Social Life Cycle Assessment – An introduction
By Andreas Jørgensen, Arne Wangel and Kossara Petrova Bozhilova-Kisheva

3.1 Introduction
Since the 1960'ies there has been an increasing awareness that our present consumption patterns are threatening the meeting of current and future human needs. The necessity in pointing out a more sustainable direction for future production and consumption is therefore evident, which was one of the motivations behind the development of LCA. However, sustainability of products is not only about the environment. Given that sustainability is the concern for meeting present and future human needs, products may over their life cycle affect the meeting of human needs by their interaction with humans or the man-made world in a number of different ways. To be able to give a more comprehensive assessment of the sustainability of products, an expansion of the LCA framework to also include these product impacts on people, known as social impacts, has been going on for the last 10 years. This expansion of LCA became known as the 'social life cycle assessment' – SLCA.

SLCA can be characterised as a methodology, or in other words some procedural steps, which if followed leads to an assessment of the social impacts of a product over its life cycle. As the SLCA is considered a kind of parallel methodology to the LCA, where the difference simply is that SLCA assesses social impacts rather than environmental impacts, the SLCA is considered to include more or less the same procedural steps as an LCA, including:

- A goal definition, which addresses what is to be assessed and why the assessment is performed.
- A scope definition, which addresses the choices made in order to perform the assessment and the limitations of the assessment.
- An inventory analysis which has the purpose to collect the data outlined through the goal and scope definition
- An impact assessment, where the inventory data is through models 'translated' into impacts.
- An interpretation, where the outcome of the previous phases is analysed in accordance with the goal definition of the study.

3.1.1 Status of SLCA
Contrary to LCA, which has been outlined in ISO standards (ISO 2006) and lately in the European Commision's LCA guideline (EC-JRC 2010), SLCA is a much less mature methodology. In the literature on SLCA there is therefore a broad variety of approaches to many of the above methodological steps, which will be visible in the following discussions. To speak of it as 'the SLCA' is therefore somewhat misguided. Rather, one could probably speak of bits and pieces of

methodological suggestions with the overall goal of assessing social impacts related to product life cycles. As an important step towards a standardization of SLCA, the 'Guidelines to SLCA' (Benoit & Mazijn 2009) should be mentioned. It was the result of a consensus process lasting several years among several researchers working on SLCA, mainly from Europe and North America, and as such presented at least the first steps towards reaching agreement across the significant differences present in the SLCA community at the time of publishing. However, because of the limited amount of research which had been published before the 'Guidelines for SLCA', it should more be seen as a first rough map, a 'skeleton' for the future work on SLCA, and not as the definitive guide, as was also mentioned by the main authors of the 'Guidelines for SLCA'. In later work on SLCA, this has especially become evident as significant problems for the methodology have been revealed, as will be discussed in the following chapter. The 'Guidelines for SLCA' will to some extent give a more stepwise description of how one *could* perform an SLCA, and in that sense it is more of a 'how-to' guide than this chapter will be.

3.1.2 Focus of chapter

This chapter will to a much larger extent than the 'Guidelines to SLCA' (Benoit & Mazijn 2009) discuss the differences between LCA and SLCA and the problems and possibilities that these differences lead to, as indicated above. Furthermore, much of this book has been dedicated to describe how to comply with these steps in the LCA, and we could probably fill another if we were to describe the same steps for SLCA. However as many of the procedures and the considerations to take will be the same for the SLCA and the LCA, and since the focus of this book is chiefly on LCA, this chapter should be seen as an introduction to the area. We will therefore only focus on the main differences between SLCA and LCA, and outline the problems or possibilities that these differences lead to.

But what is a problem in the LCA or SLCA methodologies? A problem is here understood as something that impedes either the ease of use or the accuracy of the assessment. The ease of use and the accuracy of the assessment can be considered of key importance in any assessment methodology because if it cannot be used or if it does not assess very accurately what it is meant to as assess, the methodology makes little sense.

The structure of the chapter will follow the structure of the SLCA methodology, as outlined above, however, as the interpretation step of the SLCA do not differ from the LCA, this step has been omitted from the following discussions.
The methodology overview presented in the first sections of this chapter will be followed by a summary discussing the implications of the found differences between SLCA and LCA. After this, a short presentation of three case studies applying SLCA in different contexts and using varying methodology will be presented to illustrate real applications of the SLCA. Finally, we will discuss whether SLCA, in the light of the outlined differences, can be compared to the early days of LCA or whether the development of SLCA can be expected to be something entirely different.

As we will centre this chapter on the main differences between LCA and SLCA, the chapter will not include much text explaining various LCA concepts. The chapter thus assumes good background knowledge on LCA.

