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SIMPLIFIED LCA

LCA as an element in environmental management systems—comparison of conditions in selected organisations in Poland, Sweden and Germany

Part 2: Results of survey research

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Abstract
Purpose In this two-part paper (Background and Initial Assumptions (Part 1) and Results of Survey Research (Part 2)), we present surveys whose main objective is to determine, whether and to what extent the life cycle assessment (LCA) technique is used for the identification and assessment of environmental aspects in environmental management systems (EMS) and whether there are any differences in this respect between the companies and countries analysed.
Methods The survey research was carried out using the computer assisted self-administered interviewing (CASI) method among selected Polish, German and Swedish organisations which implement EMS in accordance with the requirements of ISO 14001 and/or the EMAS regulation.
Results The organisations investigated, regardless of their country, are dominated by qualitative and semi-quantitative techniques of assessment and identification of environmental aspects. LCA was used sporadically, although some differences can be observed between the countries analysed.
Conclusions The environmental managers accustomed to traditional qualitative and semi-quantitative solutions, have not been given preparation to enable them to understand and adopt the different approaches such as LCA. On the other hand, representatives of the organisations investigated declared that they were ready to accept an even longer timescale for the identification and assessment processes relating to environmental aspects, which represents a potential opportunity for LCA. The more precise understanding and definition of environmental problems that are precisely defined in LCA would represent a novelty for environmental managers. In practice, environmental problems are defined in a general sense and rather ambiguously, as this level of detail is sufficient in the context of qualitative and semi-quantitative techniques commonly used for the identification and assessment of environmental aspects.

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1 Introduction

Processes of identification and assessment of environmental aspects constitute a key element in the operation of environmental management systems (Matuszak-Flejszman 2007). Due to the absence of stringent guidelines in this respect (ISO 14001 2004; ISO 14004 2004), organisations may use various tools for carrying out both activities and make decisions on the basis of a variety of environmental information. Thus, the analysis of the application of life cycle assessment in this area should be made in the context of assessment of opportunities provided not only by life cycle assessment (LCA), but also alternative techniques. Therefore, key elements of the survey questionnaire (presented in Part 1 of the paper) included issues relating to the tools, techniques and indicators used by the organisations analysed for the identification and assessment of environmental aspects. Responses to these types of questions are presented in this second part of the paper.

2 Results of the survey

As indicated in part 1 of this two-part paper, the size of the total population was assumed to be 13,061 and was determined as the number of organisations with ISO 14001 and/or an Eco-Management and Audit Scheme (EMAS) certificate operating in Germany, Poland and Sweden (as at 2009). The size of the sample was assumed to be 10 % of the population and a number of questionnaires sent to organisations in each of the three countries analysed was proportional to its share in the total population (Germany 55.68 %, Sweden 32.67 % and Poland 11.63 %). One thousand three hundred six questionnaires were sent and there were 85 correctly completed and returned questionnaires in total (Poland 35, Germany 26 and Sweden 24).

2.1 Identification and assessment of environmental aspects—tools

Table 1 includes responses provided by representatives of the organisations analysed to questions relating to techniques used for the identification and assessment of environmental aspects. The table represents a set of tools in which both qualitative and quantitative approaches were included. The cells with the highest values were set in italics to help the reader identify the most popular techniques. The results for life cycle inventory (LCI)/life cycle impact assessment (LCIA) are presented in bold type to emphasise those results related to the use of LCA itself.

The results show that environmental aspects are mainly identified through the use of such qualitative or semi-quantitative tools as interviews, inspections, brainstorming and screening processes. Aspects are identified through the use of mass and energy balances in individual cases (except for Germany, where 46.15 % of respondents indicated the use of this tool). A particularly high level of use of interviews was reported by Polish and German organisations (77.14 % of Polish respondents and 73.08 % of German respondents). Inspections also proved very popular in those countries, whereas in the case of the Swedish organisations analysed, inspections were applied by approximately 46 %

Table 1 List of tools used for identification and assessment of environmental aspects in the organisations analysed

