IMPROVING THE PERFORMANCE OF LIFE CYCLE ASSESSMENT

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Improving the performance of LCA. Pp. 247-252 in Proceedings of the 2. International Conference on EcoBalance, Tsukuba, 18.-20, november 1996.

Abstract

The need for improvement of LCA performance is discussed with a starting point in the demands for comprehensiveness, reliability, simplicity, and integration into day-to-day management. It is argued that simplicity can be achieved without compromising comprehensiveness and reliability. The necessary improvements are discussed in a number of development areas: standard procedures, data verification, assessment techniques, understanding of uncertainties, software.

Keywords

Standards / Critical review / Data / Verification / Impact assessment / Uncertainty / Software

Introduction

The Expectations

The future of LCA as one of the important techniques in environmental management has often been challenged by critics stating: "It's too complicated...", "You can get any result you like..." etc. (see e.g. [1]). Despite this scepticism, which is not unfounded, the interest in LCA is still increasing. The reason for this sustained interest seems to be a growing understanding for the fundamental necessity of a comprehensive and reliable assessment of all environmental aspects related to products. This is also demonstrated by the interest for product related environmental policy that is presently expressed by regulators worldwide (Australia, Canada, EU, Japan, USA).

At present, there is no other technique than LCA that holds promise of providing both comprehensiveness and reliability in this field. However, this potential is not yet fully realised and at the same time other interests - which pull in the opposite direction of comprehensiveness and reliability - demands attention: namely the needs for simplicity and integration into day-to-day management routines. Thus, at first sight, it seems difficult for LCA to meet the high expectations.

Setting the Priorities

In the search for simplicity, many researchers have argued for limiting the investigated environmental parameters, mainly to energy and mass flows (see e.g. [2, 3]) and such limiting of the investigated parameters is also being discussed seriously as part of the so-called "streamlining" of the LCA procedure [4].

Nevertheless, an opposite trend can also be seen, where more and more parameters are being introduced to enable the LCA to handle all the complexities of the current environmental debate. Land-use and biodiversity is being discussed important parameters at least for products from non-renewable resources [5, 6], the working environment has been advocated as being as important as the outer environment [7] and even human rights have been defended as an environmental issue of concern [8] with reference to the Brundtland-report [9]. The argument of these practitioners has been that limiting the comprehensiveness of LCA is reducing its fundamental advantage as a technique which can guide us to avoid sub-optimisation, where solving one environmental problem leads to another (or even the same) problem elsewhere in the lifecycle.

Truly, it is necessary to make LCA more simple. However, to maintain the potency of the technique, any limitation must rather than being based on conventions or prejudice be based on well-founded reasoning about the relative importance of different environmental topics (which on a global level could make it more reasonable to include e.g. "working environment" than "photochemical ozone").

Thus, in the conflict between comprehensiveness and simplicity, comprehensiveness must have first priority, and the aim of simplicity must be achieved in other ways.

In parallel, the conflict between reliability and simplicity has in practice led to a general disregard for some of the most important quality assurance tools available: peer review and uncertainty analysis. And again the conclusion must be: Simplicity cannot be an aim in itself, but must be sought after in ways which does not compromise the reliability of LCA.

Setting the Scene: Areas for improvement
Although simplicity does not have priority over the demands for comprehensiveness and reliability, it is nevertheless the key to making these demands manageble. Without compromising comprehensiveness nor reliability, adequate simplicity may be achieved by:

- using standard procedures and assumptions, thus speeding up the work and avoiding controversies over the result,
- having readily available, comprehensive data of high quality and detail, since data collection is the most time consuming of all LCA phases,
- using improved assessment techniques, readily allowing comparisons between different impact categories,
- having an improved understanding of uncertainties and their causes, especially reducing the time spent for data collection while improving reliability,
- using adequate software, also increasing the speed of the work.

Furthermore, the use of LCA needs to be integrated into day-to-day management routines and therefore the technique must be adapted to the specific application (e.g. strategic planning, acquisition, product management, logistics, marketing etc.).

Each of the above mentioned areas for improvement will be described below.

Standard Procedures

The main reason for the critique, that LCA "can give any result you like," has been the lack of clear decision rules. Besides compromising the result, this lack of clear rules has also made the performing of LCA studies more difficult, especially for the inexperienced practitioners, since it has been necessary to invent and justify your own decision rules. Unambiguous and generally

agreed rules would both speed up the work and result in less controversies over the final results.

International standards for LCA are currently emerging through the ISO process. Although the ISO standards will bring some order in the present chaos, their provisions must necessarily be of a general nature, since it is recognised LCA's can be carried out in many different ways, depending on the area of application. Thus, the forthcoming standards focus on the general criteria which characterises good practice, primarily related to the completeness, transparency and consistency of the assessment [10].

Thus, the ISO standards will still leave quite a number of issues at the discretion of the practitioners. Furthermore, the existence of a standard is not in itself a guarantee that it will be applied. An important aspect in this context, is the provision in the forthcoming ISO standards for critical review. For LCA's supporting a comparative assertion disclosed to the public, a strict third party critical review procedure will be a requirement. This review procedure allows further aspects to be included than those explicitly stated as requirements in the standards:

- The review shall specifically address that: (...)
- the methods used to carry out the LCA are scientifically and technically valid;
- the data used are appropriate and reasonable in relation to the goal of the study;
- the interpretations reflect the limitations identified and the goal of the study; and

It is of outmost importance for the success of the implementation of the ISO standards that this critical review procedure is applied in practice at a high level of excellence. To support this, it is important that a number of good examples of well performed critical reviews according to the ISO standards are published as soon as possible, and that practitioners start exchanging their experiences and discussing their problems in performing critical reviews.