3.2 Overview of SLCA methodology

3.2.1 Goal definition

As was noted above, SLCA assesses 'social impacts' rather than environmental impacts as done in the LCA. But what do we understand by the term social impacts? There is a general consensus in the SLCA community that social impacts can be understood as events that can lead to changes in human wellbeing (Weidema 2006, Dreyer et al. 2006, Jørgensen et al. 2009). This implies that what SLCA is basically to assess is events that change human wellbeing. How wellbeing is to be understood in more detail in SLCA, has only to a rather limited extent been discussed (Jørgensen et al. 2009). It is clear that the understanding of wellbeing in SLCA should not only be understood in terms of physical health. Psychological wellbeing is considered absolutely central as well. Furthermore, wellbeing is in SLCA in most cases seen as a concept that relates to a personal experience of being well. This may seem obvious, but in some research areas, wellbeing is seen as a concept that only relates to objectively observable living conditions, such as income, physical health, housing, etc.

Using the LCA terms, wellbeing can thereby be seen as the Area of Protection in SLCA, i.e. the concept that the SLCA is most fundamentally attempting to assess impacts on.

SLCA is thus to assess social impacts, understood as impacts on well-being. But wellbeing of who? In principle, any affected human is considered a stakeholder in SLCA, implying that if a person is affected on his or her wellbeing by the product life cycle, it should be included in the assessment. Most often these stakeholders are considered to be; the workers in the life cycle, who have gained by for the largest attention in SLCA research; the local (or regional) community around the product life cycle stages; and the product user (Jørgensen et al. 2008). Beside of these shareholders and company owners of the companies included in the product life cycle which are affected by product decisions are other stakeholders which may also be considered in SLCA (Benoit & Mazijn 2009).

3.2.2 Scope definition

3.2.2.1 Impact categories in SLCA

As already stated above, the goal of SLCA is to assess impacts from the product life cycle on affected stakeholders' wellbeing. However, since it is not directly assessable what impacts a product life cycle may have on human wellbeing, we need to spell out in more concrete terms what impacts on wellbeing may be. The list below is a summary of the social impacts the different SLCA approaches have considered relevant to include:

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

Table 1: An overview of social impacts included in SLCA approaches.

The list of social impacts to include in SLCA approaches have been identified following three different approaches, of which the first has by far been the most important for this identification. In most cases the choice of impacts to include in SLCA have been based on the international conventions relating to working conditions, namely conventions from the International Labour Organisation (ILO 2012), which is a UN organization working to establish a set of universal worker rights. ILO conventions are signed by most countries, but enforcement of the conventions is in many cases weak. Other less authoritative standards have also been used to identify which impacts should be considered in the SLCA, such as standards made by the Global Reporting Initiative (GRI 2012).

While it in many ways make sense to use these agreed upon conventions and standards as a basis for SLCA, the impacts covered by the conventions and standards are not necessarily made to address impacts on wellbeing, as SLCA is meant to assess. Rather, conventions like the ILO conventions are made through long political negotiations and should be seen compromises on what could internationally be agreed upon rather than as scientific instruments to assess impacts on human wellbeing. As SLCA is intended to be a methodology to assess impacts on wellbeing, it therefore in some cases seems problematic to adopt these conventions and standards directly.

Another approach, which is less commonly addressed in the SLCA literature, is therefore to use theories about human wellbeing and from these theories derive the social impacts relevant to include in the SLCA (Jørgensen et al. 2009). However, it should be noted that establishing these theoretically valid and to some extent mechanistic causal pathways between wellbeing and various event in the product life cycle may be difficult to establish in practice.

A final 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 included in the SLCA through participatory processes including the stakeholders affected. The idea is in other words that it is the affected stakeholders who know what affects their wellbeing and therefore that they should be the ones to define what is relevant to assess.

Even though it may seem preferable to base the SLCA on a combination of the two latter approaches, they also face several problems: One is that if what social impacts affect wellbeing varies according to the stakeholder, then different social impacts will have to be considered in different parts of the life cycle. This conflicts with a fundamental idea within the life cycle methodologies that we should be able to summarise impacts across life cycle stages, which will be significantly hampered if the impacts vary.

Another problem with the latter two approaches is that whereas the importance of the issues considered in the ILO conventions or standards have been publicly accepted as important issues to consider, this is not necessarily the case with impacts identified through theoretical analysis of the wellbeing concept or impacts defined by stakeholders themselves. The impacts defined through these approaches may therefore be more difficult to relate to as a decision maker.

3.2.2.2 Setting of system boundaries in SLCA

System boundaries in LCA, as well as SLCA, define which parts of the life cycle and which processes belong to the analysed system, i.e. which processes are required for providing its function as defined by its functional unit. Setting the system boundaries in SLCA will include many of the same considerations as when setting system boundaries in LCA, however, an important difference relate to the setting of system boundaries in consequential SLCA.

In LCA as well as SLCA, attributional modelling of the product life cycle is modelled following a general supply-chain logic (plus use and end-of-life treatment in case of a product, if these are to be included according to the goal of the study).

In consequential modelling, in contrast, all process that change as a consequence of the decision assessed in the LCA. The reason for identifying all the processes that change in consequential LCA is based on the understanding that it is from the processes or product uses that environmental impacts arise. The idea in consequential LCA is thus that it is where the processes are being carried out, impacts occur, and if no processes are being carried out, no impacts occur.