Tools used to identify environmental aspects	Number of organisations [%]			Tools used to assess environmental aspects	Number of organisations [%]		
	Poland	Sweden	Germany		Poland	Sweden	Germany
Interviews	*77.14*	*45.83*	*73.08*	Quantitative/descriptive assessment	*42.86*	*70.83*	*73.08*
Inspections	*65.71*	*45.83*	*65.38*	Point estimation method	*80.00*	*29.17*	23.08
Checklists	34.29	*54.17*	11.54	ABC/XYZ method (Pareto or 80/20 method)	0.00	0.00	*42.31*
Brainstorming	*62.86*	*66.67*	19.23	FMEA method	0.00	8.33	7.69
Screening processes	*68.57*	20.83	*88.46*	Life cycle assessment (LCA)/LCIA/	**0.00**	**20.83**	**11.54**
Benchmarking	8.57	20.83	34.62	Other	0.00	4.17	0.00
SIPOC diagram	0.00	0.00	0.00	Total number of companies replying to this question (=100 %)	35	24	26
Grid method	0.00	12.50	0.00				
Mass-energy balance	20.00	0.00	46.15				
Life cycle assessment (LCA)/LCI/	**0.00**	**20.83**	**19.23**				
Other	0.00	8.33	0.00				
Total number of companies replying to this question (=100 %)	35	24	26				

of respondents. By contrast, the Swedish organisations analysed indicated a very significant use of brainstorming and checklists as identification techniques. Screening processes were mainly reported by the German and Polish companies analysed. It is worth noting here that the low level of responses referring to benchmarking from Poland (8.57 %) in comparison to the higher values noted for Sweden (about 21 %) and Germany (about 35 %). None of the Polish companies analysed showed LCA as the technique used for identification of environmental aspects, whereas some cases of the use of the technique were noted by Swedish and German organisations. There were five Swedish companies (21.74 % of the organisations that returned the completed questionnaire) and five German companies (19.23 % of the organisations that returned the completed questionnaire), which indicated the use of LCA for the above-mentioned purpose. It is worth emphasising that nearly all the organisations analysed used at least two identification techniques although there were rare cases, in which only one approach was applied in each of the countries. A similar situation may be observed in the case of techniques used for assessment of environmental aspects (see Table 1).

In most of the techniques reported by the organisations studied, qualitative (descriptive) or semi-quantitative approaches are applied. In Polish organisations, point estimation methods with descriptive assessment prevail, whereas in the Swedish organisations studied, the qualitative approach was reported most frequently followed by point estimation methods. Half of the German organisations analysed reported the use of the ABC method. LCA was confirmed as a tool for assessment of environmental aspects by five Swedish organisations and three German organisations. They were the same organisations that reported use of LCA for identification (two German organisations declared that they used LCA for identification only).

Another issue analysed was consideration of the forms of validation and verification of completeness of data collected for identification of environmental aspects. Considering the great popularity of the use of qualitative and semi-qualitative techniques for identification and assessment of environmental aspects among the organisations analysed, it should be assumed that typically quantitative forms of verification (e.g. mass and energy balance) would enjoy lesser interest. The results presented in Table 2 seem to confirm this assumption (results presented as a percentage of organisations providing a given response in relation to the total number of organisations participating in the research). The greatest proportion of representatives of the organisations analysed indicated *internal audits* and *assessments made by the specialists* as validation tools. Internal audits constitute one of the most significant tools for assessment of the effectiveness of the organisation's activities and these may provide a basis for improvement of the management system and, for example, the area connected with improvement of the process of identification and assessment of environmental aspects (Matuszak-Flejszman 2010). In Table 2, the cells with the highest values were set in bold to indicate the most popular tools.

The tools used for identification and assessment are assessed by most of the companies analysed as simple (Poland 51 %, Germany 40 %, Sweden 17 %) or moderately difficult/difficult (Poland 49 %, Germany 82 %, Sweden 55 %). The results are presented in Fig. 1 and 2.

