the S-LCA through participatory processes involving the stakeholders that are affected. The principle is that the affected stakeholders know what influences their well-being and how, and therefore they should be the ones to define what is relevant to assess.

Even though it might seem preferable to base S-LCA on a combination of the two latter approaches, these introduce several challenges. One is that if the social impacts that affect well-being vary according to the perception of stakeholders, then aggregating impacts across the life cycle stages (which is a fundamental principle within the life cycle methodologies) might be problematic as different stakeholders along the life cycle will often have different perceptions. Another problem is related to the identification of relevant social themes. The aspects considered in the ILO conventions or standards have been publicly accepted as relevant and important to consider. This is not necessarily the case for the aspects identified through theoretical analysis of "well-being" or aspects defined by stakeholders themselves.

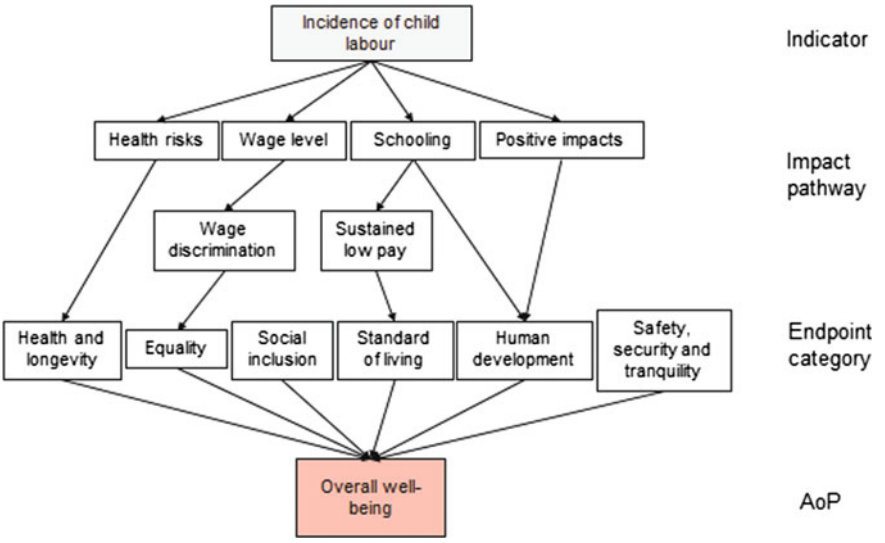

Fig. 16.1 Impact pathway for the impact category child labour (Jørgensen et al. 2010b)

These approaches may therefore be more difficult to relate to a decision-maker, let alone to be streamlined. As a compromise, it has been suggested to let the normatively based impact categories function as a core set of impact categories that should always be included in an S-LCA and then supplement by co-created impact categories according to the relevance in the specific study (Dreyer et al. 2006).

Setting the System Boundaries in S-LCA

System boundaries in S-LCA, like in LCA, define which parts of the life cycle and which processes belong to the analysed system, i.e. which processes are required for providing the function defined by the functional unit (see Sect. 8.4). A distinction is done here between attributional and consequential approaches (see Sect. 8.5). For attributional assessments, the system boundaries have not been discussed explicitly by the S-LCA community and most case studies to date use the same kind of system boundaries as an attributional LCA, i.e. following a general supply chain logic. However, in consequential assessments there is a difference between LCA and S-LCA. Consequential LCA modelling includes only the processes that change because of the decision assessed. This is based on the premise that it is from a change in these processes or product uses that environmental impacts arise. Therefore, if no process change occurs, no impact change occurs.

Social impacts on the other hand do not occur merely due to production processes or product uses. They occur in all of life's situations—also when not carrying out a process or using a product. Taking the example of a worker within production of footballs, he/she may experience impacts related to conducting the work (e.g. unsafe conditions). The worker also experiences other impacts that only partly (if at all) can be related to the work (e.g. access to education for the worker's children). This implies that when we are to assess the social impacts due to the change of a product or production process then we should account for both the direct and the indirect consequences, including those that would occur if the changes had not happened. In the example of the football worker, the social consequences of producing a number of footballs are that a number of labourers are needed, contributing to a certain employment rate in the community around the factory. A decision leading to a reduction of the production of footballs may lead to lowering the number of employed labourers. This means that less workers would be exposed to unsafe conditions, but on the other hand, more people would be unemployed. In other words, the change to be considered in a consequential S-LCA includes both the impacts associated with carrying out a process and those associated with not carrying it out in order to be able to judge the consequence of the change. Similar examples can be found for the product users (Jørgensen et al. 2010a). In a more schematic form, the life cycle stages in a consequential S-LCA include the following (Fig. 16.2):

