

LIFE-CYCLE ASSESSMENT (LCA) IN BUSINESS AN OVERVIEW ON DRIVERS, APPLICATIONS, ISSUES AND FUTURE PERSPECTIVES

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ABSTRACT

In recent years, a considerable research effort has been devoted to Life-Cycle Assessment (LCA). However, most of the work has been focusing on improving the methodology as such and providing guidelines for carrying out LCA studies. Much less effort has been dedicated to the exploration and analysis of the applications of LCA within the actual context of business. Which are the drivers for starting LCA activities in a company? Which are the main applications? Which business departments are involved? This is the kind of questions addressed by the present paper.

The paper reports the results of a survey about the use of LCA in business in four selected European Countries, namely Germany, Italy, Sweden and Switzerland. 1600 questionnaires have been sent out to selected companies in the four countries. As expected, there are considerable differences between countries because of a different level of environmental awareness. However, there are some main common results. The first one is that the cultural approach of Life-Cycle-Thinking is spreading out, but not yet the tool. LCA is not yet used as a routine tool for assessing environmental aspects of product innovation and it is still rather employed in a retrospective way than in a prospective one. Benefits of LCA are considered to be rather long-term ones. On the other hand, the large majority of firms is optimistic about the future use of LCA, most likely linked together with other instruments.

KEY WORDS: Life Cycle Assessment (LCA), LCA for business activities

INTRODUCTION

In recent years, a considerable research effort has been devoted to Life-Cycle Assessment (LCA). However, most of the work has been focusing on improving the methodology and providing guidelines for carrying out LCA studies. The LCA "technique" has considerably improved indeed. Especially the Society of Environmental

Toxicology and Chemistry [SETAC] has pushed this process by preparing a "Code of Practice" (SETAC 1991, SETAC 1993) and by organising a series of international workshops in Europe and the United States. Since 1995, there is an international research journal, the "International Journal of LCA", dealing exclusively with LCA. These

Table 1. Sample and Response Rates

	Switzerland (CH)	Germany (D)	Italy (I)	Sweden (S)	Total
Total number of questionnaires	403	410	400	412	1625
Answers (absolute number)	82	101	30	169	382
Answers (in %)	20%	25%	8%	41%	24%
LCA users	44	62	18	66	190
LCA users' share of total number ²	11%	15%	5%	16%	12%
LCA users' share of respondents	54%	61%	60%	39%	50%

activities, a lot of workshops, conferences, meeting, research activities merged and contributed to the elaboration of international standards (ISO 1996, ISO 1997).

However, the very important methodological discussions and progresses of the last 5-10 years have concentrated on the improvement of the method as such. The real integration issues of the method into the actual application context have nearly not been considered nor stressed. This is still an open challenge. New open questions arise: Which are the drivers for starting LCA activities in a company? Which are the main applications? Which functions are involved? What is the contribution of LCA to decision-making processes? This is the kind of questions addressed by the present paper.

Some research in this area has been undertaken just recently. Rubik/Grotz/Scholl (1996) explored the potential environmental benefits of LCA; also the demand for "streamlining" techniques have been analysed by several publications (e.g. SETAC 1997). Nevertheless, the questions with regard to the role of LCAs within the decision-making processes have hardly been examined. First experiences have been delivered by FTU/VITO/IÖW (1995a and b) and Baumann (1998).

The objective of the present paper is to provide further research progress in this area, supported by a strong basis of empirical information. In fact, the paper reports the results of a survey about the use of LCA in business in Germany, Italy, Sweden and Switzerland¹. 1600 question-

naires have been sent to selected companies in the four countries. Each national sample consisted of two main groups, namely environmentally-oriented companies and largest companies (by turnover). Table I summarizes the samples and response rates in the four countries.

A total of 1,625 companies received the questionnaire. 734 of them belong to the first group of environmental-oriented companies; 891 to the second group of large companies. 382 usable and completed questionnaires were returned, a number corresponding to an average response rate of 23.5%. The figures and shares of the four countries differ considerably: In Italy, the return rate was just 7.5%, in Germany 24.6%, in Switzerland 20.4 % and in Sweden 41%. However, these quotas correspond to the expected return rate for each country, due to the different specific national response "cultures".

NUMBER OF LCA STUDIES IN THE DIFFERENT COUNTRIES

Most LCA studies are not published. We performed an inventory of LCA studies in the four countries. Figure 1 summarises its results. In particular, Figure 1a) shows the total number of LCA studies carried out in each country by 1997.