Social impacts on the other hand not only happen through production processes or product uses. They occur in all of life's situations – also when not carrying out a process or using a product. To

take an example, the worker carrying out the production processes may experience impacts both through work, but also non-work experiences will be related to impacts. This implies that when we are to assess the changes that a process or a product use creates in the lives of e.g. the worker, we should not only look at the impacts created by the production process on the worker, we should also look at the impacts avoided in the lives that would have been lived, had it not been for the changes in processes or product use. In other words, the changes to be considered in a consequential SLCA is therefore the impacts associated with the carrying of the process or using the product vs. the impacts of doing something else when not being engaged with carrying out of the process or using the product. For example, the social consequences of producing, say a football, may be that more labourers are needed to stitch these footballs, leading to a lowering of unemployment in the community around the football factory. A decision leading to a lowering of the demand of footballs and thereby a lowering of the production of footballs, may on the other hand lead to a lowering of the number of labourers employed in the production, hence potentially increasing unemplyment. The social impacts on the worker as a consequence of a decision to buy a football, are therefore not only the social impacts from its production, it is the social impacts created in its production and the social impacts that are avoided when not producing. The above example related to the workers in the life cycle, and same argument could be made for the product users (Jørgensen et al. 2010).

In a more schematic form, the life cycle stages in a consequential SLCA therefore include the following:
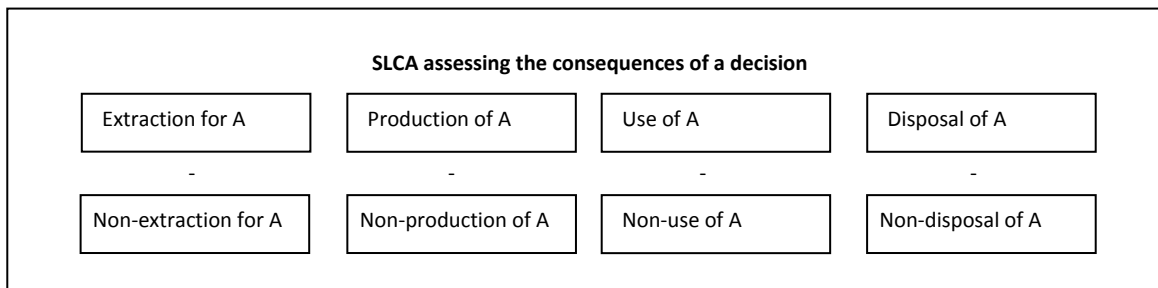

Figure 1: The structure of a SLCA for assessing the consequences of a decision to choose between product A and nothing. In consequential (and attributional) LCA all 'non' stages would normally be assumed to be zero.

This discussion about impacts of not producing may seem somewhat theoretical. But this is far from the case. Consider following real example: In 2006 Nike discovered that one of their suppliers, Saga Sports in Pakistan, employed child labour. In fear of moral condemnation from their customers, Nike chose to cut their contract with the company. But since 70 percent of Saga Sports' production went to Nike, many of the 4000 workers were dismissed, impacting not only the workers but also the local society, where an estimated 20,000 people depended on the income (CSR monitor 2006). Assume now that a SLCA 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 we produced the balls 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.

But that is obviously not the complete consequences of the situation outlined above where a large amount of people were being laid off because of the decision creating all kinds of negative social impacts in the local community. Including the impacts of not producing would give a more accurate picture of these consequences.

In the SLCA community, the attributional system boundaries have not been discussed explicitly, but most case studies to date use the same kind of system boundaries as attributional LCA, i.e. following a general supply-chain logic. If we take these studies to exemplify an attributional SLCA, then a very important difference between the LCA and the SLCA is that whereas the attributional and consequential LCA in many cases may be relatively similar, this will almost never be the case in SLCA. The impacts of not producing may easily be as important as the impacts of producing, as in the Nike case above, and any assessment addressing only the impacts of producing and not of not producing/using/discarding will leave out half the picture. Including both sides, the impacts of both the production and the 'non-production/use/discarding' is therefore essential in consequential SLCA, and a distinct feature of SLCA in comparison to LCA.

Whether to use an attributional or consequential SLCA will depend on the goal of the study, as is the case for LCA. As is stated in the European Commission's LCA guidebook, the ILCD handbook (EC-JRC 2010), whenever LCA is to be used for decision support, a consequential approach should be applied. Even though this has not been discussed in the international SLCA community, we do not see any reasons why the same argument should his should not be the same for SLCA, implying that a consequential SLCA approach should be used, whenever the SLCA is to be used for decision support.

3.2.2.3 The product relation problem
The probably most important difference between the assessment of social impacts in SLCA and the assessment of environmental impacts in LCA relates to the relationship between the product life cycle and the social or environmental impacts:
In LCA we are used to that inventory data for various processes can be found in databases. There is by other words the understanding that the environmental flows to and from a process (inventory data) will be comparable in all cases where this process is performed. It is mentioned in the ILCD handbook (EC-JRC 2010) that this standard, or generic, process data should only be used only for the less important processes in the LCA, whereas actual data for the specific processes in question should be used for the more important ones. This of course implies that there is an understanding that specific process data addressing the actual conditions where a process is carried out is more accurate than the generic data addressing average process conditions, but still

the generic data is considered to reflect actual conditions with some accuracy. There is by other words an understanding that there is a relatively strong causal relationship between the nature or type of process and the environmental flows that this process leads to. And there are many good reasons for this: Consider, for example, the process of melting iron. In such a case a certain minimum amount of energy will be required due to the physical characteristics of iron. Obviously, factory parameters may influence the efficiency of the process, but regardless of how we look at it some input of energy is going to be needed. The process of melting iron will therefore always lead to consumption of energy. There is in this case a strong causal connection between the type of process and inventory data.

