METHODOLOGY FOR CHOOSING LIFE CYCLE IMPACT ASSESSMENT SECTOR-SPECIFIC INDICATORS

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ABSTRACT

There is a wide range of indicators available for use in Life Cycle Impact Assessment (LCIA). For designers with limited experience of Life Cycle Assessment (LCA), it is difficult to decide which is the most likely to lead to a more environmentally friendly product. In industry, and in SMEs in particular, designers lacking the expertise needed to use LCA in an eco-design approach are liable to pay insufficient attention to indicator selection and may use inappropriate indicators that result in design faults. The lack of sector-specific methodological guidelines to assist them is another similar cause of problems.
This article describes the methodology of choice for selecting the most appropriate impact categories and characterisation models for a LCIA in order to facilitate the choice of eco-design solutions.

The two main stages of the methodology are described and explained.
This procedure can be used directly by individuals carrying out an LCA or by developers of specialised LCA tools that choose indicators for the user.
This methodology will make the LCA technique more accessible and better suited to designers' needs and so help encourage wider acceptance of the eco-design approach.

Keywords: eco-design, life cycle assessment, environmental assessment, sector-specific decision tool.

INTRODUCTION

In recent years the effects of climate change have become more obvious: extreme summer temperatures (south-western United States), desertification, melting ice caps and glaciers and deforestation. These changes, combined with population increase and depletion of natural resources, directly impact on human life and pose a threat to future generations. Scientists have long been aware of the significant role played by humankind in these dramatic changes. In 1972, the principle of limits to development was formulated in the Club of Rome's first report. Recognition of the reality of climate change and the role played by humankind came in 1992 at the Rio Earth Summit and with the signing of the United Nations Framework Convention on Climate Change. This increasing awareness has been accompanied by measures to start reducing the damaging impact of humankind on the environment, exemplified by the 1997 Kyoto Protocol, setting targets for the reduction of greenhouse gas (GHG) emissions. Humankind has begun to realise the need to play an active role in protecting our environment. Public interest in issues concerning the future of the planet and conditions of human existence is growing, along with an increasing concern for sustainable development.
Industry is very much involved in this because manufacturing activities significantly impact on the environment, through gas emissions, chemical waste, consumption of raw materials, etc. There are many aspects of this involvement. For example, industrial ecology seeks to reduce energy and resource flows by developing synergies between systems of manufacture. Eco-design aims to reduce the environmental impact of production [1] by taking the issue into account at the design stage, in relation to each stage of the product's life.
The success of this initiative depends on having some means of assessing the global environmental impact of production. In practice, even when the fate of all the input flows involved in the production process is known, it is still difficult to know the effect on the environment.
Life cycle assessment offers a means of understanding the connection. It is a methodology focused on the product (good or service) that enables potential environmental impacts to be assessed over the full

length of the product life cycle. The rules and requirements associated with LCA are defined by ISO Standards 14040 [2] and 14044 [3]. Programmes such as SimaPro or GaBi can be used to perform LCA simulations and calculations. These programmes make use of databases such as the Swiss ecoinvent database [4] or the Eurepean Reference Life Cycle Database (ELCD) [5].
The Standards identify 4 stages of an LCA study. This article will focus on stage 3, impact assessment, a crucial stage of the exercise because at this stage the assumptions are made that will directly affect areas of uncertainty and results and influence design decisions. It is the result of a French collaborative project involving a textile manufacturer (TF Creation), a textile technical institute (IFTH) and a research laboratory (ICD, CREIDD).
The aim has been to develop an eco-design tool, *Teksajo*, primarily intended to enable small and medium-sized enterprises (SMEs) in the textile industry to carry out LCA 'simply' but in a scientifically robust manner, thus facilitating the choices involved in eco-design. This involved looking at the choice of models of calculation and indicators. The decision was taken to pre-select a limited number of suitable robust indicators, using existing knowledge of the subject, in order to simplify this stage and the interpretation stage for the user. In the course of selecting indicators, it has become apparent that there are very few sources of specific advice available to help make a choice relevant to the sector.
In this paper, we shall be using the terminology employed in the *International Reference Life Cycle Data System (ILCD) Handbook* [6]: an LCIA methodology designates a collection of individual characterisation (or calculation) 'models' or 'methods', used in combination to examine the different impact categories to which the methodology applies. A 'method' is an individual characterisation model whereas the methodology is the collection of methods.