This discussion about impacts of not producing may seem somewhat theoretical but consider the following real case: In 2006, the multinational footwear manufacturing company Nike discovered that one of their suppliers, Saga Sports in Pakistan, employed child labour. To avoid the risk of moral condemnation from their customers, Nike chose to cut their contract with the company. But since 70%

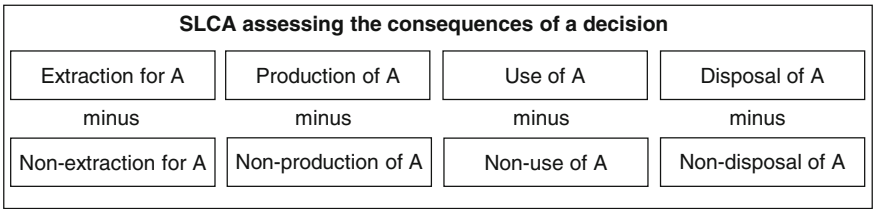

Fig. 16.2 The structure of an S-LCA for assessing the consequences of a decision to choose between product A and nothing reflecting that it must determine the difference between the induced activities and the status quo. In consequential (and attributional) LCA, all 'non' stages (representing the status quo) would normally be assumed to be zero

of Saga Sports' production went to Nike, many of the 4000 workers were fired, impacting not only the workers but also the local society, where an estimated 20,000 people depended on the income (Montero 2006). Assume now that an S-LCA was made to show the impacts related to producing a football at Saga Sports not including the impacts of not producing. The assessment would capture the impacts of child labour in the production, and show that if the balls were produced somewhere else where no children were employed, the child labour would (probably) be eliminated in the production, and all other being equal, this would create a socially better product. That would obviously not reflect the complete consequence of the situation outlined above where a large number of people were fired (and where the child workers may very well have entered into other forms of child labour, potentially under worse conditions). Given that the decision created negative social impacts in the local community, accounting for the impacts of not producing would give a more accurate picture. Including the impacts of both the production and the non-production/use/discarding is therefore essential in consequential S-LCA, and a distinct feature of S-LCA in comparison to LCA.

In Sect. 8.5.4 it was discussed whether LCA modelling should be based on a consequential or attributional approach depending on the decision context and the goal of the study (in accordance with the European Commission's LCA guidebook, theILCD handbook, EC-JRC 2010). Even though the international S-LCA community has not discussed the specifics of the modelling approach in detail, the same modelling principles as in LCA could be applied.

Identifying Causality Between Processes and Impact

The perhaps most important difference between S-LCA and LCA concerns the relationship between the product life cycle and the associated social or environmental impacts:

In LCA, generic life cycleunit process databases exist, that provide inventory data for various processes. A generic process accounts for certainelementary flows that lead to a certain assessment result. This result will be the same whenever the process is used. Although generic process data should only be used for the background processes (see the ILCD handbook and Sect. 9.3) they are generally considered representative of actual conditions with some accuracy. A good reason for

this is found in the physicochemical properties of materials, processes and related emissions. Consider, for example, the process of melting iron. Factory parameters may influence the efficiency of the process, but in all cases, a certain minimum amount of energy will be required due to the physical properties of iron. A generic process could account for an amount of energy based on average global conditions. As for the type of energy, it could be based on average energy mix. The existence of generic processes leads consequently, to a causal relationship between the nature or type of process and the assessed impacts.

However, assessing social impacts is different. Even though no empirical studies have been conducted on the topic, there is a general consensus that the degree of causality between the type of process and social impacts is much weaker and less consistent compared to environmental impacts. To exemplify, as discussed previously, one of the issues very often considered in S-LCA is violations of ILO established labour rights. This includes workers' rights to organise in labour unions and abolishment of forced labour (anti-slavery). Consider now again the example of iron melting: there seems to be no causality between the actual process and the right of workers to organise in unions. Iron may be melted by workers who have the right to be organised or by workers who are denied this right. Rather than being related to the type of the process, it is therefore often stated in S-LCA literature that social impacts are related to the conduct of the company—i.e. it is how the company is managed that determines the social impacts that it creates, rather than what it produces.

