The MIIM LCA Ph.D. Club

Introduction and Organisation of LCA Activities in Industry

Description and Analysis of Two LCA Projects in Swedish Companies

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Abstract. Explorations of the LCA practice have been less numerous compared to the conceptual descriptions of LCA. To counter this imbalance, studies of LCA projects conducted in Swedish industry were carried out. One of them is in a chemical company, the other in an electronics company. The studied LCA projects represent early attempts, but not first attempts, at LCA within these two companies. The two studied cases are contrasted with each other and aspects important for the implementation of LCA are identified. Among other things, the presence of an LCA entrepreneur seems to be important for LCA implementation. The argumentation for the usefulness of LCA needs to be situationally adapted to each organisation. Strategies of the LCA entrepreneur are described.

Keywords: Environmental management; institutionalisation; implementation; Life Cycle Assessment (LCA); qualitative case studies; Swedish industry

Introduction

Given that LCA is such an ambitious method, it is intriguing that companies work with it, as it takes them outside their normal area of responsibility, looking at environmental impacts of all the steps in the industrial process related to a product. Questionnaire surveys mainly show that the extent of LCA activities in Swedish industry has increased over time (Baumann 1996), but their crude picture of the developments make it difficult to understand the 'mechanisms' of LCA activities in industry. This led me to undertake studies of LCA projects conducted in industry, studies that closely followed a line of events as to obtain an understanding of driving forces, methodological considerations, expectations and outcomes.

1 Case Study Methodology

As people in organisations use words rather than numbers for communication, qualitative research methods, such as interviewing and observation are useful for the study of their practice (Czarniawska-Joerges 1997). In order to obtain some explanations of the practice of LCA, it is necessary to go beyond the LCA report and to hear the people involved in the project.

The strategies of 'grounded theory' (Glaser & Strauss 1967) provided the general guidance as to how the case studies were to be carried out. This approach is named after the way theories are formulated – they are 'grounded' in the empirical data gathered from the field. Instead of formulating hypotheses, one looks for similarities and differences in the cases which are discerning patterns. The grounded theory approach was thought suitable since the original purpose was to qualitatively describe how LCAs are conducted. It was then up to the case studies to show what patterns would emerge. These patterns form the basis for formulating empirically-based generalisations, which in turn can be related to existing theories or form a basis for new, formal theories. In the course of the analysis, it became apparent that the LCA projects were conducted with an ulterior motive, namely to promote LCA as such. This led to the identification of implementation patterns and a comparison with institutionalisation theory.

Another part of the analysis compared the LCA methodology in practice to that prescribed in the standards. This latter analysis is of such a different character that it deserves its own treatment and is to some extent covered in my doctoral thesis (Baumann 1998a & b).

1.1 The studied LCA projects

The studied LCA projects were carried out in two companies, both large and international companies but in two sectors with very different environmental reputation. One is in the chemical industry (Akzo Nobel), the other in the electronics industry (Ericsson). At the time of the studied LCA projects, both companies had had experience of one or two LCA studies. The studied LCA projects thus represent early attempts at LCA. The type of studied object is very different in the two cases. The LCA project involved a core product in one case (chemical company), but not in the other (electronics company).

Using the terminology of Czarniawska-Joerges (1997), the case studied in the chemical company is a retrospective one, i.e. a 'historic' case study of a finished project. This enabled me to follow a whole case from beginning to end in a relatively brief time. The case in the electronics company is a prospective one, i.e. I followed the line of events as they happened, enabling a description of the 'mechanisms' in greater detail.