In Germany, almost 300 studies have been compiled or are in their planning stages. In Switzerland and Sweden some 150 studies have been recorded, whereas Italy, by contrast, lags behind³.

¹The survey is a part of the research project "The Use of LCA's in Business Decision-making Processes and its Implications for Environmental Policy" funded by the European Commission /DGXII within the "Climate and Environment" - Research Programme of the European Union. The project has been carried out by five institutes: Institut fuer oekologische Wirtschaftsforschung gGmbH, (Germany - coordinator); Istituto Ricerche Ambiente Italia (Italy); Gothenburg Research Institute (Sweden); Institute for Prospective Technological Studies of the European Commission (Spain); Oekoscience Beratung AG (Switzerland).

²Of course, we do not know how many LCA users there are among the non-respondents.

³However, the number of LCA studies in Italy is presently increasing very fast

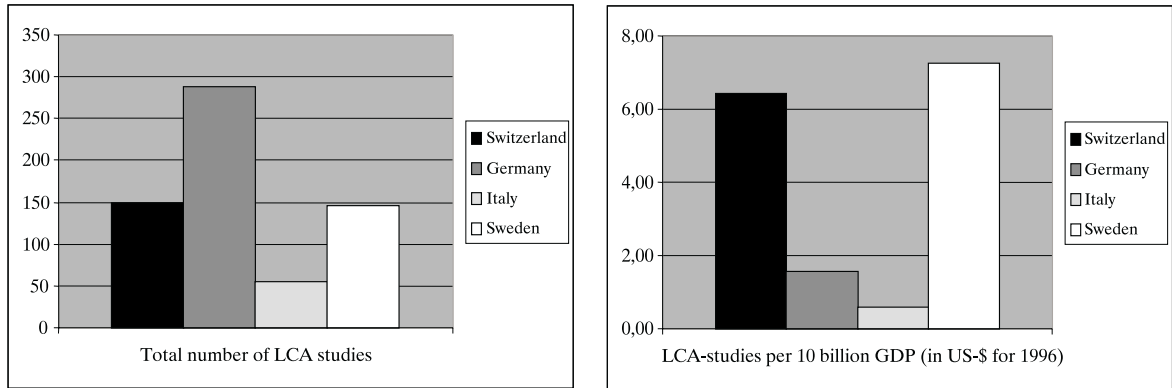


Figure 1. Total number of known LCA studies (left) and number of LCA studies per unit of GDP (right) by the end of 1996

However, if the economic importance of the different countries is taken into account, the results appear differently. Considering the GDP of the four countries, Sweden is the most important LCA-country, followed by Switzerland. In relative terms, the importance of German companies as LCA-applicants is not so great; not unexpectedly Italian companies are at the very beginning.

It should be emphasised that the statistical data-base is incomplete, as a number of studies could not be included due to the commissioning bodies' request for confidentiality. These numbers are to be taken as a lower limit in all countries. Of course, all numbers increased in the meantime, as LCA is further diffusing in all countries.

DRIVERS FOR STARTING LCA

Environmental consciousness seems to be a necessary, but not sufficient condition for starting LCA. Also the existence of an environmental management system seems to be another supporting factor for carrying-out LCA-activities. Especially Swedish companies show a deeper environmental involvement with regard to products and to the introduction of an environmental management system.

Table 2 summarises the relative importance of a set of different possible drivers for starting LCA in a company. Companies are ranked according to three possible levels of importance: high, medium and low. Each company could give several possible answers.

Table 2. Importance of drivers for starting LCA [source: Frankl & Rubik, 1999]

Drivers	CH	D	I	S
Product-related environmental problems	A	A	B	A
Cost-saving opportunities	A	A	A	B
Emerging green markets	A	A	B	B
Decision of the management	B	A	B	B
Perceived environmental discussions	B	A	B	B
Cost avoidance due to future liabilities	B	B	B	A
Collaborative study with ext. organisations	B	A	C	B
Meet eco label criteria	B	B	B	B
Initiatives by Research & Development	B	B	C	A
Encouragement by the parent company	C	C	A	B
New instruments for R & D	C	C	A	C
Environmental legislation	B	B	B	C
Competitors started to use it	C	C	C	C

A=high importance
B=medium importance
C=low importance

Table 3. Main applications of LCA [source: Frankl & Rubik, 1999]

