SOCIAL LIFE CYCLE ASSESSMENT: METHODOLOGICAL AND IMPLEMENTATION ISSUES

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Abstract:
This paper describes the development of the Social Life Cycle Assessment methodology. Introduce the debate about the inclusion of the social criteria in Life Cycle Assessment (LCA) and presents the actual framework. A second part presents and analyzes recent case studies published. This methodology allows increasing knowledge, providing information for decision makers and promoting improvement of social conditions in product life cycles. Its framework is at a very early stage compared to the Environmental Life Cycle Assessment and for its improvement it is necessary to carry out more case studies. One of the issues that are lacking into its development is the choice of social indicators for the inventory indicator and their standardization for the methodology application.

Keywords: Social Life Cycle Assessment, framework, case studies

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1. INTRODUCTION

Social Life Cycle Assessment (S-LCA) is a methodology that aims at assessing the potential social and socio-economic impact, both positive and negative, of products/services throughout the life cycle (i.e. from cradle to grave) (UNEP, 2009). It allows increasing knowledge, providing information for decision makers and promoting improvement of social conditions in product life cycles (Benoit et al., 2010).

The debate on how to deal with social and economic aspects into LCA began in 1993 with the publication of a SETAC Workshop Report: "A Conceptual Framework for Life Cycle Impact Assessment" (UNEP, 2009). The first reference of the S-LCA was in 1995 with the summary report "The social value of Life Cycle Assessment" (News & News, 1996). In 1996, O'Brien, Doig and Clift (1996), proposed the first way to integrate the S-LCA with environmental analysis, called "Social and Environmental Life Cycle Assessment" (SELCA). In that work, the authors supported the importance of integrating the results of the S-LCA with those of Environmental Life Cycle Assessment (ELCA). The same authors also stated that an integrated assessment (environmental, economic and social) provides a more complete and intuitive potential impact assessment of a product or service in its life cycle. This integrated approach liked with sustainable development can be understood as the concept of Life Cycle Thinking.

"Life Cycle Thinking is about going beyond the traditional focus on production sites and manufacturing processes so that the environmental, social and economic impact of a product over its whole life cycle" (UNEP, 2009). Following the "pillars of sustainability" (environmental, economic and social), Life Cycle Thinking is divided in Environmental Life Cycle Assessment (E-LCA), Life Cycle Costing (LCC) and the Social Life Cycle Assessment (S-LCA) (Petti and Campanella, 2009).

In 90s decade the discussion on how to deal with social and economic aspects into LCA has not undergone significant improvements, in the early 2000, the first methodologies regarding the social aspects were presented. In some of these studies, the method recommended was appointed as "S-LCA". Some researchers referred to the letter "S" as "social" and others as "sustainability" (UNEP, 2009).

The difference between S-LCA and the majority of social responsibility tools, as Corporate Social Responsibility (CSR) and SA 8000, is at the level of the social impact addressed. While CSR

addresses the social impact at enterprise level using management information and SA 8000 focuses on the plant level; S-LCA uses information gathered at company, plant and process levels and it does so for the whole product life cycle (Benoit et al., 2010).

One important feature to be emphasised is that social impact is not directly linked to the production chain process of a product (Dreyer et al., 2006) (Dreyer et al., 2010b), it is not determined by physical flows, unlike the E-LCA, but from the way it interacts with the stakeholders (Jorgensen et al., 2008) (Hauschild et al., 2008). Therefore, the identification of all stakeholders involved on the product/service life cycle is a fundamental issue when performing an S-LCA.

2. FRAMEWORK

According to Weidema (2005) the application of ISO 14040 can be extended to S-LCA. Therefore the methodology has the same four phases of E-LCA: Goal and scope definition; Inventory analysis; Impact assessment and Interpretation.

Subsequently to Weidema statement, advances in the methodology development were undertaken because its framework was harmonized and had a similar structure of the former Environmental Life Cycle Assessment (E-LCA) that was already known by researchers.

The first proposal was from Weidema (2006) that created a new indicator at endpoint level. In the S-LCA we can find two types of indicators in the cause-consequence chain; this concept comes from the E-LCA approach. Midpoint indicators are constructed category indicators located somewhere along the cause-consequence chain, such as the global warming potential, instead, endpoint indicators are category indicators at the end of the cause-consequence chain, such as years of life lost (DALY) (Hertwich and Hammitt, 2001). The new indicator created by Weidema was called Quality of Adjusted Life Years (QALY). This indicator is composed by six damage categories under a general human life and well-being category. The indicator aggregates the results across the endpoint indicator into a single one, it is calculated by a combination of different statistics data. QALY should be understood in a similar way to the DALY indicator of World Health Organization (WHO). Therefore, QALY expresses reduced quality of living by shortening the life expectancy.