The example of iron production illustrates well how the type of the process causes specific elementary lows leading to environmental impacts, but at the same time tells very little about the social impacts it creates. Note that there are other cases where a generic causality between a process and its social impacts is easier to establish. Consider for example different types of work-related injuries, which is another often-included impact category in S-LCA. For this type of impacts, it seems reasonable to expect a higher number of cuts and bruises for a technician compared to an office worker. This means that different job functions tend to be differently correlated to various impacts. Furthermore, when a job function can be closely related to a process, it seems reasonable to make the connection between the social impact and the nature of the process. Had anyone made an empirical investigation of the matter, we assume that that the general findings could be represented as in Fig. 16.3. This point has enormous implications for S-LCA, and we will return to this issue several times throughout this chapter.

The Issue of Impact Allocation

S-LCA is, like LCA, focussed on assessing impacts related to a functional unit. In order to provide the functional unit, a number of processes need to be operated throughout the product life cycle. But if it is the company's conduct rather than the operation of the process that causes the impacts, how should one allocate the impacts to each of the processes that the company performs and through that consistently to the life cycle of the product and the functional unit orreference flow? Several different approaches have been presented in literature. A frequent

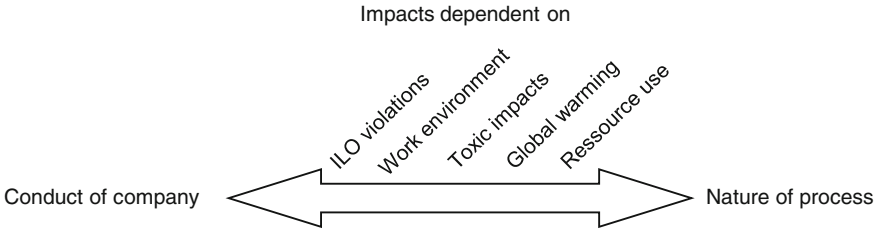

Fig. 16.3 The extent to which social and environmental impacts are controlled by the conduct of the company or the nature or type of process. In general, social can be considered much more dependent on the conduct of the company than environmental impacts

suggestion is to allocate social impacts of the company to the process, based on the working time required to perform it. Impact allocation can then be expressed by the following equation:

$$\text{Social impacts}_{\text{process}} = \text{Working time}_{\text{process}} / \text{Working time}_{\text{total in company}} \cdot \text{Social impacts}_{\text{total in company}} \tag{16.1}$$

Other allocation keys than working time are also suggested in literature. An example is to use value creation. In this case, the formula would be the same, except that "working time" would be substituted with "value creation". Although the goal of the study may indicate which approach is the right to use, it is in many cases up to the S-LCA practitioner to choose. This choice, if not arbitrary, will often depend on what information is available or on other motivations of the S-LCA practitioner. Consequently, two challenges arise. One, related to the freedom of choosing allocation key. This jeopardises the credibility of the method since the choice can heavily influence the S-LCA results. The second challenge is related to access to information. For a practitioner who is not deeply involved in the product life cycle (e.g. working in a lead company in thevalue chain) getting data on value creation and working time may be very difficult which may hinder the applicability or the ease of use of the assessment.

The goal of the assessment could specify what impacts to allocate to the process. Thus, here again, there is a difference between attributional and consequential approaches. If the goal of the study is to assess the consequences of a choice, calling for a consequential S-LCA then the allocation approach would be different than the one expressed in Eq. 16.1, since all social impacts that occur as a consequence of the decision should be included:

$$\begin{aligned}\text{Social impacts}_{\text{process}} = {} & \text{Social impacts}_{\text{total for world, process is performed}} \\ & - \text{Social impacts}_{\text{total for world, process is not performed}}\end{aligned} \tag{16.2}$$

In the football example in Sect. 16.2.2 above, we discussed that the assessment should include both the impacts that occur when the footballs are produced, and the impacts that occur when they are not. This means that identifying the consequence

of a decision will necessarily include an estimation of a counterfactual. Such an assessment will be quite difficult in most cases and though it is a central point of S-LCA, it is still unclear how it can be done in practice.