Assessing social impacts are different. Even though no empirical studies have been conducted on the topic, there is a general consensus that the degree of causality between social impacts and type of process is much weaker than it is for environmental impacts. Following example will probably make it clear why: One of the issues very often considered in SLCA is violations of ILO established labour rights, as discussed in section 3.2.2.1. This includes, for example, workers rights to organise in labour unions and abolishment of forced labour (anti-slavery). Consider now the example from before – the melting of iron: In this case there seems to be no causation at all between the melting of iron and e.g. whether or not workers have the right to organise in unions. Iron may be melted by workers who have the right to be organised and by those who do not. Rather than being related to the type of the process, it is therefore often stated in the SLCA literature that social impacts are related to the conduct of the company – i.e. it is how the company is managed that decides the social impacts that it creates, and not what it produces. Environmental impacts, on the other hand will in many cases be highly dependent on the type of process, but will not be less affected by the conduct of the company.

In the text above, we have chosen to use the iron example, because we find that it illustrates very well how the type of the process causes specific environmental flows leading to environmental impacts, but at the same time tells us very little about the social impacts that it creates. Many other examples could have been chosen where the case would have been less obvious. Consider for example different types of work related injuries, which is again an often included impact category in SLCA (see section 3.2.2.1). In this case, it seems reasonable to expect a higher number of cuts and bruises for a mechanic than for an office worker. The job function of a mechanic or an office worker will by other words presumably tend to be correlated to these types of impacts in certain ways. Furthermore, since job function is closely related to process, it therefore seems reasonable to make the connection between work related injuries and process. Had anyone made an empirical investigation of the matter, we assume that that the general findings would be something like this:
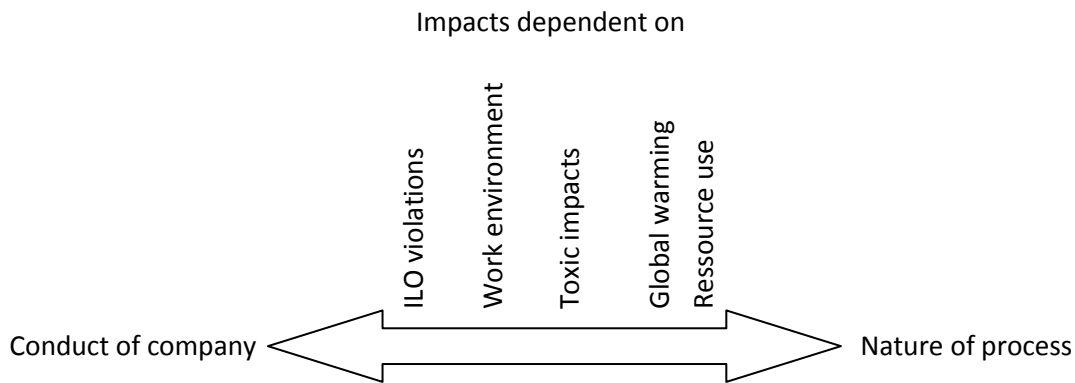
Impacts dependent on

ILO violations   Work environment   Toxic impacts   Global warming   Ressource use

Conduct of company ⟵⟶ Nature of process

Figure 2: *The extent to which various social or environmental impacts are controlled by the conduct of the company or the nature or type of process. In general, social impacts are considered to be much more dependent on the conduct of the company than environmental impacts.*

This point has enormous implications for SLCA, and we will return to this issue several times throughout this chapter.

In the current discussion, the lack of correlation between nature of the process and social impacts gives the following problem: The SLCA is, like the LCA, focussed on assessing impacts related to a functional unit. In order to provide the functional unit a number of processes are identified throughout the product life cycle, and the assessment is basically a summation of the impacts that are related to each of these processes. This identification of which impacts that comes from which process is relatively easy to identify when it comes to environmental impacts (e.g. melting this much iron takes this much energy, which should then be included in the assessment), but when it comes to the social impacts this is much more difficult. As just outlined above, it is in most cases not the process in itself that determines the social impacts that occur in the product life cycle – it is the conduct of the company. But if it is the company that 'cause' the impacts to occur, what number of impacts should then be allocated to each of the processes that the company performs? Several different approaches to this have been presented in literature. A very common approach is to allocate social impacts to the process based on the working time to perform the process. Following this approach the social impacts to be allocated to the process can be expressed by following formula:

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

Many other 'allocation keys' than working time could be imagined. An example also mentioned in literature is to use value creation as a basis for allocation. In this case the formula would be the same, except that 'working time' should be substituted with 'value creation'. In some cases, the goal of the study may indicate which approach is right to use, as we will discuss below, but in many cases it will be up to the SLCA assessor to choose. In most cases, therefore, the choice will depend on what information is available. For an assessor who is not deeply involved in the product

life cycle (e.g. working in a lead firm in the value chain) getting information about issues like value creation and working time may be very difficult. Taken together this implies that this allocation of social impacts both creates a problem related to the ease of use of the assessment, but it also creates a level of arbitrariness in the SLCA result: The choice of 'allocation key' will heavily influence the result of the study, but which will be chosen will often depend on what is available or other motivations of the SLCA assessor.