Application	CH		D		I		S	
	today	future	today	future	today	Future	today	future
Bottleneck identification	A	A	A	A	C ⁴	B	A	A
Information and education to consumers and stakeholders	A	A	A	B	B	A	A	A
Compare existing products with planned alternatives	A	B	B	B	B	B	A	A
Research development and design	B	B	B	B	A	B	B	B
Compare existing company products with products of competitors	B	B	B	B	B	B	B	B
Procurement specifications, supplier screening, product co-makership	B	B	B	B	B	A	B	B
Internal information and training	B	B	B	B	B	B	B	B
Anticipate and negotiate legislation	B	B	B	B	B	B	B	C
Marketing, advertising policies & joining eco-labelling criteria	B	C	B	B	B	B	B	B
Environmental cost allocation	B	B	B	C	B	B	C	C
Assess the gap from eco-label criteria	C	C	B	C	B	C	C	C
Radical changes in product life cycle	C	C	C	B	C	B	C	C
Shift from product to service	C	C	C	C	C	C	C	C
Other	4.5%	4.5%	6.5%	1.6%	0%	22%	0%	1.5%
Not answered	6.8%	29.5%	4.8%	37%	0%	17%	1.5%	9.1%

A=high importance (>40% of companies)

B=medium importance (between 10%and 40% of companies)

C=low importance (<10% of companies)

Important drivers for starting LCA-activities in all countries are cost savings; however, it is interesting to notice that the role of cost savings as driver is perceived in a different way in the countries: directly in Germany, Italy and Switzerland, whereas indirectly in Sweden via future liabilities. This is a modest hint that Swedish companies are more proactive-oriented than companies in the other countries. Other important drivers are product specific environmental discussions and problems. Also remarkable is the importance of Research&Development in Sweden, which is another hint for the proactive orientation of Swedish companies. For all four countries, a direct influence by the application of LCA by competing companies is not perceived as a driver. The environmental legislation, i.e. political or juridical pressures, are not important, especially in Sweden and Switzerland;

however, in Germany environmental legislation is ranked near to the most important drivers. One might also conclude that a long-term and proactive orientation of companies supports the start of LCA because LCA is able to analyze and describe future problems and risks of products. The role of environmental groups and consumer organisations must be taken into consideration as well.

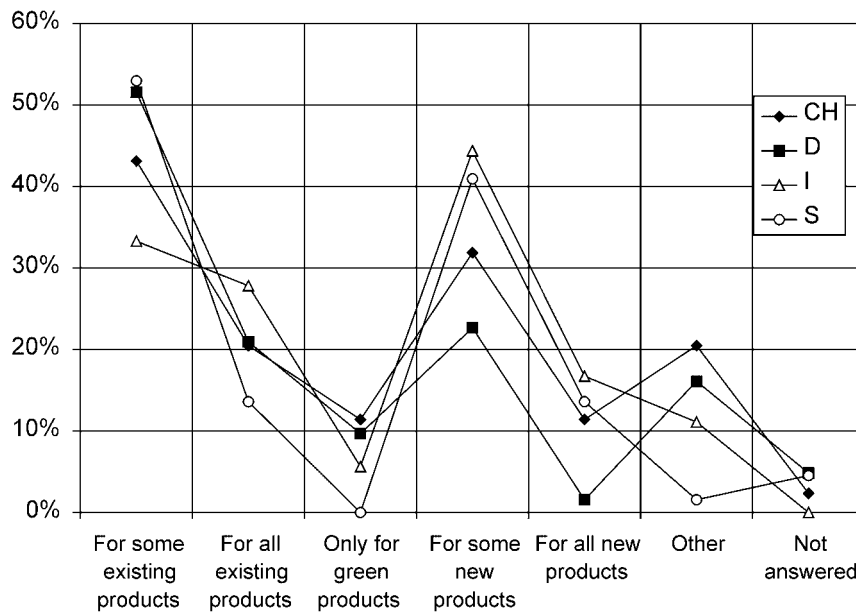
In Italy, many LCA studies were driven by the encouragement of parent companies.

APPLICATIONS OF LCA

Table 3, summarises the relative importance of possible different main applications of LCA in the four countries. Rankings are distinguished for present and future applications.

A quite common trend in Switzerland, Germany and Sweden can be observed, whereas Italy shows very different results. In the former three

⁴A possible explanation for this ranking is that the Italian term used in the questionnaire ("identificazione di colli di bottiglia") might not be common in the framework of Italian business and might not have been fully understood by the people filling in the questionnaire.