2.2 Assessment of environmental aspects—criteria

The criteria used are a key issue from the point of view of analysis of the suitability of the use of LCA as a technique for the assessment of environmental aspects in EMS. The analysis of the collection of inputs and outputs should, in theory, include elements connected with those very aspects such as type, size and frequency of occurrence, whereas LCIA should include, directly or indirectly, the issues connected with impacts upon the environment (scale,

Table 2 Tools used by the organisations analysed for verification of completeness and consistency of information during identification of environmental aspects

Tools used to check and verify the consistency and completeness of data gathered during the identification of the environmental aspect	Number of organisations [%]		
	Poland	Sweden	Germany
Assessments made by specialists in the particular processes e.g., technologists, designers, logistic specialists	**60.00**	**62.50**	**53.85**
Comparisons with data for similar processes/products	28.57	25.00	23.08
Mass and energy balance for particular processes	20.00	12.50	34.62
Internal audits (first-party audits)	**82.86**	**50.00**	**92.31**
Second and/or third-party audits	**45.71**	**29.17**	11.54
According to the guidelines of the ISO 14044 standard (consistency and completeness check)	20.00	16.67	11.54
Other	0.00	0.00	0.00
We do not use any procedure to check the consistency and completeness of data	2.86	4.17	0.00
Total number of companies replying to this question (=100 %)	35	24	26

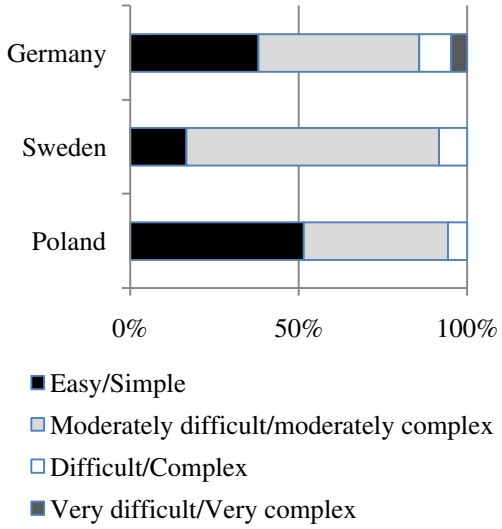

Fig. 1 Opinion of the organisations surveyed on the techniques they used for the identification of environmental aspects (total number of companies replying to this question=85)

severity and duration). The results included in Table 3 show that most of the criteria included in the questionnaire are considered by the organisations analysed. It is worth noting that the relatively low result for the *scale of the impact* criterion for German companies (30.77 %). Among the criteria that are not related to the environment, *compliance with legal requirements* and, in the case of the Polish companies, *compliance with interested parties' requirements,* enjoy great popularity. The companies analysed reported less frequent use of the *public image of the company* and *environmental policy* as criteria for assessment.

Considering LCA as a tool for assessing the environmental aspects in EMS, the way of determining *the severity of the impact* is also significant. The survey included a question relating to the type of information on the basis of which

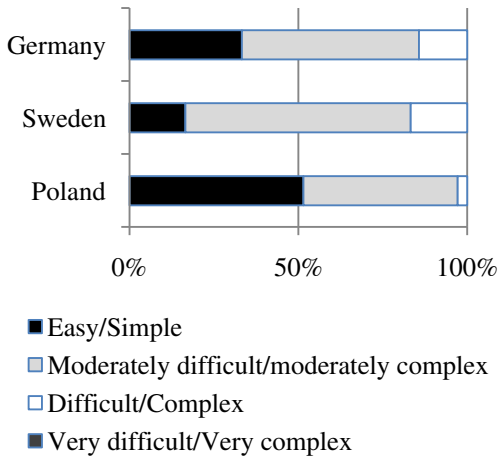

Fig. 2 Opinion of the organisations surveyed on the techniques they used for the assessment of environmental aspects (total number of companies replying to this question=85)

organisations determine the severity of the impact. As shown in Fig. 3, representatives of organisations completing the questionnaire have the choice between different types of environmental information with various impact modelling levels and environmental relevance: from descriptive information taken from literature, through midpoint indicators (e.g. GWP, ODP and toxicity indicators) up to a value of a cumulative and damage-based eco-indicator. Most of the organisations studied from all three of the countries surveyed indicated literature (descriptive information) as a basis for the determination of the *severity of the impact* (*coloured black* in Fig. 3). Severity of impact is visibly determined more frequently in Germany and Sweden than in Poland on the basis of more advanced indicators which consider a further or closer level of impact modelling (*light and dark grey colour* in Fig. 3). The sample analysed included particular German and Swedish companies using full LCA and cumulative indicators for the determination of *severity of the impact* (white colour). A proportion of the organisations participating in the survey declare that they did not use this criterion for assessment of aspects at all. In Table 3 the cells with the highest values were set in bold to facilitate the identification of the most popular criteria by the reader.