There are a number of different methodologies used to carry out impact assessment (CML [7], TRACI [8], EDIP [9][10], etc.). Each uses its own set of indicators, which differ according to the measurement approach or the model of environmental mechanism.
The methods themselves are still in the course of significant development and improvement [11], with new methods regularly suggested and updated.
As a result, there are a substantial number of methods currently in use, each suggesting indicators for impact categories. The non-specialist finds it difficult to choose the appropriate method and appropriate indicators to apply to the impact assessment of a specific product.
This article seeks to facilitate the use of LCA in industry, in particular by SMEs, suggesting a methodology that will allow the selection of characterisation models of impact categories indicators appropriate to the sector concerned.
A brief introduction to the basic principles of LCA will help to anchor the study and define the terms used throughout the rest of the article. A brief historical review of LCA focusing on methodologies will help to explain the variety of methodologies available and their principal differences. This will be followed by a brief review of the literature illustrating the lack of guidance available when choosing indicators appropriate to the specific sector. On the basis of this observation we then proceed to describe a methodology that enables a choice of indicator to be made for the sector under consideration. At the same time we describe the approach that will be followed in the development of this methodology whose general aim is to make LCA available to non-specialists in industry as a way of encouraging the wider adoption of the eco-design approach in business.

BACKGROUND

Basic principle of LCA and impact assessment

Life cycle assessment is a methodology focused on the product (good or service) that makes it possible to assess the product's potential environmental impact over the full course of its life cycle, from the raw materials stage, through to production, use, end-of-life treatment, recycling and disposal [2].
Life cycle assessment makes it possible to compare a variety of component elements, products, systems with one another and also to highlight the points of greatest impact during the life of the product and so implement measures to reduce the global environmental impact.
The principles and basic structure of LCA are as defined in ISO Standard 14040, which identifies four essential stages in the process:

- Goal and scope definition.

- Inventory analysis (LCI).
- Impact assessment (LCIA).
- Interpretation.

Stage 1 is a preliminary stage that establishes the structure and the limits of the assessment. In it the boundaries of the system and the functional unit and the level of detail of the assessment are defined. The functional unit provides a quantified reference point for the service provided by the product. At the inventory analysis stage, data is collected concerning the quantities of resources and pollutants entering and leaving the system for each process in the system covering the whole life cycle. The results of the inventory analysis are used in the impact assessment stage, during which the data relating to the service provided by the product concerning the flows entering and leaving the system are aggregated and translated into environmental impact indicators capable of interpretation by the user.

Subsequent to their emission, each element identified by the LCI passes through a series of chemical, physical and biological processes known as the environmental mechanism or route of impact, whose comprehensive modelling allows the impact of a substance in one of the three 'areas of protection' (alternatively 'endpoint categories' or 'damage categories')— resources, human health, and natural environment—to be determined. When the assessment is carried out at this final point of the environmental mechanism (at the level of areas of protection), it is described as endpoint approach or damage assessment.

Assessment can also take place at earlier stages of the environmental process. This is referred to as intermediate assessment or midpoint approach. Midpoint impact categories representing the environmental points of impact are defined and used to structure the results of the inventory analysis (Acidification, eutrophication, global warming …).

For each impact category or damage category, an indicator allows the impact to be represented in quantitative terms via a reference unit. Characterisation measures enable the contribution of an inventoried substance to the impact to be quantified by establishing the relationship between flow quantity and the reference unit. For each emission, the environmental mechanism is modelled and the characterisation measure is calculated, in the characterisation model. There are several characterisation models for each emission (most obviously endpoint or midpoint models). Methodologies provide a variety of models applicable to different impact categories.

Evolution of LCIA methodologies

First developed during the 1980s, LCA was the subject of a revival of interest at the end of the decade in relation to issues concerning solid wastes. A debate concerning the standardisation of methodology was encouraged at the time by the Society of Environmental Toxicology and Chemistry (SETAC) [12].