[Up to two answers possible]

Figure 2. Products subject to LCA studies (relative shares in % of LCA-using companies in each country) [source: Frankl & Rubik, 1999]

countries the identification of bottlenecks is the most important application of LCA (with a very high peak in Sweden). This application seems to be absolutely irrelevant in Italy, although a misunderstanding in the corresponding question might be also a possible explanation. Another common application in the three countries is for the external information of consumers and stakeholders. Once again, there is a big difference in Italy. This reflects the fact that in Italy people mostly think that LCA results are still too complicated to be communicated to the public. This might be connected to the fact that LCA in Italy is still at a rather early stage of development. As a matter of fact, a more "external" use of LCA results is expected in the future (see next paragraph).

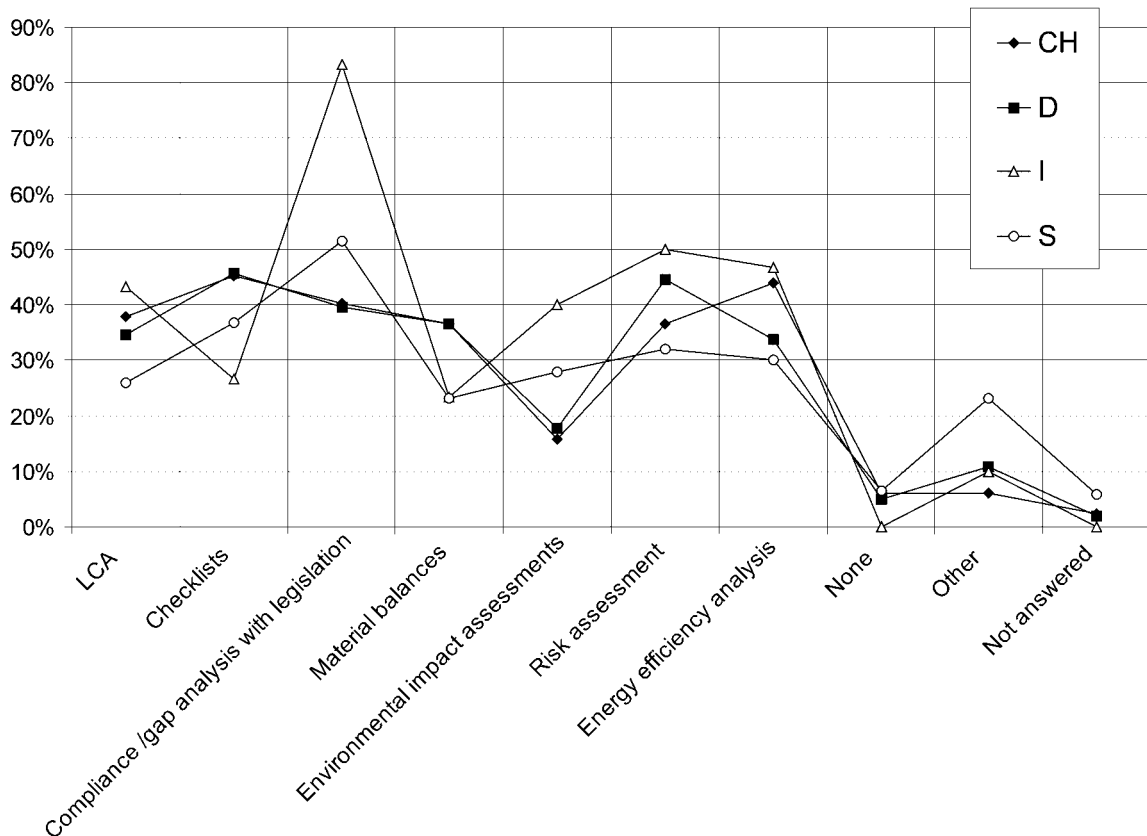
As far as this is concerned, it is also interesting to observe that LCA is not used too much for marketing, but it is heavily used for information and education to consumers and stakeholders. This reflects the fact, that in many cases today LCA cannot be used directly for marketing because of complex and sometimes disputable results. On the other hand however, companies do use LCA already today as a basis for external information, and are actively exploring ways to eventually and

correctly use LCA for marketing in the future.