The assessment of environmental aspects on the basis of information connected with environmental impacts is also related to the issue of the type and number of environmental problems that are considered during the assessment as well as the method of defining of the same. LCA research includes basic terms such as the *impact category* and *damage category* which represent an image of some environmental problems defined more or less generally. Table 4 shows environmental problems defined in various ways (in the further and closer aspect of LCA) and responses provided by representatives of those organisations which completed the questionnaire (the data are shown according to the percentage share of representatives of the organisations, which provided positive responses to a given question in relation to the total number of organisations participating in the survey in a given country). As earlier, in Table 4, the cells with the highest values were set in bold to indicate the environmental problems most often taken into account while assessing the environmental aspects.

On the basis of the data included in Table 4, we may observe that environmental problems defined generally enjoy greatest interest among the organisations analysed. The problems that are most often taken into account when assessing the environmental aspects include water pollution, soil contamination, air pollution, environmental pollution by waste and noise. An exceptionally high percentage of Polish companies are characterised by degradation of the ground, a factor that generates visibly lower interest among the German and Swedish organisations analysed. By contrast,

Table 3 Criteria used by the companies analysed during assessment of the environmental aspects

Criteria used during assessment of environmental aspects	Number of organisations [%]		
	Poland	Sweden	Germany
Type of an environmental aspect	**82.86**	**70.83**	**92.31**
Size of an environmental aspect	**82.86**	**95.83**	**84.62**
Frequency of an environmental aspect	**88.57**	**66.67**	**76.92**
Scale of the impact	**82.86**	**66.67**	30.77
Severity of the impact	71.43	83.33	76.92
Duration of the impact	42.86	37.50	**69.23**
Applicable legal requirements	**91.43**	**70.83**	**61.54**
Interested parties' requirements	**65.71**	41.67	38.46
Public image of the company	28.57	45.83	38.46
Environmental policy	54.29	54.17	46.15
Other	0.00	4.17	0.00
Total number of companies replying to this question (=100 %)	35	24	26

climate change is most frequently taken into account in the case of the latter two respondents, and, in the case of Swedish organisations, ozone layer depletion is also considered.

3 LCA in EMS—companies' experience

Table 5 below presents short characteristics of ten organisations (five Swedish and five German) using LCA for identification and/or assessment of environmental aspects in EMS. Two German companies, despite declaring the fact of using of LCA, did not complete the second part of the survey, justifying their decision on the basis of company policy and confidentiality of data. As regards the above, responses to the second part of the survey were obtained from only eight organisations.

As there are few such organisations, it is difficult to make any generalisations and search for correlations. These are mainly medium or large companies operating in various sectors and having environmental management systems complying with the requirements of ISO 14001 or the EMAS regulation. As has already been mentioned, they would prefer to use a package of tools. There was only one Swedish organisation that confirmed using LCA as the only method of assessment of environmental aspects. It is worth emphasising that in only one of the organisations analysed was that the person filling out the questionnaire is a specialist in LCA (see Table 5).

The first of the questions to which the organisations analysed responded related to software used for LCA. German companies reported using GaBi software, whereas Swedish companies used Excel or GaBi (one organisation uses the two tools jointly). The next question related to elements of the methodology and the levels of LCA results used by organisations for the identification and assessment of environmental aspects. The results are presented in Table 6. All eight organisations use the idea of a functional

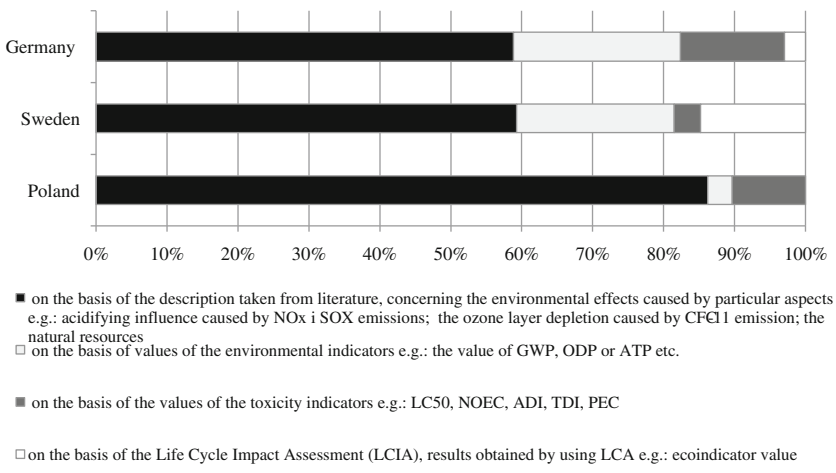

Fig. 3 Methods of determination of the value of the criterion of *severity of the impact* for assessment of environmental aspects in the organisations analysed (total number of companies replying to this question=85)