16.2.3 Inventory Analysis

In both LCA and S-LCA, an inventory of data is made. In LCA, these data aim to capture environmental exchanges. Physical flows such as mass and energy to and from the processes are included in the assessment (as discussed in Chap. 9). Depending on the accuracy of the measurement techniques, these can often be determined with a very high degree of certainty. For assessing social impacts, the same "mass and energy balance approach" cannot be applied. Instead, we have to specify some interplay between the process and its social surrounding on which data should be collected.

Table 16.1 presents impact categories which we could include in an S-LCA. Nevertheless, identifying data that are both available and can capture the impact we are trying to assess is not straightforward. For example, as shown in Table 16.1, almost all S-LCA approaches consider discrimination towards workers as a relevant impact to include in an S-LCA. However, what data should be collected to assess its occurrence? Some have suggested using the ratio between male and female workers. Although corresponding data could be easy to collect, this does not seem to be a very accurate indicator for company induced discrimination. The reasons for a lower representation of a gender, e.g. women in the company, may for example be that the company gets more male than female applicants, which will lead to more male employees all other things being equal. A more accurate indicator, but by no means bulletproof, may relate to, e.g. workers' direct experiences of being discriminated due to gender, race, religion, etc. However, getting data on the actual experience of the worker can be quite difficult and time-consuming.

This case exemplifies the dilemma between the ease of use of the indicator (relating to access to information), and its accuracy (relating to how well the indicator captures the phenomena we are trying to assess). An underlying debate relates to the essence of well-being and to the extent to which the concept can be meaningfully described objectively or subjectively. In Sect. 16.2.2 we discussed both approaches in terms of choosing the social issues to be included in "well-being". A similar discussion is relevant regarding the indicators that can represent these issues.

Objective indicators relate to living or working conditions that can be identified without consulting the stakeholder about his or her perceptions. However, research on well-being indicates that there is a rather poor correlation between subjective experience, and objective living conditions. One is not necessarily happy when he/she is rich, healthy, has many friends, etc. Thus, in order to get an accurate measure of how a product life cycle changes the well-being of the affected stakeholders, subjective indicators are also needed. A subjective indicator may be an

open question asked to the relevant person about, e.g. *how satisfied are you with X*. Existing S-LCA approaches have prioritised the development and application of objective indicators due to higher data availability and reproducibility at the expense of the limited accuracy in indicating actual changes in well-being.

Another methodological debate concerns whether one should use process—or result indicators, i.e. indicators that are related to the quality of a company's formal management system or to the company's measured social performance compared to the other companies in the product life cycle. The idea behind the first approach is that the occurrence of social impacts in a company will correlate with the initiatives in place to avoid them. For example, if a company has a strong system in place to ensure that discrimination in the hiring of employees is not occurring, then fewer cases of discrimination will occur. The second approach is about assessing the actual occurrence of social impacts based on reports or observations. The idea is simply that the reported incidences give an accurate picture of the impacts occurring.

Both approaches have pros and cons. The mere existence of a high-quality management system does not certify compliance and implementation in the everyday routines of the company. Likewise, a low reported or observed occurrence of impacts may be because the company (intentionally or unintentionally) or an external auditor does not report the incidences systematically. Which of the two approaches is most accurate, is difficult to tell. To date, the most common approach is to use performance indicators. For more information about the management indicators, the reader may refer to Dreyer et al. (2010).

The Data Collection Problem

While LCA may be performed at an acceptable level of accuracy using generic databases, the focus on company behaviour in S-LCA implies that site-specific data are indispensable. Specific information is needed not only for the company in question, but also for the context of national and regional regulatory frameworks, monitoring agencies, socio-economic conditions, etc. Obviously, this requirement for site-specific data imposes a tremendous burden in terms of costs and time spent. A second, but related, problem is the difficulty to identify the companies in the product chain and get relevant data. Often, only first-tier suppliers can be reached easily. Reasons for this may be that suppliers are unwilling to hand over information to the buyer about who their suppliers are in fear that the buyer would simply circumvent them. Another reason is that the goods might be bought on open markets with a large number of unidentified suppliers.

Three different approaches have been proposed to mitigate this data collection challenge:

One is to create databases of social impacts where one could find a specific company's performance. This would enable the S-LCA practitioner to circumvent the central problem of having to audit each implicated company. However, the strenuous task of company identification would still remain. Compiling such databases may seem very ambitious. Yet, the main challenge is not about collecting the data (many companies already undergo social audits which could potentially be

used as data source in an S-LCA), but rather about making these data publicly available.