However, in some cases, the goal of the assessment will specify what impacts to allocate to the process. This may be the case if the goal of the study is to assess the consequences of a choice, calling for a consequential SLCA. In this case the approach would be different than expressed in the above formula. In this case, all social impacts that occur as a consequence of the decision should be included. As in the football example in section 3.2.2.2, we saw that this is a product of both the impacts that happen when we produce the footballs, as well as the impacts that happen if we don't. As can be seen from this example, identifying the consequence of a decision will necessarily include an estimation of a counterfactual, as we cannot both produce and not produce the football. Put into a formula this would look something like this:

$$\text{Social impacts}_{process} = \text{Social impacts}_{\text{total for world, process is performed}} - \text{Social impacts}_{\text{total for world, process is not performed}}$$

Quite clearly, making this assessment will be quite difficult in most cases, and we have yet to see how this would be done in practice.

3.2.3 Inventory analysis

In both the LCA and the SLCA an inventory of data is made. In LCA, this data is the mass and energy flows to and from the processes included in the assessment, which due to the accuracy of the measurement apparatuses often can be determined with a very high degree of certainty. But when it comes to creating an inventory of data for the assessment of social impacts, the same 'mass and energy balance approach' will not apply. There is no simple way in which we can get the 'total social exchanges' with the surroundings as we can when we are dealing with environmental exchanges. Instead we have to specify some interplay between the process and its surrounding on which data should be collected. In the section above we saw an outline of the impact categories which we would like to include in a SLCA, but despite of their definition it is in many cases not straightforward to identify the data to collect which can both capture the impact we are trying to assess and for which data can be found. For example, as can be seen in table 1, almost all SLCA approaches consider discrimination towards workers as being relevant to include in an SLCA. But what data should be collected to assess the occurrence of this impact? Some have suggested to use the ratio between male and female workers. This could probably in many cases be a relatively easy ratio to get data on, but it will probably not be a very accurate indicator for whether discrimination is occurring in a company. The reasons for a lower representation of e.g. women in the company may for example be because the company gets more male than female applicants, which will lead to more male employees all other things being equal. A more accurate indicator,

however 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 will probably in most cases be quite difficult. As was exemplified in this case we will often when assessing social impacts be caught in a dilemma between the ease of use of the indicator, relating to the ease with which we can find the necessary information, on the one hand, and the accuracy of the indicator, relating to how well the indicator captures the phenomena we are trying to assess, on the other.

A more general example of this problem lies in the discussion about subjective and objective indicators in SLCA: As was discussed above, the fundamental goal of SLCA is to assess changes in wellbeing, which in SLCA in general is understood as a concept that relates to an experience of being well. Research on wellbeing indicates that there in many cases is a rather poor correlation between the subjective experience of being well, and the objective living conditions, i.e. one is not necessarily happy because one is rich, is healthy, has many friends, etc. This indicates that in order to get an accurate measure of how a product life cycle affects the wellbeing of its stakeholders, subjective indicators are needed. An example of a subjective indicator may be a question asked to the relevant person about e.g. *how satisfied are you with X.* Objective indicators on the other hand relate to living or working conditions which can be identified objectively, i.e. without consulting the stakeholder about his or her feelings about it. As can easily be imagined, this creates the dilemma as indicated above, about whether to prioritise objective indicators, which can be based on more available data, but at the same time are less accurate, or whether to use subjective indicators, which are better at accurately assessing what we intend to assess in SLCA, but where the data may be very demanding to get. In existing SLCA approaches the choice has been to develop and apply objective indicators, which implies that there will most likely be a significant problem with accuracy of the actual indicators included in SLCA in relation to their ability to indicate changes in wellbeing.

Another indicator choice which has been discussed within SLCA is whether to use indicators relating to the quality of a company's management system or to its performance in relation to assessing social impacts from companies in the product life cycle. The idea behind the indicators relating to the quality of the management system 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, the idea is that fewer cases of discrimination will occur. In the other approach, assessing the occurrence of social impacts based on reports or observations, the idea is simply that the reported incidences will give an accurate picture of the incidences actually occurring. Pros and cons can be mentioned for both approaches. It is obvious that just because a high quality management system is in place, does not necessarily indicate that this is actually followed in the everyday routines of the company. Likewise, a low reported or observed occurrences of impacts may simply be due to the fact that the company or an external auditor do not report systematically about incidences,

and that the reported number therefore only illustrates a small part of the actual incidences. Which of the two approaches are most accurate, therefore is difficult to tell, however, it seems reasonable to expect that in relation to some impacts, e.g. child labour, which will probably never be reported by the company themselves, and which may be difficult to spot by an auditor, relying on reporting may not give a very accurate measure.