Norris (2006) proposed a method that uses the existing LCA impact endpoint of human health by introducing a simplified empirical relationship to characterize the health pathway, called Life Cycle Attribute Assessment (LCAA), to assist in the aggregation of data about processes attributes like “child-labor-free” or “fair Trade certification” of site specific information.

Hunkeler (2006) suggests the use of working hours as an intermediate variable in the calculation for the evaluation of societal life cycle assessment. He assumes that processes can be dismembered into labour statistics, considering only a single impact category. The approaches created by Weidema, Norris and Hunkeler have in common that make use of statistics data availability.

Dreyer, Hauschild and Schierbeck (2006) have defined a framework for Social Life Cycle Impact Assessment with a company perspective, affirming that companies have responsibility for the people affected by their business activities, but also are able to compete and make profit in order to survive in the marketplace. This shows that the two goals (social responsibility and the competitiveness in the market) are not in conflict with each other. Later, the same authors proposed a characterization model based on multi-criteria indicators to four impact categories (forced labor, discrimination, restrictions of freedom of association and collective bargaining and child labor) (Dreyer et al., 2010a). They also applied this model to six companies concluding that it is more suitable for larger traditional industries, primarily employing blue-collar workers, due the typical employment conditions, type and organization of work carried out (Dreyer et al., 2010b).

In 2004, the United Nations Environment Programme (UNEP)/SETAC Life Cycle Initiative recognized the need for an international task force on the integration of social criteria into LCA. In

2007, the task force was renamed to Project Group (Benoit et al., 2010), which resulted in the book presenting the guidelines on S-LCA (UNEP, 2009).

The guidelines propose two types of SLCIA approach of impact categories, which Parent, Cucuzzela and Reveret (2010) understand as characterization models. They also explain that the Type 1 use performance reference points, which means use of additional information, like international levels accepted as minimum performance, to understand the magnitude and the significance of the data collected in the inventory phase. The guidelines also established for the SLCIA approach Type 1 five stakeholder categories and the correspondent impact subcategories (table nr. 1) which were recognized internationally, although, the measurement and definition of these categories remains still a challenge. Not taking into account one of these subcategories should be justified, nevertheless new subcategories can be included. It is also important to highlight that the regionalization is an important issue because the context, in which the company is inserted, affects the relevant stakeholders involved in the product/service life cycle considered.

According to Parent, Cucuzzela and Reveret (2010) in SLCIA approach Type 2 the impact is assessed according to the use of impact pathways, where the inventory indicator is translated into a midpoint and after endpoint indicator. Furthermore, they also believe that for this type the approaches of Weidema and Hunkeler are indicated.

Ciroth and Franze (2009) proposed an assessment method to evaluate social impact with bases on the UNEP/SETAC guidelines. It's a simple and intuitive assessment method that uses excel tables and colours (read, green, orange and white) to show the social impact level (positive, negative or not present) from qualitative data.

Traverso et al. (2010) used the tool Life Cycle Sustainability Dashboard to perform the impact assessment phase.

Recently, the Project Group has released methodology sheets for each impact subcategories for public consultation (UNEP, 2010). The purpose of these sheets is to help in the implementation of the S-LCA with the suggestion of inventory indicators for each stakeholder and subcategories (Benoit, 2010). Even being internationally recognized the subcategories measurement and the definition of impact categories are still a challenge.

3. CASE STUDIES

An accurate literature survey was carried out to identify as many papers as possible available about S-LCA case-studies published at national and international level. In order to have harmonized studies, the effort was focused in the studies that applied the guidelines from UNEP. The output was four case-studies, of which the subjects were: 1) polycrystalline photovoltaic (Traverso et al., 2010); 2) biofuels: ethanol, biodiesel and biogas (Blom and Solmar, 2009); 3) a bouquet of roses (Ciroth and Franze, 2009); 4) Services: Video Conferencing and News regarding mobile phone (Moberg et al., 2009).

The first case-study aims at the identification of hot spots of social aspects in the production and assembly phase, using data from Italy and Germany. The second one has the purpose of performing social and economic impact hotspot of the production of the biofuels: ethanol, biodiesel and biogas, relative to each other, in order to identify the best socially sustainable option, using theoretical data. The third case has as a target the comparison of the social effects caused by the production of a bouquet of roses in Ecuador and Netherlands. The last one is a project that provides a basis for a discussion and considers the availability of information for these type of services; the system boundaries proposed include: materials (raw and manufactured ones), production, use and disposal. In this project no assessment was performed, just the classification on stakeholders category.

Table 1. Stakeholder categories and subcategories. Source: Benoit et al. (2010).