A second approach is to base S-LCA on indicators that are more closely related to the nature of the process. An example may be to relate the local value creation from a company in a product's life cycle to the increase in average lifetime of the population where the value creation results in increased income (Norris 2006). Then value creation, which is a relatively process-related phenomenon, could be used as an indicator for impacts on average lifetime in the affected population. However, whether this, or other more process-related indicators, will actually be able to capture the breadth of social impacts and well-being is questionable.

A third and probably the most feasible approach is to make databases of social impacts related to sectors and countries. These could provide a basis for the assessment and the S-LCA practitioner would only need to know where the various stages in the life cycle take place. An example is the Social Hotspot Database (SHDB 2016) presenting social impacts in a number of categories per working hour in different sectors and geographic regions. However, given that in many cases there will be significant differences in the social impacts within one sector in a country, the S-LCA based on this approach is generic and its representativeness for a specific product will be highly uncertain. Companies in the product's life cycle would risk being assigned an outright invalid score and this lack of accuracy makes this approach less useful for S-LCAs of specific products.

16.2.4 Impact Assessment

The impact assessment of an S-LCA, similar to LCA, consists of the elements classification, characterisation, normalisation and weighting (see Sect. 8.2.5). Of these, only classification and characterisation will be addressed below. Even though literature on the area is scarce, normalisation and weighting are considered to be performed like in LCA.

Classification

According to ISO 14044 (2006) classification is the element of the impact assessment, in which the inventory flows are assigned to different impact categories. Classification in LCA is central because of the nature of the inventory analysis. To capture the exchanges between a process and the environment, data collection is based on inputs and outputs of energy and mass. The same approach is not feasible in S-LCA, since there is no way to capture the total exchanges between a process (or a company) and the social world. Therefore, the inventory analysis in an S-LCA is designed to measure certain aspects of interest such as the ones shown in Table 16.1. It is thus known beforehand why this type of data is collected, and to what they contribute. Classification is in this way built into the indicators in S-LCA.

Characterisation

In LCA, hundreds of elementary flows may be included in the inventory. For a decision-maker to be able to evaluate this information there is a need for translating these flows into a number of meaningful environmental impact scores. This translation is essential, to indicate the importance of the flows. For example, emissions of benzene need to be translated into some measure of toxicity, which can be compared to and summarised with impacts from other toxic emissions, to give results that are meaningful for decision-makers.

In S-LCA, the situation is somewhat different. Similar to LCA, there is a list of impact categories. However, the number of social indicators (which are the equivalent for the elementary flows in LCA) is much smaller. In some cases, there is a one-to-one relationship between number of indicators and impact categories, e.g. when accounting for work-related diseases, ILO violations or the like. In this case, there will be no need for characterisation, i.e. the indicator results are directly meaningful for the decision-maker. In other cases several indicators are established for each impact category, e.g. in order to describe "decent working conditions". In the latter case, there will be a need for translating the data on these indicators into impacts. An example of such a translation is given in Spillemaeckers et al. (2004). Their approach is to collect data on certain conditions A, B, C and D. Then a certain impact is said to occur depending on the number and the extent to which the conditions are met. Another example can be seen in Dreyer et al. (2010).

A separate discussion, similar as in LCA (see Sect. 10.2.3), is whether the assessment should be done at a midpoint level in theimpact pathway, or whether the characterisation should aim to go all the way to an endpoint. An example for midpoint assessment is to establish impact groups such as "violations of ILO conventions", "non-lethal working accidents", etc. Whenever an incidence within each group occurs, then a score is assigned, e.g. if workers are not allowed to organise in unions (which is a violation of an ILO convention) in the product life cycle the "violation of ILO convention" impact group gets a score of 1. If there is also child labour (which is also a violation of an ILO convention), the "violation of ILO conventions" impact group gets a score of 1 more. In this way, social impacts can be grouped and characterised. However, the question here is, whether this is meaningful. What is the value for the decision-maker given that all kinds of nuances are disregarded through a more or less random grouping and scoring?