The most common in SLCA approaches is to use performance indicators. For more information about the management indicators, the reader may refer to Dreyer et al. (2010).

3.2.3.1 The data problem

While environmental LCA in many cases may be performed at an acceptable level of accuracy using generic databases, the focus on company behaviour in SLCA implies that site-specific data are indispensable. Not only are data needed for the company in question, also specific information within the context of national and regional regulatory frameworks, monitoring agencies, and socio-economic conditions etc. Obviously, this requirement imposes a tremendous burden in terms of costs and time consumption when collecting site-specific data.

A second major problem is the identification of companies in the product chain. Often, only first-tier suppliers can be reached easily. Reasons for this may be the that suppliers are unwilling to hand over information to the buyer about who their suppliers are in fear of that the buyer would simply circumvent the supplier, or because the goods were bought on open markets furnished by a large number of unidentified suppliers.

To cope with the data problem challenge, three different attempts to mitigate the problem have been proposed:

One approach is to create databases of the conduct of specific companies with regards to their social impacts. If this database was very extensive it would enable the SLCA user to circumvent the central problem of actually having to audit the implicated company. However, the SLCA user would still have to identify the actual company, which in itself may be a significant task. This may seem a very ambitious way of handling the problem, but it should be noted that many companies already undergo social audits which could potentially be used in a SLCA, but the data from these audits is not publicly available.

Another approach could be to base the SLCA on indicators that are more closely related to the nature of the process than the indicators used today. An example may be the attempt to relate value creation from product life cycles to increases in average lifetime (Norris 2006, Feschet et al. 2012). Having established such a correlation value creation in one country, which is a relatively process related phenomenon, may be used as an indicator for impacts on average lifetime. However, whether this or other more process related indicators will actually be able to capture the breadth of what are considered as social impacts is questionable.

A final and probably most feasible solution could also be to make databases of social impacts related to sectors and countries. Hereby, if a SLCA user knows where the various stages in the life

cycle is taking place, the user may use this as a basis for the SLCA. Such solutions are already becoming available, for example through the Social Hotspot Database (SHDB 2012). However, given that there in many cases will be significant differences within one sector in a country, the SLCA based on this approach will easily become highly uncertain, in fact companies risk being assigned an outright invalid score, and this approach will therefore probably not be usable for all purposes.

3.2.4 Impact assessment

In environmental LCA impact assessment consists of classification, characterization, normalization and weighting. Of these, only the classification and characterization step will be addressed below, as even though literature on the area is scarce, normalisation and weighting are considered to be performed like in LCA.

3.2.4.1 Classification

According to ISO 14044 (2006) classification is the stage of impact assessment, at which the inventory results are assigned to a specific impact category. Classification in LCA is central because of the nature of the inventory analysis: The approach to collect data in LCA is basically to weigh the mass of all inputs and outputs. In this way, the inventory analysis in the LCA captures the total exchanges between process and the environment. But as noted in section 3.2.3, the same approach is not feasible in SLCA: There is simply no way that the total 'exchange' between process and the social world can be captured. As the inventory analysis in an SLCA cannot measure 'all exchanges' it is designed to measure certain aspects of interest – which are of interest because they are known to contribute to or cause a certain social impact. It is by other words known on beforehand why the data that is collected in the SLCA is collected, and what it contributed to. As this is the case there is therefore no need for classifying the data after its collection as there is in LCA – the 'classification' is, so to speak, build into the indicators in SLCA.

3.2.4.2 Characterization

In LCA several hundreds of flows may be included in the inventory result. For a decision maker to be able to overview this information, there will often be a need for 'condensing' the inventory result into fewer categories. As an integrated part of this 'condensation' is the 'translation' of these many hundred flows into a relatively small number of meaningful environmental impacts. This translation is essential, for without it, a decision maker may have no idea of what is important and what is not. For example, emissions of benzene needs to be translated into some measure of toxicity which can be compared to and summarized with other toxic emissions, for it to be meaningful for many decision makers.

In SLCA, the situation is somewhat different. Even though the list of impact categories may be relatively similar to LCA, the number of indicators, which in this terminology can be compared to the flows in LCA, will be much smaller. In some cases there is a one-to-one relationship between number of indicators and impact categories whereas in other cases several indicators are

established for each impact category. In the former case, there will be no need for characterization, whereas in the latter case, there will be a need for translating these several indicator results into impacts. An example of such translation is given in Spillemaekkers et al. 2004). Her approach is to collect data on condition A, B, C and D, and if all a certain number of these conditions are not met or met to a certain extent, then a certain impact is said to occur. Another example can be seen in Dreyer et al. (2010).

If there is a one-to-one relationship between the indicator and the impact, then no characterization needs to be made and the inventory results (i.e. the indicator results) can simply be presented directly, which, contrary to LCA will often be directly meaningful for the decision maker, as they for example relate to the occurrence of work related diseases, ILO violations or the like.