The application for the purpose of comparing existing products and possible alternatives suggests a more proactive use of LCA in Switzerland and Sweden. This application is much less relevant in Germany (29%) and is rather rare in Italy (17%). On the other hand, Germany and Italy seem to be quite susceptible to pressure from outside (Compare existing company products with products of competitors; Procurement specifications...; Assess the gap from eco-label criteria, etc.). Finally, LCA is used in all countries as a tool for research, development & design. This is the main application in Italy, where LCA is still mostly regarded as an internal tool. However in the other countries as well, more than 30% of the companies use LCA for this particular application.

In all countries, LCA seems not to be used for the two "strategic" applications, i.e. radical changes in the product life-cycle and shift from product to service. The only (modest) exception to this pattern is represented by the 15% of German LCA companies using LCA for radical changes in the product life cycle.

In future, only minor changes of application patterns are expected in Sweden, Germany, and Switzerland. In the latter country, an increased appli-



[Several answers possible]

Figure 3. Mostly used management tools in the context of environmental improvements of products (relative shares in % of all respondent companies - both using LCA and not using LCA - in each country) [source: Frankl & Rubik, 1999]

cation for research & development, for comparing with products of competitors and for procurement specifications are expected. In Italy a major shift towards more external applications is expected.

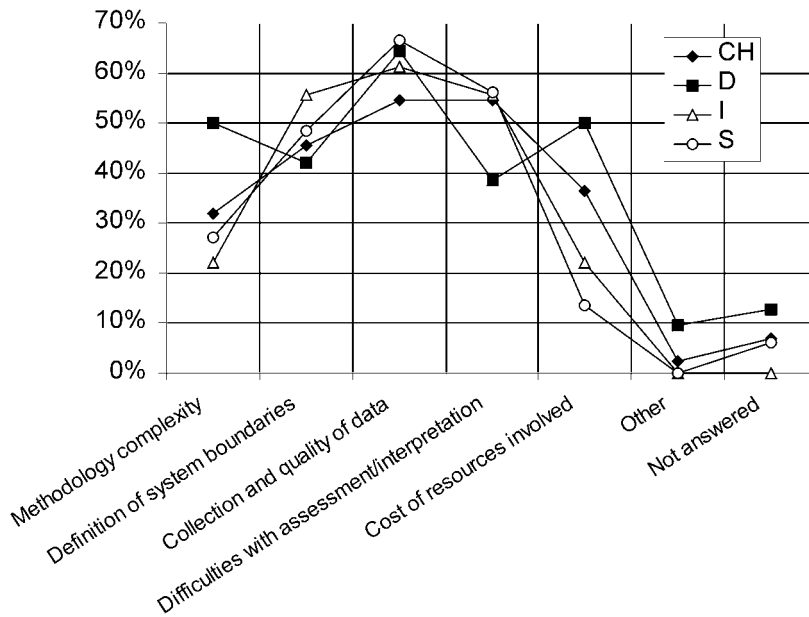
PROSPECTIVE OR RETRO-SPECTIVE USE?

In order to identify whether companies use LCA in a rather retrospective or more prospective way, firms were asked which kinds of products they have analysed with LCA. Figure 2 shows the products which have been subjected to LCA studies in the various countries. Once again, in order to compare the different countries, the results are expressed in per cent.

A common trend for all countries can easily be seen. LCA is generally applied to some products but not to all products. Moreover, LCA is mostly used for a few existing products, and is clearly not used for green products only. In general, at present

LCA is still more frequently used in a retrospective way than in a prospective one, since it is applied more to existing products than to new ones. In particular, the percentage of LCA application to all new products is low. All this suggests that LCA is not yet used as a routine tool for product innovation, nor for environmental product innovation in particular. This seems to be especially true in Germany, where very few companies apply LCA to all new products, and 23% apply it to some new products. In comparison, the higher percentage of Swiss and Swedish companies applying LCA to all new products and some new ones hints at a slightly more proactive use of LCA in those countries.

All these considerations have to be considered with some care, because the application of LCA to all or to new products also strongly depends on the size and branch sector of the company (i.e. a small company can have a small set of products, while a



[Several answers possible]

Figure 4. Methodological problems of doing an LCA (relative shares in % of LCA-using companies in each country) [source: Frankl & Rubik, 1999]

big chemical company might have thousands of different products). In particular, the Italian results are not consistent with those of their previous ranking and do not seem to be highly reliable because of the low absolute number of respondents (all of the 18 LCA-companies responded, but nine identified only one preference).