Earlier in this chapter, we discussed that the ultimate goal of SLCA is to assess the changes in human well-being. Consequently, S-LCA researchers have suggested that the midpoint-oriented impact categories should be further related to the Area of Protection in S-LCA, i.e. human well-being. Along these lines, Weidema (2006) established quantitative severity scores for various social impacts, whereby very different social impacts could be compared and summarised. More concretely, he suggested translating all impacts into loss of QALYs (Quality adjusted life years), according to the equation:

$$\mathrm{QALY} = \mathrm{YLL} + \mathrm{k}^{*}\mathrm{YWL} \tag{16.3}$$

where YLL is years of life lost, YWL is years of well-being loss and k is a constant denoting the loss of life quality associated with the impact. When knowing what are the social impacts that affect life expectancy, how severe they are and their duration, the loss of QALYs can be calculated for each social impact. Then, impacts can simply be added to give a total score. The approach is similar to assessing DALYs in LCA (see Sect. 10.2.3). The advantage of a single score is that it supports an easy overview of the product performance. The weakness, however, is that one needs to assign severity scores to very different types of impacts, ranging from incidences of discrimination to cancer. This is a rather difficult and uncertain task, which might lack comprehensiveness and consistency.

16.3 Implications of the Problems Related to the S-LCA Methodology

As we have seen in this chapter, there are two main differences between LCA and S-LCA, which have a significant impact on the usability of S-LCA. The first relates to establishing a causality between processes and impacts. The environmental impacts depend on the nature of the process, whereas social impacts depend on multiple factors such as the conduct of the company and the culture in which it operates. This affects inventory analysis and data collection. In order to perform a reasonably accurate LCA we only need to know the types of the processes involved in the life cycle. However, this approach would drastically lower the accuracy of S-LCA, because of this low causal relationship between process and social impacts. Additional information about the company that operates the process is needed, which in most cases is going to be more difficult to get than simply getting an overview of the type of processes. The second difference is that when S-LCA is to be used for decision support, there is a need for assessing both the impacts of producing/using/discarding and of not producing/using/discarding the product. This adds complexity anduncertainty to data collection in comparison to LCA.

From an overall perspective, these differences indicate that the combined accuracy and ease of use of S-LCA is, and is likely to continue to be, poorer compared to LCA. Same accuracy would require detailed knowledge about the actual life cycle of the product and about the impacts of not producing. Same ease of use would require generic process data, which in most cases will give us assessments of very low accuracy. Existing initiatives, such as databases with social audit information about companies, partially address the issue. Yet, the challenge of identifying the companies that carry out each process, remain.

The third identified barrier is the meaningfulness of S-LCA results for providing decision support. For the case of LCA, *better decisions* are understood as decisions that lead to less environmental impacts. The LCA informs the decision-maker about

the environmental impacts related to the entire life cycle of, e.g. two products with comparable functional units. The decision-maker can hereby choose the product that is associated with lower environmental impacts. The LCA hereby has an environmental effect if used in decision support by eliminating the 'bad' environmental choices, assuming that the LCA is carried out correctly.

One may think that the same argument is valid when it comes to S-LCA, with the only difference that it should improve social impacts when used for decision support. However, this may not be the case. The effect of using S-LCA in decision support may in fact be outright negative as the following example shows.

Assume that an S-LCA of a product shows that the workers in the product life cycles experience very poor working conditions. The decision-maker may on this basis choose not to buy or use the product. But how will this decision improve the working conditions? One way may be that the company with the poor working conditions will go out of business. This will eliminate the poor working conditions for the worker but will increase unemployment. Going unemployed will rarely help the worker despite the poor working conditions—remember that the worker took the job in the first place and probably only had worse alternatives. Another scenario could be that instead of going out of business, the company will become aware that the social conditions of the working place are a market parameter (measured through S-LCA). This realisation may lead to improving the working conditions at the working place. However, research on the topic indicates that creating improvements, which are not only improvements on paper but real experienced improvements for the workers, is very difficult, and will often require a change in working culture, which is not likely to happen as a result of living up to the standards set by the S-LCA (Barrientos and Smith 2007; Bezuidenhout and Jeppesen 2011). Further detail about the effect of using S-LCA is explored in Jørgensen et al. (2012) and it is outside the scope of this chapter to go into all details of the argument. Yet these examples indicate that the same logic, which is valid for LCA, may not be directly transferable to the SLCA area when it comes to the effect of using SLCA and LCA for decision support.