In 1990, the first SETAC workshop incorporated the impact assessment stage in the LCA procedure. The first assessment methodologies were proposed as way of structuring this third stage of the LCA. In 1992, the Leiden University's Institute of Environmental Science (Centrum voor Milieukunde Leiden - CML) published a methodology in the form of a guide [13], which marked a turning point in the scientific basis of the LCA methodology [12]. This is still one of the most commonly used methodologies. It replaced the critical volumes method, one of the earliest LCA methodologies employed in LCA impact assessment, introduced in 1984 by the Swiss Federal Office for Environmental Protection (Bundesamt für Umweltschutz - BUS) following an impact study of packaging materials.

Other methodologies appeared, employing different approaches, including EDIP 97 [14][15], and Eco-indicator 95 [16]. More than 15 LCA environmental impact assessment methodologies have been identified.

There are a number of reasons why there are so many different methodologies.

To begin with, some developments are targeted at a particular area of activity or profession. For example, the BEES [17] software is intended to assist architects, quantity surveyors and engineers in the construction industry with decision making and design.

However, the main reason why there are so many of these methods is the complexity of modelling environmental mechanisms. These models are derived from very broad, highly specialised areas of science, such as molecular biochemistry, meteorology, geology, thermodynamics, etc.
Advances in the understanding of complex phenomena in these fields have been a particular driving force in the constant development of new methods of characterisation.

Methodologies, and characterisation models in particular can be distinguished according to whether they take account of intermediate (midpoint) impacts or final (endpoint) impacts. The midpoint approach reduces the degree of uncertainty but may be less helpful in decision making than the final approach [18]. Since the strengths and weaknesses of the two approaches complement one another, some methodologies offer a mix comprising several midpoint indicators and several endpoint indicators. This was the basis for the development of the Impact 2002+ [19] and ReCiPe [20] methods, which aim to combine the two approaches.
Another important difference is the general concept on which the methodology is based. For example:
- The *distance to target* political approach: Swiss ecoscarcity [21].
- The monetary approach based on willingness to pay (willingness to pay approach): EPS 2000 [22], [23].
Finally, certain methodologies have been updated to keep pace with scientific advances in LCA, particularly regarding the modelling of impact routes, such as EDIP 97 [14][15] and 2003 [9][10] or Eco-indicator 95 [16] and 99 [24].

The current position concerning comparison of methodologies and sector-specific choice of indicators

At the impact assessment phase, the selection of impact categories, category indicators and characterisation models is important. It determines how the results of the study can be used. As described in ISO Standard 14044 [3], this selection must be conducted on the basis of defined rules, in particular concerning consistency with study goals and the comprehensive character of the environmental problems considered in relation to the product.
However in practice, it is difficult to carry out this selection with confidence. It is, above all, experience and a thorough knowledge of methodologies and methods of calculation that guide decision making.
The literature allowing a comparison of the available tools is very generalised in nature. The Joint Research Centre ’s (JRC) studies of LCA have led to a set of widely respected technical documents (*ILCD Handbook*) [6], of considerable value in terms of the summary of information concerning the recommended practices, data, and models and indicators. The *ILCD Handbook* positions itself clearly as a ‘starting point’ for the formulation of recommendations, criteria or simplified tools focusing on a particular sector (or a product).
Studies have shown that the methodology chosen affects the results obtained, as a comparison of the methodologies EDIP 97, CML 2001 and Eco-indicator 99 illustrates [25]. This demonstrates how the choice of method is particularly important when chemical impacts on human health are the principal subject of the study.
In Bare’s 2000 publication [18] midpoint and endpoint approaches are compared and critiqued. This article, reporting on the conclusions of a workshop of experts, demonstrates the complementarity of the two approaches. The midpoint approach involves less uncertainty because the evaluation is carried out at an earlier stage in modelling the environmental mechanism. However, midpoint indicators may be more difficult for decision makers to interpret. This remains a real issue despite the emergence of methodologies combining the intermediate and final evaluations (ReCiPe). The issue is knowing how much uncertainty is acceptable in the context of the study and what interpretation can be made using the indicators selected. Only rarely will the type of sector be a factor influencing the choice of an endpoint or midpoint approach.

The article by Haes [26] identifies best current practice with regard to impact categories and suggests characterisation measures for LCA use. It only offers general guidelines. A publication currently being prepared will for the first time set out general recommendations for the choice of impact category models by impact category. This is the last of the series of documents of ILCD handbook published by the JRC. It will examine, analyse and assess each model of environmental mechanism on the basis of criteria identified in the handbook [27]. This should provide a generally agreed basis for selecting characterisation models and indicators relevant to each impact category in a European context but, like all the *ILCD Handbook* series, is also a basis for sector-based recommendations.