PRODUCT INNOVATION - DRIVERS AND TOOLS

According to our survey, product innovation is driven by marketing, costs and competition. In all countries environmental pressure is the least relevant factor for pushing product innovation. Most involved departments are the top management and the marketing and sales department. Environmental departments/officers usually do not take regularly part in product innovation processes. As a consequence, today it might be concluded that there is not a straightforward connection between LCA and (environmental) product innovation. This is further confirmed by the fact that only 50%-60% of LCA companies declare to apply LCA itself for environmental product improvements. As a matter of fact, the majority of LCA carried out until now have rather been retrospective/learning ones. However, LCA-using companies rank drivers slightly higher, in

particular marketing and environmental opportunities. This might suggest a correlation between a more strategic and proactive view towards environmental product innovation and the use of LCA. LCA companies also tend to use a larger mix of tools for product environmental assessment and improvement (with the exception of Italy). Moreover, there is a tendency towards a more prospective use of LCA.

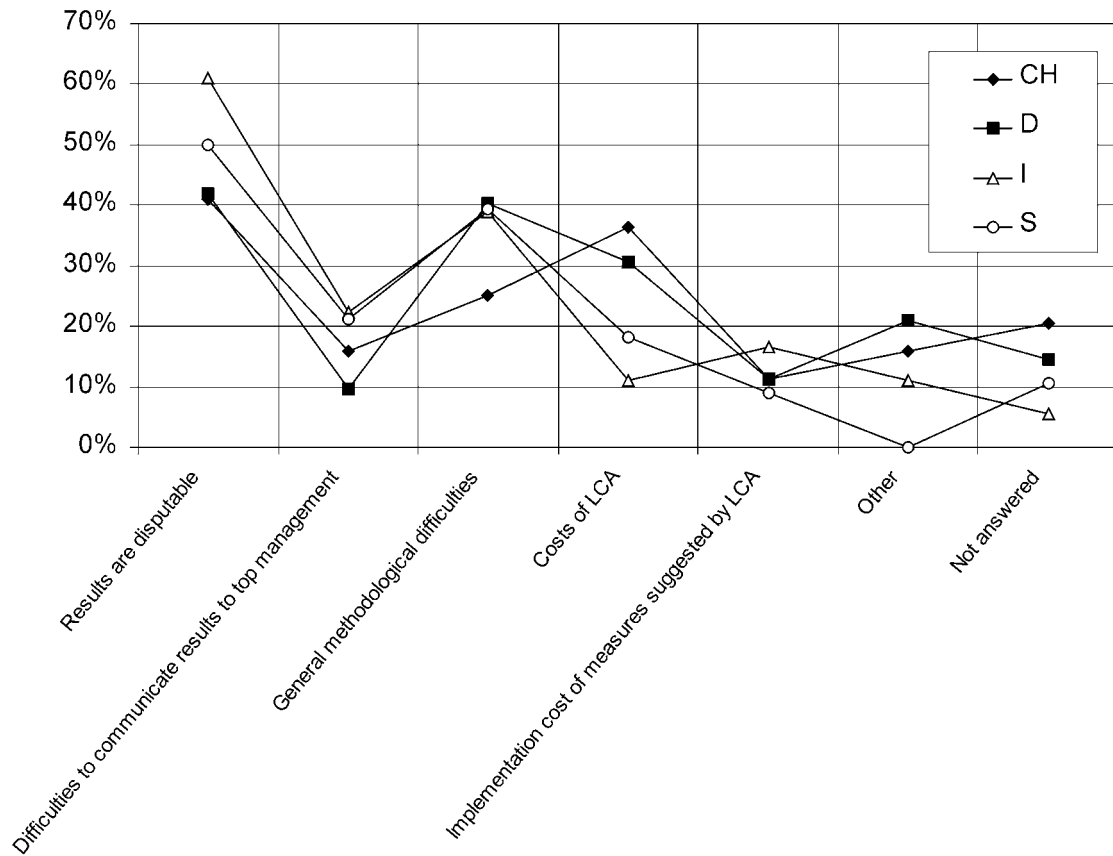
Figure 3 shows the main environmental management tools employed for an ecological improvement of products. The figure clearly shows that LCA is an important tool among others.

LCA-TECHNIQUE AND OPEN ISSUES

In all countries, LCA are more and more carried out internally, often involving several functions within the company. In Sweden, the percentage raises up to 77% of companies. This suggests that the "internalisation" of LCA competence within the firm increases with the wider use of LCA.

Figure 4 shows the main methodological problems encountered by companies while carrying out LCA studies.