Whether these issues will deem S-LCA unusable is impossible to say—it will depend on the needs of the user. It seems though they may well prevent S-LCA from gaining the popularity and widespread use that is seen for LCA. Limitations for its usability can be exemplified for two main areas where LCA is used for decision support:

(i) Prospective assessments: in this case, LCA aims to assess the *expected* environmental impacts from new innovations. This assessment is only possible because we assume a causal link between process and environmental impact. Future environmental impacts can be estimated based on reference products and technologies. Thus, if there is no (or only a very weak) link between process and impact, as is the case for social impacts, this prospective assessment will have no or only a very limited accuracy.
(ii) Assessment of product families: Following a parallel argument as used above, it is possible to make a generic LCA for, e.g. vacuum cleaners, as they more or

less all include the same components and consume comparable amounts of electricity throughout their use. Again, this is possible because of the link between environmental impacts and process. In S-LCA, where there is no or only a very weak link this will impede the possibility for reaching an assessment of a product family with a reasonable degree of accuracy.

16.4 S-LCA Case Studies

While the S-LCA methodology is still immature, experiences from its application in product case studies are important drivers for its future development. This section will present three cases to illustrate how main challenges are addressed in current research.

16.4.1 Laptop Computer

The first case study by Ciroth and Franze (2011) concerns a lightweight laptop (ASUSTeK UL50Ag notebook for office use) and assesses environmental and social impacts in parallel. Thus, the goal is not a comparison of products, but (1) identification of social and environmental hotspots, (2) recommendations on company andpolicy level and (3) application of the UNEP/SETAC Guidelines for S-LCA on a complex product. Specifically regarding (4), the effectiveness of the EU Ecolabel (the Flower) criteria is discussed. The case study is very comprehensive and detailed; however, the use (and re-use) stage is not considered. Note that for this stage most S-LCA studies only account for the aspects included in the stakeholder group "consumers".

The case study points to human well-being as the ultimate goal of LCA and notes the pervasive significance of computer use in modern life. Nonetheless, it stops at the UNEP/SETAC Guidelines for S-LCA, which relates to company behaviour and to general behaviour within the specific industrial sector. Thus, the indicators proposed are found "not applicable to use phases as there are no companies or industries involved". The study is concerned with midpoint categories only, as "the use of endpoint implies the aggregation of results, which in turn reduces transparency and increases uncertainty".

The study acknowledges that interviews with directly affectedstakeholders are to be preferred to other data collection methods. However, it mentions that, with a few exceptions, the time needed for local and site-specific data collection is prohibitive. Although the study suggests a participatory approach in defining impact categories and indicators, there is no reflection on the assessment's validity, in relation to cultural differences between nations and regions.

Allocation is not applied. Instead, "each company is considered as one unit no matter which different products the company produces and which of these products are relevant for the study". Thus, if an impact is occurring in a company in the life cycle, all the company's products will be associated with this impact to the same extent regardless of, e.g. the working time used for producing each product. Also, an equalweighting factor for the companies included in the life cycle is used, meaning that regardless that one company contributes far more than another in terms of, e.g. the total working time, to the final product, all companies will 'count' the same in the final assessment.

The computer case study represents a thorough effort to test the UNEP/SETAC Guidelines for S-LCA and does substantiate a range of methodological problems as well as overall issues of relevance and comprehensiveness. Most significantly, it demonstrates that the S-LCA findings and conclusion bring no new insights beyond those that could already be expected prior to the study. Considering the costs and time involved in an S-LCA study like this, the question about what the UNEP/SETAC Guidelines for S-LCA have to offer compared to more simple audit tools remains unanswered.

16.4.2 Cut Roses from Ecuador and the Netherlands

The second case study, by the same authors (Franze and Ciroth 2011), compares the production in Ecuador and the Netherlands of a bouquet of cut roses with 20 flowers per bouquet, packaged and transported to the flower auction in Aalsmeer, the Netherlands. The main objective is to "try out" the UNEP/SETAC Guidelines for S-LCA. The study conducts in parallel an LCA and an S-LCA of the production system. It does recognise that social impacts are inter-related and may include many indirect effects. Nonetheless, the discrete impact categories associated with each stakeholder group and the wide range of sub-categories are considered satisfactory. Problems with quality of data from various sources, considering the motivation, structure of companies, NGOs and government institutions, are mentioned.