1.2 Data collection

The methods used for data collection are described as follows. An overview of the collected field material is presented in **Table 1.**

- A case study diary was kept. In this, notes on all telephones calls, contacts, events, and thoughts related to the study were entered in order to keep track of my activities.
- A number of interviews were carried out, generally as face-to-face meetings. Most interviews lasted between 1 and 2 hours. All interviews were tape-recorded. Before each interview, a list of questions and topics was prepared. The list was based on what I wanted to know (e.g. 'What was your role in the project?') and already knew from earlier interviews. Several times, our conversations revolved around unanticipated events and aspects. Interviewees thus talked relatively freely about their involvement in the LCA project and they were asked about concrete events or activities in which they had taken part. My objective was to make them explain to me in such a way that I could make sense of what had happened.
- Observations of meetings and LCA work presentations. Extensive field notes were written on these occasions.
- Documents were collected. These included minutes, company brochures and web-pages.

Table 1: Quantity of field data

	Number of interviews	Number of observations	Number of documents
Chemical company	11	3	27
Electronics company	8	3	13

1.3 Analysis

The amount of data in a case study grows quickly, and a system to document and retrieve data is necessary. The following methods were used:

- Transcripts of interviews. All tape-recorded interviews were transcribed verbatim.
- Observation field notes were typed out.
- Coding of data. Information in the interview transcripts, observation field notes and documents were categorised into 6 categories (Actors; LCA methodology; Time/timing & money; Technology; Activity of the project; Other activity). Words, sentences and sections in the transcripts were labelled according to the 6 categories.
- A table of contents for each interview of the Ericsson case was constructed as a mind map using the 6 categories. These provided overviews, so as to avoid the risk of overlooking important data.
- Report writing. Data were retrieved and summarised category by category. In work like this, 'writing is thinking'. Through writing and rewriting, the account of the LCA project and the analysis of it appear. Suspecting that my analysis would interrupt rather than enhance the chronological narrative of the LCA project, I separated the description and the interpretation. The descriptive section can be seen as subtle analysis and the analytical sections as more heavy-handed analyses (Wolcott 1990).

2 Case Descriptions

The case descriptions have been summarised to mainly present the organisational aspects of the studied LCA projects (for the full case descriptions, see Baumann 1998a & b). To protect identities of people described, their names have been changed. The chemical company changed its name after a merger during the studied LCA project. Only the resulting name is used in the account here for the sake of simplicity.

2.1 Company in the chemical industry

Mr. Isaksson, the enterprising manager of the 'viscose niche' at Akzo Nobel Surface Chemistry, had heard about LCA and was curious about it. As a member of what was called the 'non-woven group' at the Institute of Fibres and Polymers (IFP), Mr. Isaksson discussed about the possibility of commissioning an LCA study from IFP with the director of IFP. This was in the spring of 1993. Several suggestions were discussed: to compare viscose fibres with synthetic ones (viscose comes from wood fibres), or to compare different types of viscose production. It was thought that Mr. Björnsson, the 'programme secretary' of the non-woven group was going to do the study. Mr. Björnsson immediately started to collect and study LCA literature. During the summer, it was decided that the project was to be a non-woven group project (rather than an Akzo Nobel project). The members of this group were producers of different types of fibres and process chemicals for non-woven applications and manufacturers of non-woven applications. As a consequence, the LCA study was defined so that it would be of interest for all group members: a comparison of viscose and synthetic fibres. Mr. Isaksson, also an organiser of a conference series for the global viscose industry, suggested that the study was to be presented at the next viscose conference in May 1994. To this, they all agreed.

What Mr. Isaksson hoped for was that the LCA study would raise the spirits of the viscose industry. Not only did it have a poor environmental reputation because of its problems with carbon disulfide, CS_2 (a toxic and explosive chemical), it was also losing market shares to the synthetic fibres. Nevertheless, Mr. Isaksson was hopeful. After all, the viscose fibre came from a renewable resource.

By November, Mr. Isaksson was frustrated since the LCA study had made little progress. However, by chance, he had found an 'LCA specialist' within the company. This LCA specialist, Thomas Ohlin, was a young man recently employed on a short-term contract after having finished his MSc Diploma project (an LCA study) at the company. Thomas had strong support from his manager, who had already set up an informal LCA steering group, and agreed to let Mr. Isaksson use Thomas as an advisor to Mr. Björnsson at IFP. Mr. Isaksson then called IFP saying, "We've got someone who could assist you."