Stakeholder "worker"	Freedom of association and collective bargaining
	Child labor
	Fair salary
	Working hours
	Forced labor
	Equal opportunities/discrimination
	Health and safety
	Social benefits/social security
Stakeholder "consumer"	Health and safety
	Feedback mechanism
	Consumer privacy
	Transparency
	End of life responsibility
Stakeholder "local community"	Access to material resources
	Access to immaterial resources
	Delocalization and migration
	Cultural heritage
	Safe and healthy living conditions
	Respect of indigenous rights
	Community engagement
	Local employment
	Secure living conditions
Stakeholder "society"	Public commitments to sustainability issues
	Contribution to economic development
	Prevention and mitigation of armed conflicts
	Technology development
	Corruption
Value chain actors* (not including consumers)	Fair competition
	Promoting social responsibility
	Supplier relationships
	Respect of intellectual property rights

In order to analyze each case study, specific information was chosen, already used by Petti et al. (2010), which could well characterize them. This information was: geographic area of reference, product considered, objectives, functional unit, system boundaries, data origin, impact assessment method and strong points. Table nr. 2 summarizes this information.

Table 2. Case-studies characteristics

Case-Study Characteristics	Polycrystalline photovoltaic	Biofuels: ethanol, biodiesel and biogas	A bouquet of roses	Services: Video Conferencing and News regarding mobile phone
Geographic area of reference	Germany and Italy	Ethanol: Brazil to feedstock production, processing and refining Swedish for storage and transport to pump. Biodiesel and Biogas: Swedish.	Ecuador and Netherlands: production phase; Netherlands: cutting and packaging phase	News regarding via mobile phone: offices in Sweden for production: editorial work ; Video Conferencing: user in Sweden just for users the other information are general
Product considered	Polycrystalline photovoltaic	Fuel type: ethanol, biodiesel, biogas	A rose bouquet	Services: Video Conferencing and News regarding via mobile phone

Continuation Table 2. Case-studies characteristics

Case-Study Characteristics	Polycrystalline photovoltaic	Biofuels: ethanol, biodiesel and biogas	A bouquet of roses	Services: Video Conferencing and News regarding mobile phone
Objectives	Identification of hot spots or potential improvements of social aspects in the production and assembly phase	Performer social and economic impact hotspot of the production of the biofuels: ethanol, biodiesel and biogas. And identify the best socially sustainable option	The comparison of the social effects caused by the production of a rose bouquet in Ecuador and in Netherlands. And compare with the environmental assessment	Provide a basis for a discussion and consider the availability of information for services (Video Conferencing and News regarding mobile phone)
Functional unit	m^2 of Polycrystalline photovoltaic	Driving a car 100km	A bouquet of roses with 20 caulis per spray	News regarding via mobile phone: the average mobile reading of newspaper Y by one person during one year. Video Conferencing: one year of video conference meetings at Company A
System boundaries	Production phase	Feedstock production, processing, refining, storage and transport to pump	Production, cutting and packaging phase	Materials (raw and manufactured ones), production, use and disposal.
Data Origin	Research and interviews in two companies (one Italian and one German) of modules assembly	Internet, in literature, from national statistics and from interviews with interest and trade organizations with reference to the geographic area of the study	Mainly from governmental or non-governmental organization, with reference to Ecuador and Netherlands	Primary Data: news-company mobile anonymous manager and one user MALIN Picha. Use of video Conferencing equipement-TeliaSonera survey considering 574 employees answered the questionnaire. Bibliography data (News regarding via mobile phone average data and general information on the production of mobiles phones, electronics and raw material. Video Conferencing: considered similar social aspects for the workers involved in laptops production in China. The LCD

				production: the screen is fully automated and closed. Social impacts of notebooks production.)
Impacts assessment method	Life Cycle Sustainability Dashboard.	Excel tables and proposing a score system to indicate positive, negative or not presence of social impacts and also an aggregation trough the impact categories	Own method developed to the study with excel tables	------- No assessment performed
Strong points	First works published using company data. Also proposed the use of Dashboard to assess the social impacts	First case study. It is based on the methodology of the UNEP/SETAC. Also proposed a method to assess social impacts	The case study is based on the methodology of the UNEP/SETAC guidelines for SLCA. Also proposed a new method to assess social impacts	First case involving services which a classification on stakeholders category is made. Category indicators for SLCA for use of Video Conferencing Equipment: – Usability, – Coordination With Other Daily Activities, – Efficiency.

A common problem in the assessment of social impacts is data availability. Data is often not available, is often qualitative and hard to quantify. Another common problem is the existence of different indicators for social impacts that render the interpretation of results difficult and not harmonized to make comparison of S-LCA studies.

3. CONCLUSIONS

This paper has established the state of the art of S-LCA methodology that is still in the early stages. Some work has been done to establish the framework, but much more is needed to make this methodology a useful tool for organizations (governmental and non- governmental) to assess their products. The choice of social indicators and their standardization for the methodology application still need to be developed. One assessment and aggregation method to the impact assessment phase, recognized by the Project Group from UNEP to be used in the S-LCA, is lacking. They are necessary to harmonise the results of the case studies. To improve the methodology it is also necessary to carry out more case studies to highlight where the methodology is weak. Indicators definition to be used for product categories that allow uniformity for S-LCA studies can be a feature.

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