Not surprisingly, the study concludes that social impacts in the Netherlands are mainly positive, while environmental impacts, in particular during winter, are rather negative. Thus, from an environmental point of view, importing roses from Ecuador is to be preferred over producing them in the Netherlands. Yet, from a social perspective, the Netherlands is preferred over the production in Ecuador. Regarding social conditions, the study outlines a general scenario for improvement, but such an intention is beyond the scope of the UNEP/SETAC Guidelines for S-LCA. For the social impact assessment, a simple colour coding is used for scoring, and noweighting is performed. The use stage is only marginally considered in terms of health and safety of consumers.

16.4.3 Greenhouse Tomatoes

The third case study by Andrews et al. (2009) departs from the calculation of quantitative impacts based on the UNEP/SETAC Guidelines for S-LCA and asks the question "What percentage of my supply chain has attribute X". The X may represent an existing CSR indicator, and the basis for calculating the percentage is the total working hours within the chain. The case study points to the potential of life cycle attribute assessment (LCAA) "to piggyback off other initiatives" (ISO 14001, GRISustainability Reporting, SA 8000, FSC, and the US Green Building Council's LEED programme).

However, depending on different stakeholder interests, working hours may be substituted, e.g. by "forested acres" to check on the percentage of FSC certified acres. The study selects eight indicators, one of which is "wage levels", and asks the question whether wage levels have properties as an indicator in S-LCA that equal energy consumption in LCA which in many studies serve as "an important indicator that is closely related with results across many impact categories". All indicators are selected at a midpoint, i.e. regarded as means to an end. The study recognises that data quality declines as Input–Output tables at sector level are used instead of more detailed process flows. Therefore, primary data were collected through company interviews. The fact that the tomato company in this case dominates its own supply chain and that no supplies are produced overseas limits the data quality problem. The study manages to pinpoint the percentage of compliance with CSR criteria and the spots where more CSR activity is needed.

The three case studies respond to the call of the UNEP/SETAC Guidelines for S-LCA, except for the third, which adopts the holistic perspective of life cycle assessment and then aligns with CSR criteria. These selected case studies and other contributions to the S-LCA literature suggest solutions for a range of unresolved issues. However, establishing a methodological consensus and a base for comparative studies is still needed. In conclusion, the studies exemplify that S-LCA is not yet a mature methodology. Findings are often predictable, and the additional value of an S-LCA is not evident in comparison to other approaches, particularly when considering the heavy data requirements.

16.5 Future Development

The major driver for the S-LCA development has been to create a social assessment method that "mimics" as closely as possible the principles of LCA with a view for a possible integration of the two and also acknowledging that a life cycle perspective is relevant for social impacts as it is for environmental impacts. This is supported by a concept of sustainability, according to which societies are operating within environmental limits. Having elaborated LCA to some level of consensus and maturity, it is now time to tackle the social dimension of sustainability.

A fundamental problem in the social version of theLCA framework is that central differences between the environmental and social issues may be overlooked. One reason may be that natural scientists venture beyond their scope in the effort to establish S-LCA as a clone of LCA. Considering the well-established LCA paradigm and institutionalised LCA research community the risk of disregarding social sciences altogether cannot be excluded.

Seen in this light, it seems that future development of S-LCA might follow two paths. One is to continue the current trend and fully exhaust the 'LCA cloning' approach, which will call for more research within areas such as indicator development, characterisation modelling in S-LCIA, establishing and validatingimpact pathways, aggregation procedures, normalisation references and valuation methods. Another path, however, would be to more fully acknowledge existing social science research, which would raise fundamental questions about the foundations of the methodology. It would for example lead to reviewing recent concepts of human well-being in order to inspire a redefinition of an integrated set of social impact categories.

Regardless of whether S-LCA will succeed in integrating important lessons from the social sciences, S-LCA cannot escape its purpose of being a methodology that is (1) life cycle oriented and (2) aiming for social assessment. This conjunction will inevitably lead to significant data requirements for which there is no miracle cure. Without a solution to this issue, S-LCA studies will probably continue to be limited to one or a few companies. This will raise the question: "what makes S-LCA worthwhile to develop and use considering that assessments of social impacts in companies have long been developed?"

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