When Thomas first met Bjarne Björnsson, he soon realised that he had to be more active than an advisor if the study was to be finished in time. In this he saw his chance: if he saw to make it a good study, it would help get both LCA and himself established within Akzo Nobel. Thomas began

with explaining that the fibres could not be analysed 'just like that'; they had to be analysed in an application. They decided then to study viscose and polypropylene (PP) fibres in a nappie cover application (the surface that keeps a baby's bottom dry). After this, they decided on the functional unit, drew the flowcharts, identified data sources, etc.

By the time they were busy with the data collection, the informal LCA steering group had come to realise that Thomas was more involved than an advisor, and reminded him of their priorities (another ongoing LCA project that Thomas was working on).

As the work went ahead, Thomas and Bjarne computed preliminary results whenever new data arrived. In the beginning, the results were in favour of PP. Later, when more data had been collected, the results were in favour of viscose. Bjarne took the results quite literally, and told some non-woven group members that "viscose is better than PP". This was unexpected and sensitive information since PP held around 95% of the market for nappie covers. The PP producers and manufacturers using PP reacted strongly with a lot of phoning around and there was talk of stopping the presentation at the viscose conference. The non-woven group resolved the problem at an emergency telephone conference: results were not to be weighted with the EPS valuation method. Instead, results were to be presented in a less aggregated form, as inventory results and characterisation results. A revised manuscript was faxed to all the non-woven group members who gave their approval to the paper the day before the conference.

The conference presentation was a success. The study showed that the environmental impact of CS_2 was smaller than expected in comparison with other environmental impacts in the viscose life cycle. Also, the overall difference between viscose and PP was much smaller than expected. This was good news for the viscose industry since it meant that it was worthwhile to develop the viscose process. With the presentation, the LCA project was formally over according to Mr. Isaksson. Nevertheless, Thomas took it further. He decided on his own to make a more detailed analysis of the results. Of the around 100 steps in the viscose life cycle, only a handful mattered (none of the Akzo Nobel steps). He wrote a report and gave feedback to several data suppliers.

When disseminating the results, Thomas always tried to show that LCA came up with surprising and interesting results. Another part of his strategy was to refer to the image of the chemical industry. Everybody within the industry knew that the chemical industry was an environmental villain in the eye of the general public. Thomas explained that with LCA came a possibility to identify new points of improvement since LCA made it possible to see a company's part in the overall picture. In combination with Einstein's saying that 'today's problem are caused by old thinking, and that it takes new thinking to resolve them', he made himself a position when talking to older managers.

Apart from two industrial processes, transportation stood for a relatively large part of the total emissions from the viscose life cycle. A few individual transports could be singled out. Thomas surprised the people at the pulp mill by showing that their forestry transportation stood for a relatively large part. This led to reorganisation of forestry transportation instead of the planned investment to reduce another 1% of the emissions at the pulp mill. By involving other pulp and paper companies, an exchange scheme was worked out: instead of taking your logs to your own pulp mill, the logs are taken to the nearest pulp mill, and participating companies settle their accounts with each other regularly. A transportation project was also started at Akzo Nobel Surface Chemistry. This led to a change from lorries to railway for certain distances.

The LCA study was a success for Thomas as well as for LCA. Thomas was given the opportunity to present his work for the Board of Surface Chemicals, and then one level up, also to the Board of the chemicals division. Two weeks later, he got a permanent position as LCA specialist. At the same time, the LCA steering group obtained formal status. Later, Mr. Isaksson commissioned an update of the viscose study, but that's another story.