Our project is focused on the textile sector. We have found a scarcity of documents available concerning the choice of indicators for the textile sector.
The study by Lisabeth Dahllöf [28] focuses on the problems of LCA in the textile sector. It tackles the problems of data quality and the definition of the functional unit, which are recurrent problems in LCA in the textile industry. One of the particular features of the textile sector highlighted in this document is the frequent exclusion of certain environmental impacts, which may have a strong local impact in relation to textiles but a weak impact on a more global scale, for example noise and dust in the work environment. The irrigation of cotton crops, which in certain parts of the world is leading to the depletion of water resources and soil salinisation, is another problem specific to the textile industry that it is difficult to identify in the impact categories. The same is also true for pesticide use in cotton growing or sheep farming.
These are issues that need to be considered when selecting impact categories and highlight the problem of how these indicators can be taken into consideration in the assessment when appropriate methods of calculation are not available.

There is no way at present of comparing methodologies and methods of calculation that takes account of the sector's specificities. We are proposing a methodology that makes it possible to select indicators appropriate to a particular sector. Our project intends to apply this to the textile industry in the context of the ongoing refinement of the Teksajo tool.

PROPOSAL OF A SECTOR-SPECIFIC MECHANISM FOR THE SELECTION OF IMPACT INDICATORS

Manufacturers—SMEs in particular, as they lack specialist expertise—tend to pay little attention to the selection of indicators and may even use indicators of limited relevance to their analysis.
This has led us to propose a methodology for the selection of impact indicators. It is intended for use directly by manufacturers or in the development of dedicated LCA tools in which indicators are pre-selected for the user.
The intention is to make LCA more accessible to non-specialists in industry, with a view to encouraging the use of the eco-design approach. To avoid any confusion with LCA methodologies, in the rest of this article we will use the term ‘mechanism’ to describe the process of indicator selection.

This mechanism consists of two main stages:
1. Assessment and screening of methods of calculation for all sectors combined.
2. Ranking and selection of sector-specific indicators.

The first stage, the assessment and screening of methods of calculation, yields results that can be used in all sectors. It allows the most appropriate method of characterisation for each impact category to be selected without reference to the sector. For impact categories where this is not possible, only models that are particularly subject to criticism will be excluded.
The second stage, the ranking and screening of sector-specific indicators, introduces sector-specific criteria with a view to identifying the most appropriate indicators in each impact category.

Figure 1 sets out the general mechanism. Here at the start of the study we find all the indicators available (ind. a, ind. B, etc.) to a particular method of characterisation. These are grouped under the impact categories that they quantify (Cat. I, Cat. II, etc.). The two stages consider each impact category independently. The most appropriate indicator for each particular impact category is determined. By the end of the first stage, an indicator will already have been selected for some impact categories. The others will still have several potentially suitable indicators that will be weeded out in the second stage.

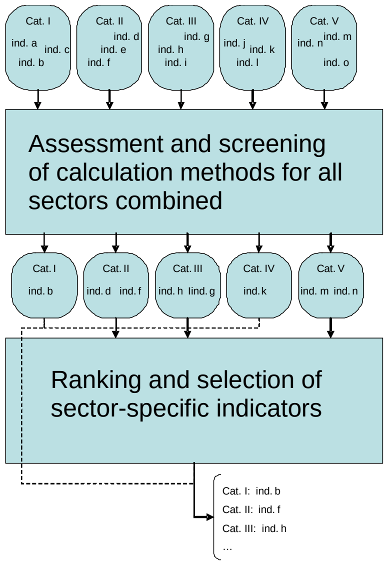

Figure 1: General outline of the methodology

Stage 1: assessment and screening of methods of calculation for all sectors combined

This first stage does not involve the selection of impact categories but aims to identify the best characterisation models available for each impact category. This is a two-stage operation, as shown in Figure 2:

- Identification of consensual methods: this stage involves the selection of methods of calculation whose use in the relevant category is 'consensus-based' and the scientific community does not currently envisage any alternatives. The most obvious example is the climate change indicator. The scientifically recognised reference method is the one published by the United Nations Environment Programme's Intergovernmental Panel on Climate Change. It aims to evaluate the potential contribution of individual substances to the increase in the greenhouse effect using the GWP (global warming potential) index [29]. The indicator used to assess ozone layer depletion is also consensual as far as the international scientific community is concerned. Most methodologies use the World Meteorological Organisation's (WMO) model of ozone depletion potential (ODP).
- Assessment of non-consensual methods: the impact categories for which no consensual indicator has been identified are dealt with at this second stage. It involves comparing the characterisation models with one another and assessing them on the basis of criteria listed below. In some impact categories, an indicator will have a significantly higher assessment and is liable to be recommended irrespective of sector. In other impact categories, indicators with a significantly lower rating than the rest will be eliminated because they are not going to be recommended for any sector. The remaining indicators may however be suitable for one or more sectors and will be considered in the second stage.

This evaluation is currently being carried out by the JRC (for the forthcoming *ILCD Handbook*). As previously explained, it is intended to establish the consensus and serve as a basis for sector-specific recommendations. It has therefore been proposed that this publication should be used as a reference for the assessment stage of non-consensual methods.

As this publication is not yet available, to meet the needs of the project with which we have been involved, we have carried out a more modest-scale study using a matrix for the comparison of methods of calculation which provides a first level assessment of the non-consensual methods of calculation. This matrix is based on 8 criteria defined on the basis of the issues discussed in the literature, the answers provided by LCA experts to a targeted survey, and other publicly available information on the subject methods of calculation. By ascribing a value of 1 to 3 to each criterion a score can be obtained for each method of calculation. When one method obtains a score clearly higher than the rest, it can be ranked highest. If the scores are identical or similar, the methods cannot be distinguished and the categories concerned are then considered in the second stage.

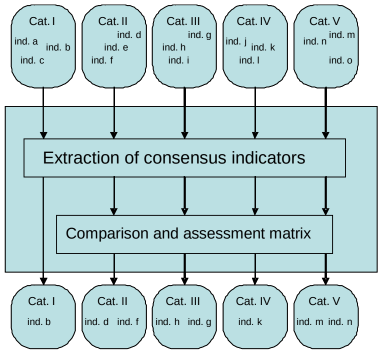

Figure 2: Assessment and screening of calculation methods for all sectors combined

Stage 2: Ranking and election of sector-specific indicators

This second stage, the ranking and selection of indicators, is a sector-specific approach to the problem. It allows the best indicator for the impact categories for which several potential indicators were identified at the end of stage 1 to be identified.

It consists of:

- A literature matrix.
- A diagnostic matrix.
- A filter.

These elements will be described in more detail later in this article. They are organised as shown in Figure 3. A literature matrix is prepared for a particular sector. It uses information obtained from a literature review. The diagnostic matrix uses diagnostic parameters to translate the constraints and requirements of the project into study conditions. The filter allows the components of the literature matrix that satisfy the study conditions to be selected as the means of achieving a final result.
The diagnostic parameters should be regarded as variables capable of having a finite number of values. They must be capable of representing those conditions and requirements of the project or study that are liable to influence the choice of impact indicators. A survey of a large sample of companies will be carried out in order to identify key parameters—for example, geographical location and type of product are two possible diagnostic parameters.
For a given project or a study, each parameter will have a fixed value (for example ‘textile technique’ and ‘Europe’, etc.). This set of values will constitute the study conditions for a given study.