On top of this, some SLCA researchers have suggested that the midpoint oriented impact categories presented in table 1 should be further characterized into impacts on the Area of Protection in SLCA, i.e. human wellbeing. Along these lines, Weidema (2006) established quantitative severity scores for various social impacts, whereby very different social impacts could be compared and summarized (Weidema 2006). More concretely, he suggested to translate all impacts into QALYs (disability adjusted life years), in the following way:

$$QALY = YLL + k*YLD,$$

where ILL is years of life lost, YLD is years lived with disability, an k is a constant denoting the severity of the disability. When knowing how much a social impact will affect life expectancy, how severe they are and their duration, the DALY score can be calculated for each social impact, after which they can simply be added to give the overall impact of the product measured in QALY. This approach obviously has the advantage that the final result can be expressed in a single score, which makes it is very easy to get an overview of how a product performs according to the given metric. The weakness, however, is that you need to assign severity scores to very different types of impacts, ranging from incidences of discrimination to cancer, which is obviously a rather difficult and uncertain task.

Another approach to the so-called endpoint modelling suggested by Weidema (2006) discussed above has been to establish some relatively random groups, e.g. 'violations of ILO conventions', 'non-lethal working accidents', etc. and whenever there is e.g. a 'violation of ILO convention' in the product life cycle, the violation gets a score of 1. In this way social impacts can be grouped, but the question is, of course, whether a decision maker is better off with this kind of characterized result where all kind of nuances are simply erased through more or less random grouping.

3.3: Implications of the problems related to the SLCA methodology

As we have seen in the discussions above, there are two very important differences between LCA and SLCA, which will have a very significant impact on the usability of SLCA. The first difference relates to how environmental impacts depend by the nature of the process, whereas social impacts depend on the conduct of the company. Most significantly, this showed to change the way in which we can get data about the process: In order to perform a reasonably accurate LCA we only need to know the types of the processes involved in the life cycle (if we assume we have a database of environmental flows related to different processes, which we often have in available databases). A rough overview of the processes involved in a product can be gained simply by dismantling the product and weighing the components. However, if the same approach is used in SLCA, the accuracy of the assessment will be drastically lowered, simply because of this low causal relationship between process and social impacts – we need to know more. Preferably some information about the company who has carried out the process is needed, which in most cases is going to be a lot more difficult to get than simply getting an overview of the type of processes.

The second very important difference between LCA and SLCA was the need for assessing both the impacts of producing/using/discarding and of not producing/using/discarding in SLCA when it is to be used for decision support, which will equally add to the data demands in SLCA in comparison to LCA.

From an overall perspective, this indicates that the combined accuracy and ease of use of the SLCA is, and is likely to continue to be, poorer than it is for LCA: If we try to aim for the same accuracy of the SLCA as we can get from the LCA, we will need to get detailed knowledge about the actual life cycle of the product we are assessing and in many cases even what happens if we do not produce too, which in most cases will be difficult. On the other hand, if we go for the same ease of use in SLCA as we have in LCA, we will have to rely on generic process data, which in most cases will give us assessments of very low accuracy. Some initiatives have been launched, which to some extent may alleviate this problem, for example databases with social audit information about companies. But despite of this, we will still need to know which company actually carried out the process in question, which in many cases will be difficult to find out.

Whether these problems with usability and accuracy in SLCA will deem SLCA unusable is impossible to say – it will depend on the needs of the user – but it seems likely that SLCA because of these characteristics will never gain the same popularity as LCA. Besides these general comments the above characteristics also impose some important specific limitations for the SLCA in comparison to LCA:

LCA is often used to make prospective assessments, i.e. an assessment of the environmental impacts that are to be expected from a product which is maybe not yet in production. This assessment is only possible because we assume the causal link between process and environmental impact: We can estimate the future environmental impacts because we know

already now the processes that are going to be included in the product that we intend to develop. It is by other words the strength of the causal link between the process and the impact that determines the accuracy we can expect from the prospective assessment. Thus, if there is no link, 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. In some cases, however, especially if the prospective assessment is addressing a very near future, it may be possible to identify the companies who will be included in the life cycle of the product, and in this way reach an acceptable level of accuracy of the assessment.

Another limitation is that assessments of product families will not be possible in SLCA. Following a parallel argument as used above, it is possible to make a generic LCA of e.g. vacuum cleaners, as they more or less all include the same components and consume comparable amounts of electricity through their use. Again, this is possible because of the link between environmental impacts and process. In SLCA, 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.

3.4 SLCA case studies
In elaborating the methodology, experiences from its application in product case studies are important drivers. This section will present three cases to illustrate how main challenges are addressed in current research.

3.4.1 Laptop computer
The first case study concerns a lightweight laptop (ASUSTeK UL50Ag notebook for office use) and assesses environmental and social impacts in parallel. Thus, the goal is not comparison of products, but (a) identification of social and environmental hotspots, (b) recommendations on company and policy level, and (c) application of the UNEP/SETAC Guidelines for SLCA on a complex product. Specifically regarding (b), 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) phase, which most Social LCA studies do not cover, except for aspects included in the stakeholder group 'consumers', is not considered in the case study.