2.2 Company in the electronics industry

Mr. Bok, a technical product specialist within the division making business telephone switching exchanges, was on the lookout for LCA projects. He had started to work with environmental matters part-time after many years in the business and had attended some short courses and seminars to learn about environmental issues and management. At one of these, he was introduced to LCA and had become enthusiastic: "LCA was product-related and quantitative; exactly what the design engineer likes." He also knew that Ericsson, as a member of CPM (an industry-university centre for LCA in Sweden), had committed itself to conduct LCA projects within the context of that centre.

One day by the coffee machine, he was approached by the documentation manager. The documentation manager had run a project to modernise the product documentation system for a long time, but with little success. Instead of each set of 80 ring binders with product information about business telephone switching exchanges, he wanted the information on some electronic medium. Unfortunately, neither technical nor economic arguments had convinced the product managers. However, he had started to think of using morally 'unchallengeable' environmental arguments since he had realised that there was an environmental side to the modernisation (reduced use of paper).

No one had ever spontaneously talked about environmental matters with Mr. Bok before. He thought he ought to seize the opportunity. He convinced the documentation manager (who had never heard about LCA) about the need for an LCA study. Mr. Bok then put together a detailed plan for the LCA project: ring binders were to be compared with CDs. To his great surprise he received the project funding he had applied for without any reductions. Now, he only had to find someone to conduct the study. He turned to CPM and the university. By September 1996, an LCA analyst was found: a student looking for a MSc Diploma project. Mr. Bok instructed the LCA analyst. This LCA study should be different from earlier LCA studies at Ericsson, which he

found "sloppy". This time, it should be a "proper" LCA based on ISO 14040. In addition, a particular software was to be used. With this software, he wanted to build up a global, corporate network for LCA data within Ericsson.

The LCA analyst spent 2 weeks to study the LCA concept. He then spent around 2 months searching and collecting data. After that, he spent about 2 months in front of the computer. The calculations took so long because of the many bugs in the software. He was in contact with the software suppliers several times, and by the time the project was ended, the software suppliers had issued 3 upgrades of the software.

In March 1997, it was time to present the results of the study. Mr. Bok was eager to launch LCA within Ericsson and sent out a corporate-wide invitation to the seminar. His problem was that according to the general perception, there was no need for environmental projects since electronic products were superior due to the continuing miniaturisation. In the corporate environmental report, it said, "Our technology is in itself adapted to the environment..." Mr. Bok chose not to challenge the notion of electronic products' environmental superiority. Instead he said that the LCA was to prove what everybody already knew, which they needed to communicate since he was getting questions from the market (that none of them was related to LCA in particular, he didn't mention).

The LCA study showed that CDs caused much less environmental harm than ring binders (1:700). Such a large difference was unexpected, and so was the overview of the whole documentation system that the LCA provided. Each set of 80 ring binders could be replaced by a single CD. A change would therefore lead to a substantial weight reduction. Since the documentation was transported by air to customers, weight was of great importance. Apart from that, the plastic cover of the ring binders and the paper production stood for a relatively large part of the overall emissions.

With the project, Mr. Bok had gone from part-time to fulltime on environmental matters, and an LCA group was formed around him. The project also put the documentation system on the agenda of the product managers – it had long been an overlooked area. The ring binders had started to be replaced by CDs before the project was ended. The project was also presented in the next corporate environmental report. Later, technical newspapers reported on similar modernisations of product documentation systems in other parts of Ericsson.

3 Analysis

At a first glance, there don't seem to be many similarities between the two cases. At a closer look, a pattern emerges. Both cases show individual projects with a role of making LCA a routine activity in the companies. In fact, after the projects, LCA activities obtained a more established position in both cases. In both cases, the LCAs led to unexpected outcomes (Table 2), and thus acted as learning devices rather than as decision tools. In both companies, a key person driving the LCA activities with an entrepreneurial spirit is found. In both cases, this 'LCA entrepreneur' argues for the usefulness of LCA from a context-specific perspective.

