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Definition of sustainability impact categories based on stakeholder perspectives

R.G. Souza [a, *, 1], J. Rosenhead [b], S.P. Salhofer [c], R.A.B. Valle [a], M.P.E. Lins [a]

[a] Production Engineering Program, Federal University of Rio de Janeiro, Ilha do Fundao, Cidade Universitaria, Centro de Tecnologia, Bloco F, Sala 103, 21941-972 Rio de Janeiro, RJ, Brazil
[b] Department of Management, London School of Economics and Political Science, Houghton Street, London WC2A 2AE, UK
[c] Institute of Waste Management, BOKU – University of Natural Resources and Life Sciences, Muthgasse 107, A-1190 Vienna, Austria

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ABSTRACT

Sustainability assessment is an important approach for decision-support in waste management systems. Life Cycle Sustainability Assessment (LCSA) is the most promising tool for this purpose, but it still lacks a formal methodological framework. One requirement for establishing an effective LCSA methodology is the necessary involvement of stakeholders in decisions on LCSA models, which still constitutes a gap in current assessments. In this paper we develop and apply a methodology for stakeholder consultation regarding the selection of LCSA impact categories (focussing, in this case, only on social and economic issues). The methodology is based on decision science concepts and tools with an emphasis on the elicitation of stakeholders' perspectives depicted in cognitive causal maps. Results from a case study illustrate a useful contribution from the methodology, revealing both well-established and innovative impact categories with very positive feedback from stakeholders. A methodological issue is the sensitiveness in defining endpoint and midpoint levels of impact categories. The method revealed straightforward and effective, with no necessity for quantitative ratings and minor influence of the analysts' perspectives.

1. Introduction

Sustainability assessment has developed to be an important approach to support decision-making in waste management and other decision contexts (Kaufman et al., 2010; Wagner, 2011; Menikpura et al., 2012; Aparcana and Salhofer, 2013). However, taking the perspectives of involved stakeholders into consideration is still a major gap if such applications are to be successful for real decision problems.

The most promising methodology for sustainability assessment is Life Cycle Sustainability Assessment (LCSA). It consists in evaluating and often comparing potential social, economic and environmental impacts that can result from alternative *product systems*[2] that could be considered for implementation in the real world.

LCSA, which can be expressed by: LCSA = LCA + LCC + SLCA (Jørgensen et al., 2013), aggregates potential environmental, economic and social impacts using three complementary methodological *modules*:

- LCA (sometimes eLCA – *environmental Life Cycle Assessment*), the environmental module whose methodological framework is well established, being standardized in ISO 14040 to 14044 and richly developed in the ILCD Handbook (EC-JRC, 2010);
- LCC (*Life Cycle Costing*), which usually focuses on costs for different actors along the chain; this is not yet standardized, but some suggested methodological guidelines do exist (Swarr et al., 2011); and

* Corresponding author. Production Engineering Program, Federal University of Rio de Janeiro, Ilha do Fundao, Cidade Universitaria, Centro de Tecnologia, Bloco F, Sala 103, 21941-972, Rio de Janeiro, RJ, Brazil. Tel.: +55 21 3938 7045.
E-mail addresses: ricardo@latec.uff.br, ricardo@sage.coppe.ufrj.br, ricardogabbay@gmail.com (R.G. Souza).
[1] Present address: D.Sc. Program on Sustainable Management Systems, Fluminense Federal University, Rua Passo da Patria, 156, Bloco E, sala 329-A, 24020-971, Niteroi, RJ, Brazil.

[2] Each product system describes a chain of processes within a product's life cycle (for example from manufacturing to waste disposal – gate to grave). The currently operating system is usually regarded as one of the options, in order to assess impacts of the system 'as is'.

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- SLCA (*Social Life Cycle Assessment*), still under constant development due to its higher levels of subjectivity but also provided with some suggested guidelines (UNEP-SETAC, 2009).

The social, economic and environmental impacts are characterized by a set of *impact categories*[3] and their respective performance indicators. The selection of impact categories is a crucial step in performing a sustainability assessment of available alternatives that can enhance real world systems.

The process for selecting LCSA impact categories may differ between the methodological modules, but both SLCA and LCC approaches need to be anchored to the "root" LCA standard (Swarr et al., 2011; UNEP-SETAC, 2009). In LCA, "the selection of impact categories must be comprehensive in the sense that they cover all relevant environmental issues related to the analysed system" (EC-JRC, 2010). Therefore in LCSA this must also be true for social (SLCA) and economic (LCC) issues.

In LCC, impact categories relate strictly to direct costs experienced by one or more actors in the product life cycle (e.g. supplier, producer, user or consumer, end-of-life agent), narrowly referring just to real money flows (Swarr et al., 2011). Thus the costs associated with waste disposal fees can be attributed to consumers; with take back programms to producers; and landfill development and closure to society. One limitation of LCC is that it only refers to costs, and therefore does not cover other economic aspects, such as: profits; competitive advantage; impacts on the product market and on the regional economy; etc.