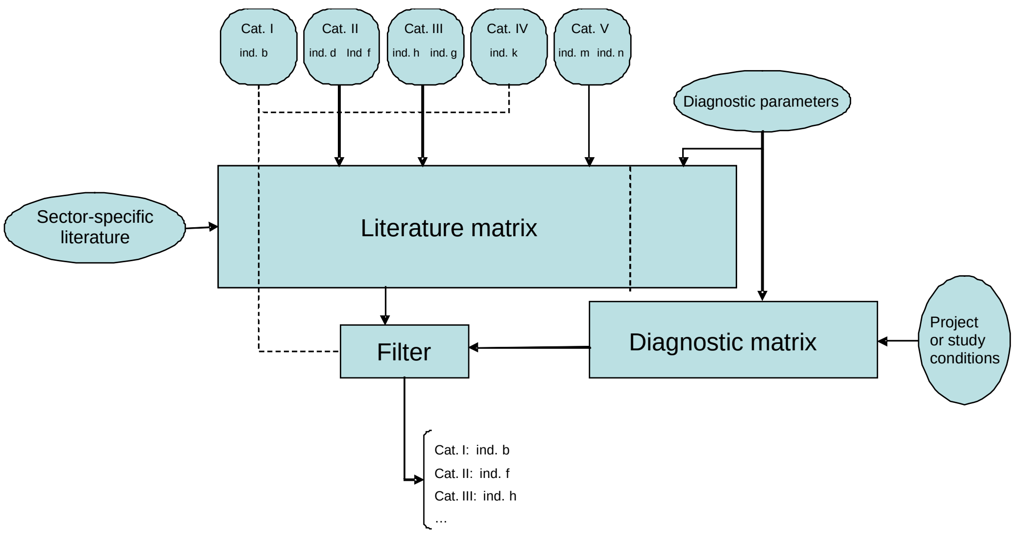

Figure 3: Ranking and selection of sector-specific indicators

Construction and completion of the literature matrix

The literature matrix referred to in this article is based on the methodology described by Laratte *et al.* in an article pending publication.

The basic information entered into the matrix consists of the category indicators obtained from phase 1, the assessment and screening of methods of calculation, and from the individual publications included in the sector-specific literature review.

The literature review covers only the target sector but is nevertheless very extensive. It draws on three types of publication:

- Local and global standards, legislation and policy documents.
- LCA studies.
- Scientific publications.

The indicators identified, recommended or used in each publication included in the literature review are marked with a cross in the matrix.

We propose to add to this matrix by indicating the study conditions defined by each publication, in other words, the diagnostic parameter values employed. The diagnostic parameter values are included in the table next to the indicators.

An example how the matrix appears is shown in Figure 4.

	Indicators								Analytical parameters				
	Impact category I		Impact category II			Impact category III			Parameter A		Parameter B		
	ind. a	ind. b	ind. c	ind. d	ind. e	ind. f	ind. g	ind. h	value 1	value 2	value 1	value 2	value 3
doc 1	x			x			x		x	x	x		x
doc 2	x			x			x			x		x	x
doc 3	x		x			x			x		x		
doc 4		x	x				x		x	x			x
doc 5	x				x	x			x		x		
doc 6	x			x						x		x	x
doc 7		x					x			x			x
doc 8	x								x	x	x		
doc 9	x					x							x
doc 10	x			x		x				x	x	x	x
doc 11							x		x			x	
doc 12		x						x	x		x		
doc 13	x						x		x		x		

Figure 4: Literature matrix

Diagnostic matrix

The diagnostic matrix enables the user to translate the constraints and requirements of the study into a study condition compatible with the filter. It takes the form of a multiple-choice questionnaire in which each question corresponds to a diagnostic parameter and each of the choices gives a value for the diagnostic parameter.

Operation of the filter

The filter enables the diagnostic matrix to be analysed and to provide score-based results. Only publications satisfying the specified study conditions are taken into consideration for scoring purposes. The scoring procedure involves tallying the number of times each indicator occurs in the bibliographic matrix.

This allows the indicators that are used most frequently in the study conditions to be selected.

Indicators								Analytical parameters				
Impact category I		Impact category II			Impact category III			Parameter A		Parameter B		
ind. a	ind. b	ind. c	ind. d	ind. e	ind. f	ind. g	ind. h	value 1	value 2	value 1	value 2	value 3
9	3	2	4	1	4	6	1		x			x
12		7			11							

Figure 5: Example of results for selected conditions of analysis (value 2 for parameter A and value 3 for parameter B). In this case, indicators a, d and g will be recommended.

The results are determined twice. The procedure calculates a score for the number of occurrences in relation to each impact category, separately from the indicators, allowing the impact categories to be ranked. So, if for the purposes of the analysis the number of impact categories taken into consideration needs to be reduced, those showing the lowest number of occurrences will be eliminated first as having the least potential relevance.

This allows the user to identify the most appropriate indicators for the assessment and the most relevant impact categories.

APPLICATION

As said in the introduction, this work concerning the choice of indicators is included in a French collaborative project which aims to develop an eco-design tool based on the LCA methodology for the textile industry: *Teksajo*. This section intends to show how, by the production of those kinds of eco-design tools, the above methodology helps SME's to achieve its eco-design development process. Let's take the example of *TF Creation*, one of the partners of the project.