Just because LCA has been invented does not mean it will be used in industry. To cut it short, the process of going from learning to doing as a matter of course was identified as institutionalisation, a term from organisation theory. In the following, the generalisations from the cases are formulated in an institutionalisation terminology, highlighting the 'mechanisms' of LCA implementation.

3.1 Institutionalisation

Tolbert and Zucker (1996) have described a model for the institutionalisation process:

> Stages of the institutionalisation process:
> Innovation > Habitualisation > Objectification > Sedimentation

Table 2: Expected and actual outcomes of the LCA studies

Expected outcomes	Actual outcomes
Akzo Nobel case	
1. Maintained or improved market situation for the viscose niche	1. The results were better than anticipated regarding the environmental situation for the viscose fibre (market expectations may be realised).
2. More thorough understanding of LCA	2. Employment for Thomas Ohlin as an LCA specialist; 2b/ Plans for more LCA projects at the viscose niche.
	3. New funding routines for certain types of LCA projects (LCA studies no longer funded from 'overhead sources'; instead funded by 'consultancy fees' paid by the commissioning department.
	4. Forest transportation projects at pulp mill company and at Akzo Nobel Surface Chemistry.
	5. Changed transportation routines for forest transportations at pulp mill company.
	6. Changed transportation routines at Akzo Nobel Surface Chemistry.
Ericsson case	
1. Produce support for a decision on a future documentation system	1. The results were not used to support a change, although it helped to putt product documentation issues on the agenda of product managers. The decision to switch to CDs was taken during the course of the study, but on other grounds.
2. Knowledge about LCA	2. Experiences of LCA not as expected
3. Knowledge about the software	3. Experiences of the software not as expected
	4. New and upgraded versions of the software on the market
	5. Something to write about in the corporate environmental report
	6. Further suggestions on changes reducing the environmental impact from paper-based and CD-based documentation systems

Habitualisation is the first stage, which is concerned with adoption of a new innovation, here LCA. According to Tolbert and Zucker (1996), factors predicting adoption of an innovation are mainly of a technical and economic character. Internal political factors are also important. Decisions on adoption of LCA in the two cases were related to inadequacies in other environmental management tools and, to some extent, to environmental pressure. Since organisational decision-makers may share a common core of knowledge and ideas, adoption of a given innovation often occur in close association with adoption processes in other organisations. Such associations were observed in both cases. Both companies were closely involved in the group of companies collaborating on LCA issues. This group was first known as the Product Ecology Project. Later, in a somewhat different constellation, it became CPM. In addition, collaboration with a branch institute was sought in one case. Such associations provide opportunities to develop structures for LCA activities and also to monitor their own activities against adoption processes in other organisations. Imitation may follow from this, but this is not necessarily so since there is no consensus on the general utility of LCA yet.

Objectification is probably the most crucial stage of the institutionalisation process. At this stage, technical, economic and political factors are no longer as important, and activities may have a fashion-like quality – "LCAs are done for the sake of LCA". This is most clear in the Ericsson case. During the objectification stage, a consensus concerning the use of the innovation (here, LCA) has to evolve in the organisation. This is necessary for the LCA activities to develop beyond their point of origination. Consensus can generally emerge through two different mechanisms. The mechanism mainly observed in the two cases is the LCA entrepreneur, who promotes LCA activities. The second mechanism, monitoring of LCA activities elsewhere, was also present, although not much described in the cases here for the sake of brevity. Such monitoring is important to confirm adoption as well as to assess the risks of adoption; a large number of adopters lower the hurdle for adoption. In other words, 'if everyone is doing LCA, then it cannot be wrong for us to do it as well'.