The case study notes the pervasive significance of computer use in modern life and points to human wellbeing as the ultimate goal of life cycle assessment. Nonetheless, it stops at the UNEP/SETAC Guidelines for SLCA, which relates to company behaviour and to general behaviour within in sector. Thus, the indicators proposed 'are not applicable to use phases as there are no companies or industries involved'. The study is concerned with mid-point 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 affected stakeholders are to be preferred to other data collection methods and mentions the time needed for local and site specific data collection as prohibitive for this study, except for a few cases. It adopts a critical and selective

approach to the use of secondary sources, e.g. NGO and company reports. However, there is no reflection on validity in relation to cultural differences between nations and regions, for which a participatory approach in defining impact categories and indicators at a specific level has been suggested.

Allocation is not applied. In the study, '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'. Also, an equal weighting factor for the companies included in the life cycle is used.

The computer case study represents a thorough effort to test the UNEP/SETAC Guidelines for SLCA and does substantiate a range of methodological problems as well as problem of relevance. Most significantly in the fact that the conclusion has no findings beyond what could be expected prior to the study. Considering the costs and time involved in a SLCA exercise, the fundamental question about what the UNEP/SETAC Guidelines for SLCA have to offer as compared to more simple audit tools, remains unanswered.

3.4.2 Cut roses from Ecuador and the Netherlands

The second case compares the production in Ecuador and the Netherlands of a bouquet of cut roses with 20 caulis per spray, packaged and transported to the flower auction in Aaalsmeer, the Netherlands. The main objective of the case study is to "try out" the UNEP/SETAC Guidelines for S-LCA. It conducts in parallel an environmental and social assessment of the production system. It does recognize that social impacts are inter-related and may include many indirect effects. Nonetheless, the discrete impact categories associated with each of the five stakeholder groups and 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 very negative. Thus, from an environmental point of view, the import of roses from Ecuador is to be preferred. On the social conditions, the study outlines a general scenario for improvement, but such an effort 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 no weighting is performed. The use phase is only marginally considered in terms of health and safety of the consumer.

3.4.3 Greenhouse tomatoes

The third case study departs from the calculation of quantitative impacts of the UNEP/SETAC Guidelines for SLCA 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 performed within the chain. The case study points to the potential of Life cycle attribute assessment (LCAA) "to piggyback off other initiatives (ISO 14001, GRI Sustainability Reporting, SA 8000, FSC, and the U.S. Green Building Council's LEED program).

However, in line with different stakeholder interests, working hours may be substituted e.g. by forested acres to check on the percentage of FSC certified acres. The study select eight indicators, one of which is wage levels, and asks the question whether wage levels as an indicator in SLCA equals energy consumption in environmental LCA: "an important indicator that is closely related with results across many impact categories" . All indicators are mid-point indicators, i.e. regarded as means to an end. The study recognizes that data quality declines as Input-Output tables at sector level are used instead of more detailed process flows. However, 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 only and then aligns with CSR criteria. These selected case studies and other contributions to the SLCA literature do argue suggested solutions to a range of unresolved issues, however, consensus on the methodology to the extent of establishing a base of comparative studies is not yet in sight.

Thus, in conclusion, SLCA is not a mature approach. Findings are predictable, and the value-added of the S-LCA methodology is not evident in comparison to other approaches, in particular when considering the much heavier burden in terms of man hours and costs to be spent.

3.5 Future development
The major driver in the development of SLCA has been to create a social assessment method that "mimicked" as closely as possible the principles of Environmental LCA with a view for a possible integration of the two. This is supported by a concept of sustainability as constituted by three parallel pillars of the economic, environmental and social dimensions. Having elaborated LCA to some level of consensus and maturity and having introduced Life Cycle Costing (LCC), it is now time to tackle the social dimension. The agenda being a social version of the LCA framework. A fundamental problem in this approach can easily lead to is that central differences between the environmental and social issues may be overlooked.
One explanation for why this path is taken may be the fact that natural scientists venture beyond their scope in the effort to establish SLCA as a clone of LCA. Considering the well established LCA paradigm and institutionalized LCA research community the risk of disregarding social sciences altogether cannot be excluded.

Seen in this light, it seems that future development of SLCA may follow two paths. One is to follow the current trend and fully exhaust the 'LCA cloning' approach, which will call for more research within areas such as indicator development, characterization modelling in SLCIA, establishing and

validating impact pathways, aggregation procedures, normalization 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, for example leading to reviewing recent concepts of human wellbeing to inspire a redefinition of an integrated set of social impact categories.

However, regardless of whether SLCA will succeed in integrating important lessons from the social sciences, SLCA cannot escape its purpose of being a life cycle oriented social assessment methodology. The conjunction of at one hand being 'life cycle oriented' and on the other being a 'social assessment' methodology will inevitably give rise to a data demand to which there is no miracle cure, as discussed in section 3.2.3.1. Without a solution to this problem SLCA studies will probably continue to be limited to one or a few companies, which will raise the question: If SLCA is merely a 'one life cycle stage assessment' what makes it worthwhile to develop and use considering that assessments of social impacts in companies from a methodological point of view has long been developed?

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