TF Creation creates, develops and markets technical textiles designed to be used in places requiring specific properties in terms of security (cinema, plane, theatre …). One of its flagship products is *Veltoseat*, for seats covering. Here below are the technical requirements:

- Fire resistance : M1 classified (French standard)
- Abrasion resistance : 50000 revolutions (martindale abrasion test)
- Pleasant visual aspect.

Moreover, the product can't exceed 4.5€/m² ex-work.

Today, the product is a polyester knit and is piece dyed.

Some simple eco-design measures have already been taken: intentionally, dying is operated by a subcontractor which emits a very small amount of water pollutants and which is located close to the main factory, despite the extra cost. Two operations on the filament, initially made by two different subcontractors, have been grouped together and both of them are now made at the same plant in order to reduce the transport.

TF Creation has shown a lot of common sense that has led them to those measures, but the firm wishes now to go deeper in this thinking.

A first evaluation has been done, with an expert software. A simplified LCA using a generalist methodology (CML) was submitted to TF Creation. The evaluation of the existing product was interesting but it appears to be too complex to test new solutions. Moreover it's quite difficult to understand all the indicators calculated. It has been decided to find a way to select the most relevant indicators. The methodology described before, has been developed to achieve it and the selected indicators were integrated to the software *Teksajo*. Because TF Creation has no specific skills for carrying out environmental assessment, it needs a tool to carry out LCA, easy to use but with a solid scientific base. That's the way *Teksajo* is being developed, with specific indicators with an adapted vocabulary (based on a semantic study by survey), a specific database, and some technical information.

TF Creation will now be confident, before launching heavy studies for reaching the technical and financial requirements, that a concrete environmental gain will be obtained. As an example, for *Veltoseat*, it will be able to evaluate whether it is environmentally benefic to substitute natural fibers (wool, cotton …) for the raw material from petrochemical industry such as polyester (a reduction of gas releases could be expected, but what about water focused indicators?). Furthermore this modification would involve process adaptations (flat knitting) and an additional operation for fireproofing the material which is not necessary with the polyester filament (PE Trevira CS) because it is naturally non-inflammable. The benefits regarding the environmental aspects are then not obvious.

But now, with the help of *Teksajo*, TF Creation will answer this question very early and use, added to its usual financial and technical indicators, relevant environmental indicators to help its eco-design oriented decision-making process.

Comparable tools for other sectors can be developed using this methodology for selecting indicators.

DISCUSSION

The methodology described in this article can be applied across all sectors. A number of refinements are anticipated that will improve its usefulness. In particular the filter parameters are currently set to take account of study conditions only. This could be improved by including a weighting system for the criteria, increasing the sensitivity of with which study conditions are taken into account. The filter may also be developed to include a results matrix that takes account of the specific recommendations of the JRC and general rules governing the choice of indicators not previously considered. That would require the compilation of a sector-specific matrix by one or more experts in LCA. This matrix would then provide a very useful synthesis of the literature review and the experts' recommendations, enabling very accurate results to be obtained.

As indicated above, the methodology in question is being developed as part of a French collaborative project. The T_Soft project has demonstrated the usefulness of a methodology of the kind described here. The aim of the collaborative project involving IFTH, ICD and the textile manufacturer TF Creation has been to encourage the use of eco-design in the textile sector. The *Teksajo* eco-design software, developed specifically for the textile industry, is based on the life cycle assessment approach. It will allow uncomplicated product LCAs to be carried out as part of the process of product design without requiring expert intervention, enabling simple environmental impact assessments to be carried out during the product design process as a means of ensuring that environmental considerations are fully and effectively built into the decision-making process. This tool will be tested by the partner company and will allow products to be designed and manufactured on the basis of an eco-designed textile technique.

The methodology set out in this article will assist the design of LCA tools for sector-specific use—Teksajo in the textile industry, for example—making the eco-design approach more accessible in the industrial context.

ACKNOWLEDGMENTS

We wish to express our thanks to Nicolas Thériault, international exchange student at the University of Technology of Troyes in France and candidate for the Master’s degree in Environment at the Université de Sherbrooke, for his substantial contribution to the method assessment matrix, and also to our other partners in the project.

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