The LCA entrepreneur is generally someone with a material stake in the promotion of LCA, be it to obtain employment or something similar. They are most easily recognised by the self-imposed responsibility to promote LCA activities (report writing and dissemination of results in the Akzo Nobel case, and corporate-wide initiatives in the Ericsson case). To be successful, the LCA entrepreneur has to link the use of LCA to the solving of a problem that is generally acknowledged within the organisation. The way this is done is very different in the two cases and reflects a situational adaptation to the context. At Akzo Nobel, LCA is justified as a means to improve the poor environmental reputation of the chemical industry. At Ericsson, LCA is justified as a means to prove the environmental advantages of the electronics industry. The LCA entrepreneur also develops strategies to make LCA a part of the normal activities in the company. In both cases, for example, the LCA entrepreneur conducted LCA studies wherever possible, rather than defining LCA studies for the environmentally or strategically most important product areas. Part of the strategy is to stimulate an LCA interest (the element of surprise in presentations of LCA results at Akzo Nobel), which is thought to create a demand for LCA in the organisation. The LCA entrepreneur is also busy accumulating evidence on the usefulness of LCA and disseminating successful examples (dissemination of LCA results to various data suppliers in the Akzo Nobel case and to the environmental report in the Ericsson case).

Sedimentation is characterised by the fact that LCA activities have become taken for granted. The promotion and accumulation of evidence of the usefulness of LCA is no longer necessary. In addition, LCA activities survive across generations of organisational members since the 'idea of LCA' pervades through the organisation.

With increasing institutionalisation, organisational structures related to LCA activities become more long-lived. Both cases show a development going from informal LCA alliances involving people with partly self-imposed LCA responsibilities to the forming of official LCA committees/groups and the appointment of specialists with explicit LCA responsibilities working towards integration of LCA into general environmental management and business processes.

A factor influencing the institutionalisation process is the status of opponents (Tolbert & Zucker 1996). As the status of those opposed increase, the degree of institutionalisation decreases. Vague and unorganised opposition was observed in the Ericsson case. Its role in the institutionalisation process was not studied. Another important factor is the cost of trials. According to the institutionalisation theory, the higher the investment costs, the higher the degree of institutionalisation. This means that if the first attempts at LCA are costly, it should not lead to the abandonment of LCA if there is a willingness to make the most out of the investment.

3.2 Comparison with other case studies

The two case studies in my doctoral project were also part of an EU project, in which a total of 20 cases were studied (Frankl & Rubik 1999). These represented companies at different stages in the institutionalistion process. They also provided more material for comparison.

An implementation through a bottom-up approach was observed in the two cases presented here as well as in the three additional Swedish case studies which are also part of the EU project. In contrast, top-down approaches were more common in the other countries. In a study by SPRU (1996), top-down and bottom-up implementation patterns were identified as sector-specific patterns. For example, a top-down approach was considered typical for the chemical industry. The Akzo Nobel case does not support such an observation, nor do the other case studies of LCA projects in Scandinavian chemical companies reported in Frankl & Rubik (1999) support such a sector-specific pattern. It seems that the Swedish cases represent a different style of management. The existence of a particular Scandinavian management style has been suggested by Jönsson (1995).

There is still some way to go from learning to doing since there is still much experimenting. LCA as a standard operating procedure was not observed in any of the 20 cases, although it had a strong foothold in some of the companies

(Frankl & Rubik 1999). Whether a company would continue, alter or abandon LCA usage seemed to be related to:

- how well surprises are acted upon and the situational adaptation made;
- if results in subsequent LCA studies are too similar, there is a probability that LCA use will be much simplified (will appear as LCA-based guidelines or indicators). To some extent, this is related to the size of the company, or rather the diversity of its products and operations. LCA application can continue to offer new insights in larger companies with broad product ranges;
- if the study is triggered by external debate and external consultants were used, there is a probability that LCA will be abandoned since in-house knowledge about LCA will be limited.

4 Conclusions

It is not sufficient to justify LCA in its own right. LCA also needs to be justified in its organisational context. This means that identical implementation recipes will not work everywhere, since there are elements in the implementation process that call for a situational adaptation. How well the situational adaptation is made is crucial for the continuation of the LCA activities.

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