Regarding SLCA, Finkbeiner et al. (2010) argue that the "selection of social criteria and their quantification is still one of the major challenges", as "there is currently no uniform usage of a standardized set of indicators". According to the same authors, "there are still research needs and consensus needs of the involved stakeholders". The UNEP Guidelines for Social Life Cycle Assessment (UNEP-SETAC, 2009) highlights the importance of developing impact categories based on "social issues of interest to stakeholders and decision makers".

The involvement of stakeholders is indeed one major gap in current LCSA implementations – as it is for each of its components, when applied independently. Concerning LCA, Sala et al. (2012) state that "the interested parties should be involved in order to better define the decision context and the purpose of the study, but in practice an LCA is carried out for one actor only".

But how can LCSA applications successfully cover "all relevant issues", if they are based on a "one actor only" perspective (usually of the client or that of the analysts themselves)? In the light of the methodological recommendations cited above, it would appear all too likely that disregarding relevant stakeholders perspectives will lead to the incompleteness or failure of LCSA models and their results.

As identified by Sala et al. (2012), there is still no structured framework where "stakeholders will not only serve as audience but as active, informed and responsible parties in the decision making process". The objective of this paper is to suggest and demonstrate a methodological approach for the selection of LCSA impact categories based on consultation of real stakeholders, and elicitation and structuring of their perspectives.

To do so we will apply some concepts and tools from the decision sciences to the task of selecting impact categories in LCSA. The field of decision sciences has developed tools and skills to manage multiple stakeholder perspectives, including the selection of decision criteria. It would appear likely that such tools can make a significant contribution to the development of an overall LCSA framework.

To demonstrate the applicability of such tools to the selection of LCSA impact categories, we investigate here a real decision problem, which involves sustainability assessment in waste management: the definition of a model for the Brazilian Waste Electric and Electronic Equipment (WEEE) reverse logistics system, which must be implemented in accordance with the recent National Solid Waste Policy (PNRS, 2010).

2. Background theory

2.1. Impact categories as decision criteria

Our methodology is based on a combination of theories drawn from LCA and the decision sciences. To do this we need to demonstrate that LCSA impact categories can be interpreted as *decision criteria*, by which alternative product systems can be evaluated in order to define the best solution for implementation.

In decision sciences, a *decision criterion* or *attribute* is defined as "a performance indicator employed to measure the impact of adopting each decision alternative on the organizational objective being pursued" (Franco and Montibeller, 2009). We can assume that the fundamental objectives for any product system assessed in LCSA are: to avoid negative impacts and maximize positive impacts on some well-defined sustainability (social, economic, environmental) *areas of protection* (AoP). In the case of eLCA studies, the scope needs to cover the potential impacts on the three environmental AoP: human health, natural environment and natural resources (EC-JRC, 2010). In the case of LCSA studies, the purpose, according to Jørgensen et al. (2013), is to assess the impacts of product systems on: poverty in the present generation; and to maintain the stock of capital for people living in the near and long-term future. Certainly, many other strategic objectives could also be considered, like culture and education, life quality, damage to ecosystem etc. Thus, the impact categories can be seen as the criteria by which we can measure the impact of each decision alternative on those objectives.

2.2. Definition of impact categories in current LCSA applications and in WEEE LCA studies

To the present, most LCSA studies (Bachmann, 2012; Ostermeyer et al., 2013; Martínez-Blanco et al., 2014) have adopted impact categories specified in established frameworks like the UNEP SLCA Guidelines (Norris, 2013) and an LCC core reference (Swarr et al., 2011). These frameworks organize pre-defined impact categories and subcategories related to each stakeholder group. In those LCSA applications, choice of impact categories is usually made by the analysts themselves, rather than deriving those from the perspectives of stakeholders involved in each problem situation. An interesting approach is to derive categories from a Sustainability SWOT of a product (Pesonen and Horn, 2012), drafted with stakeholders and experts.

Regarding WEEE systems, many LCA studies have been carried out by LCA and WEEE specialists worldwide (Hischier et al., 2005; Wäger et al., 2011; Bigum et al., 2012; Traverso et al., 2012; Rocchetti et al., 2013). Those studies present a standard set of LCA impact categories:

- Damage to human health; damage to ecosystem diversity; resource scarcity (*endpoints*);
- Global warming; acidification; human toxicity; eutrophication; resource depletion (*midpoints*).

[3] In ISO (2006a), an impact category is defined as a "class representing environmental issues of concern to which life cycle inventory analysis results may be assigned". For LCSA, this definition is extended to social and economic issues.