Clearly, major difficulties are connected with the environmental inventory (collection and quality of data in Italy, Germany and Sweden, defini-



[Several answers possible]

Figure 5. Main obstacles to a wider use of LCA (relative shares in % of LCA-using companies in each country) [source: Frankl & Rubik, 1999]

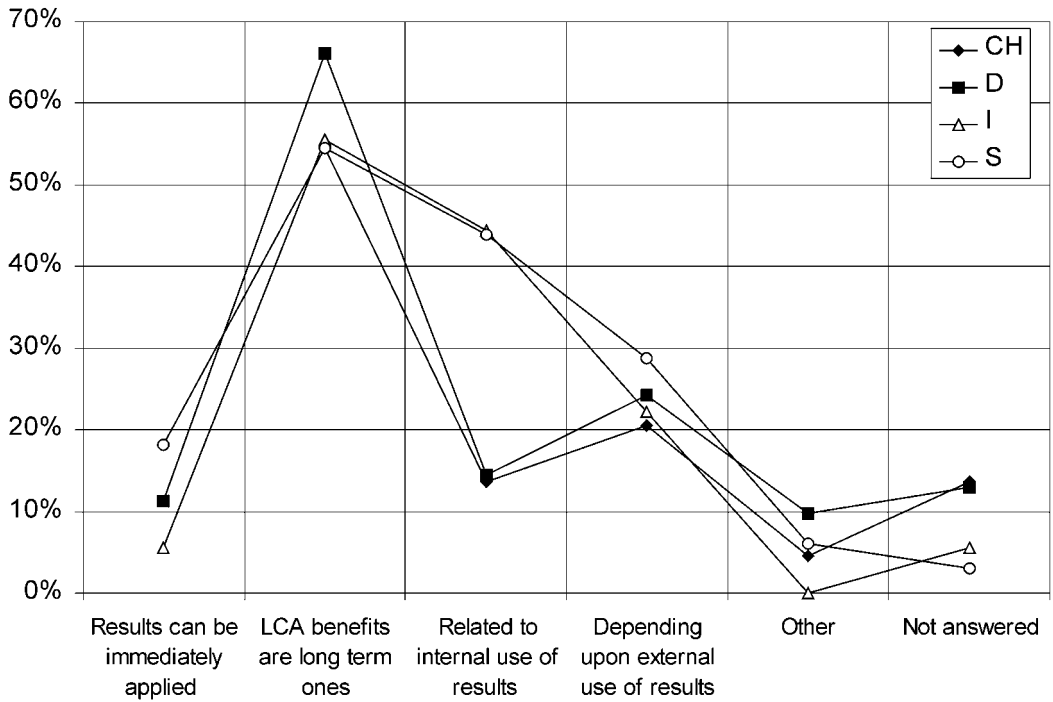
tion of boundary system in Italy). Switzerland seems to have a better data collection system, most likely connected with a higher availability of public data. As expected, a large fraction of companies has significant problems with the assessment and interpretation of results in all countries. Interestingly, in Sweden, the problem of costs is much less perceived than in other countries. In this country, LCA is a more routine tool and LCA users in company profit from past experience and from more external support by the state and by research institutes than in the other countries.

Figure 5 shows the main perceived obstacles against a wider use of LCA in the future.

The general trend is quite clear. Two results are similar in all countries: The first major obstacle to a wider use of LCA in business is the fact that results are disputable (40-60%). The second common result is the low ranking of difficulties to communicate results to top management. This result is quite surprising.