Until now, critical reviews have not been generally applied - not even for LCA's supporting a comparative assertion disclosed to the public. The main

argument against critical reviews is their costs. However, if the critical review is used as an interactive review (where the review is performed both after the scope definition, after the data collection and after the conclusion) the review is likely to increase efficiency of data collection to the extent that the benefit of the review will exceed its costs. Besides this, the critical review should improve reliability of the results to the extent that this in itself will justify the review costs.

On a slightly longer time horizon, the use of the standards and their review procedure should be linked to an accreditation scheme. However, at the moment this is still not agreed as part of the ISO framework. There is therefore a need for a private accreditation scheme for LCA practitioners. Such an accreditation scheme could for example be set up in the framework of a practitioners' association. A practitioners' association may also in other ways seek to improve the general conduct of practitioners, e.g. by drafting a standard contract, reacting on misuse of LCA's, setting up a court of arbitration and promoting an annual award for "best published LCA".

Being generic in nature, the forthcoming ISO standards will not eliminate arbitrariness completely. A further step could be the development of standards for specific product groups covering more specifically the procedures which presently add to the uncertainty of the results (such as choice of the most relevant data, choice of functional unit, cut-off criteria, geographical and technological assumptions, allocation procedures, impact assessment methods and data). Such specific standardisation can only be carried out in close co-operation with the affected industry and standards need to be updated at regular intervals. Some industries have already experience in working together on LCA's in specific product domains, such as packaging materials, detergents, electronics and food products. It may be possible to speed up international standardisation by establishing an international clearinghouse for sector specific standardisation work, so that the need for initial face-to-face meetings could be reduced.

Readily available data of hight quality

Data collection is the most time consuming of all LCA phases. Therefore, improvements in data availability will have a major impact on the speed and price of LCA studies. A large number of databases are established locally [11],

but data is typically in different formats and its quality is often low and/or insufficiently documented. SPOLD is presently developing a common format for LCI data, which should allow different databases to be linked in an open network [12]. Thus, data should become more transparent and more easily available.

However, even when an adequate management and maintenance of such a database network is ensured, it remains to ensure that data are also comprehensive and of high quality and detail. For this purpose it is necessary to develop a set of criteria for classifying data as being "verified data of high quality" and a procedure for implementing the verification procedure and for identifying the resulting data in the database network.

Improved Assessment Techniques

For efficient use of LCA in many routine decisions, it is necessary that the results be presented in a quickly surveyable form. Although the final assessment may sometimes depend on company specific priorities of environmental aspects, it is of general interest to obtain a valuation technique that can find general acceptance. Results would be less disputable and different studies would become more comparable.

For these reasons much effort has been placed in developing a common framework for impact assessment, both in SETAC [13] and ISO (TC 207/SC5/WG4). Within this framework, several approaches to valuation have been suggested, most of them relying on either monetarisation, the distance of the actual situation to a target situation or panel methods. It is likely that the most viable result will be obtained from an intelligent combination of the three approaches, i.e. by supplying the available information on monetary values, actual situations, sensitivity of the environment and so on, to a representative panel in an interactive procedure arriving at one or more agreed weighting sets for environmental impact categories.

Understanding Uncertainity

Most published LCA's are based on data without indication of uncertainty and without sensitivity analysis of the results. Thus, there is a large room for improvement here, an improvement which could benefit not only the reliability of the result (a result without indication of uncertainty is actually

no result at all) but could also increase data collection efficiency, since the only sound basis for excluding a process from the inventory is its demonstrated insignificance compared to the uncertainty on the overall result. That means: Unless you operate with estimates of uncertainty it is not possible to simplify your data collection.

Furthermore, there is a large need to improve our understanding of methodological uncertainties, i.e. in definition of scope (functional unit, cut-off criteria, geographical and technological assumptions, allocation procedures) as well as in impact assessment [14]. Such an understanding is a prerequisite for making more detailed and improved standard procedures in these areas.

Adequate software

Software for LCA is currently forthcoming in an overwhelming amount (see [11, 15]). The market is not very transparent and it is quickly developing. Most LCA-software consists of a database-part and a calculation-part. These two parts are more or less integrated and supplemented with different kinds of graphics to make the programs more user-friendly. Compared to standard-databases and -spreadsheets, the LCA-softwares have the disadvantage that they are less flexible. They are typically developed with a specific user and application in mind and are not easily adaptable to the needs of other users. For example, only few LCA-softwares can carry out calculation on data uncertainties. Similarly, only few LCA-softwares can readily provide information on the contribution of the individual processes to the overall result.

To encourage transparency and adequacy of software, it could be an advantage to develop a list of criteria against which any LCA software can be tested, as well as an adequate testing procedure, and to encourage that an independent testing according to these criteria and this procedure is performed and published regularly.

Integration into management routines

Until now, LCA has mainly been applied as a stand-alone technique, either in a concrete case of a marketing challenge or in an exploratory phase typically

in relation to product development. However, the full benefits from LCA will only be obtained if the technique is integrated in day-to-day management routines. Today, only a few leading companies have adopted what you could call "life-cycle-management", but as experience is being gained and the technique becomes better known, this is likely to become more widespread. The adaptation of the LCA technique to the specific application (e.g. strategic planning, acquisition, product management, logistics, marketing etc.) is a process that requires both experience and involvement of many different actors in the companies. To speed up this process, exchange of experiences among different companies should be encouraged, e.g. through benchmarking or joint development courses. Teaching materials in LCA have so far focused mainly on general methodological aspects and applications in product development. Teaching materials directed specifically towards other applications such as strategic planning, acquisition, product management, logistics, and marketing need still to be developed.

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