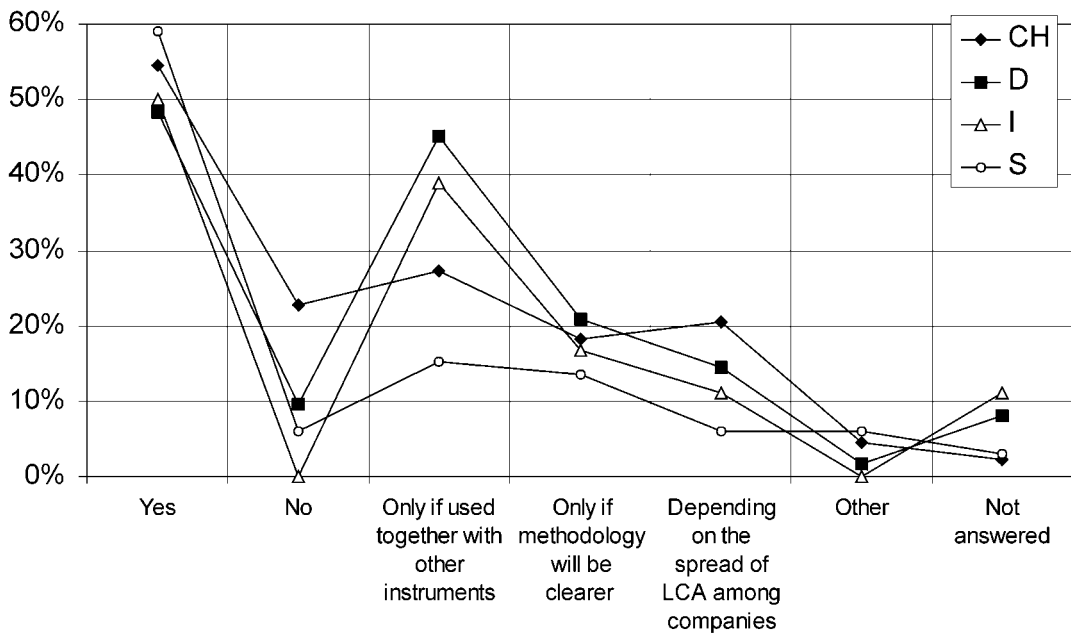
General methodological difficulties are perceived as a significant obstacle in Germany, Italy and Sweden. The Swiss "deviation" must be interpreted with some care, because Switzerland's rate of non-respondents in this case amounted to 20%. However, a plausible explanation for this might be that there is more public support from the state through its ministries and other important organisations (for example ÖBU, BUWAL) in this country.

The result referring to costs is consistent with earlier results: Costs are perceived as a main problem in Germany and Switzerland, but significantly less in Italy and Sweden. Interestingly, in no country is the cost of implementing measures suggested by LCA considered a main obstacle. To us, this is a rather surprising result. However this might be explained by the fact that many LCAs carried out until now have been retrospective/learning ones and not intended from the beginning as a design tool to introduce changes in production. Most of these studies have been carried out within envi-



[Several answers possible]

Figure 6. Benefits of LCA as they are perceived in companies in the different countries (relative shares in % of LCA-using companies in each country) [source: Frankl & Rubik, 1999]



[Several answers possible]

Figure 7. Increased use of LCA in companies in different countries (relative shares in % of LCA-using companies in each country) [source: Frankl & Rubik, 1999]

ronmental departments, which are "far away" from accounting and production departments. Another possible explanation is that the cost is accepted anyway before the study starts.

OUTLOOK

Figure 6 shows the time-horizon of the benefits of LCA, as perceived by the surveyed companies.

Companies in all countries do agree on the fact that results of LCA cannot easily be applied immediately and that benefits deriving from LCA are long-term ones. A quite large percentage (20-30%) of companies think that benefits depend on the possibility of diffusing results externally. However, results suggest that in Italy and Sweden, LCA (and its benefits) is perceived mostly as an internal tool, whereas in Switzerland and Germany there is a stronger focus on the external use of LCA. This result is consistent, at least to some extent, with the results mentioned earlier.

Figure 7 shows the response of companies to the question "will the use of LCA increase in the future?"

Companies are generally optimistic about the future use of LCA as a supporting tool for business. The main results can be summarised as follows: A large percentage of companies (up to almost 60% in Sweden) think that the use of LCA will increase in the future. Contrary to this, only a few companies (with the partial exception of 23% of Swiss LCA-using companies) think that the use of LCA will decline in the future.

The large difference between the answers to "only if used together with other instruments" sug-

gests that Swedish companies are largely convinced that LCA will further develop on its own anyway and does not necessarily need other auxiliary instruments to expand its role in business. This is further confirmed by the low response rate to only if the methodology will be clearer and depending on the spread of LCA among companies. This opinion is much less supported in other countries, particularly in Germany and Italy.

CONCLUDING REMARKS

As expected, there are big differences between countries because of a different level of environmental awareness. This is already reflected in the different response rates, ranging from 41% in Sweden down to 7.5% in Italy. Despite differences, there are some main common results. The first one is that the cultural approach of Life-Cycle-Thinking is spreading out, but not yet the tool LCA itself. LCA is by far not used yet as a routine tool for assessing environmental aspects of product innovation and it is still rather employed in a retrospective way than in a prospective one. Benefits of LCA are considered to be rather long-term ones. On the other hand, the large majority of firms participating at the survey is optimistic about the future use of LCA.

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