Table 4 Environmental problems taken into account by the organisations analysed while assessing the environmental aspects

Environmental problems taken into account while assessing the environmental aspects	Number of organisations [%]		
	Poland	Sweden	Germany
Carcinogenesis and/or human toxicity	45.71	50.00	30.77
Respiratory effects	20.00	25.00	15.38
Climate change (global warming)	40.00	**91.67**	**65.38**
Depletion of the ozone layer	22.86	**70.83**	34.62
Ionising radiation	34.29	25.00	23.08
Photochemical oxidation	2.86	25.00	23.08
Noise	**74.29**	**58.33**	**76.92**
Acidification	22.86	62.50	15.38
Eutrophication	2.86	45.83	11.54
Bioaccumulation	2.86	33.33	23.08
Land use (land degradation)	**62.86**	25.00	19.23
Aquatic ecotoxicity	51.43	50.00	42.31
Terrestrial (soil) ecotoxicity	57.14	33.33	34.62
Resource depletion	**85.71**	**54.17**	**50.00**
Environmental pollution by waste	**94.29**	**70.83**	**84.62**
Risk to human life	**62.86**	33.33	**57.69**
Risk to human health	42.86	54.17	23.08
Water pollution	**97.14**	**87.50**	**73.08**
Soil contamination	**94.29**	**62.50**	**65.38**
Air pollution	**88.57**	**87.50**	**65.38**
Visual aspect	45.71	8.33	15.38
Total number of companies replying to this question (=100 %)	35	24	26

unit during identification of environmental aspects. There are three Swedish organisations and one German organisation that also use a division of the system into unit processes. Allocation procedures, validation of the processes through balance and the use of cutoff criteria were only indicated by Swedish companies. In most cases, aspects are assessed through the use of the environmental profile, whereas three Swedish organisations and one German organisation also use cumulative results of, e.g. eco-indicators, for these purposes.

The last question was related to the assessment of LCA as a tool used for this particular purpose. Representatives of the organisations analysed were to describe their LCA on the basis of their experience, by indicating its strong points and its weak points as compared to traditional methods used for the identification and assessment of aspects in EMS. There were eight representatives of the organisations analysed who answered this question. The results are presented in Table 7. Representatives of the organisations analysed could choose between four answers (definitely yes, rather yes, rather no, and definitely no) for each of the LCA characteristics. The results presented in Table 7 show that the organisations analysed using LCA in EMS are convergent in the majority of strong points of LCA as compared to traditional methods used for the identification and assessment of environmental aspects. Representatives of the organisations analysed indicated positive answers to the exclusion of others such as "definitely yes" and "rather yes" in relation to such characteristics of LCA as the *possibility of determining potential impacts caused by environmental aspects on the basis of scientifically established and widely accepted impact modelling methodology; the possibility of including the life cycle perspective; getting qualitative results and covering several elements concerning the environmental aspects (size, frequency and type) by one methodology.* Among the strong points mentioned, the *general availability of software* used for LCA aroused most doubts. The lowest result was obtained for potential weak points of LCA such as *time-consuming analysis*, which is, theoretically, higher than in the case of the application of simpler and less methodologically advanced tools. Two organisations stated that the time-consuming nature of LCA analysis should not be perceived as a weak point, whereas four other companies answered "rather yes". A relatively high accordance among the bodies analysed (71.43 % of the organisations completing this part of the questionnaire) was obtained for features of LCA such as *lack of possibility to cover one common*

Table 5 Characteristics of ten organisations participating in the survey and using LCA for identification and/or assessment of environmental aspects

No.	Tools used to identify environmental aspects	Tools used to assess environmental aspects	Size of company (number of employees)	Professional profile of person completing the questionnaire	Profile of the company's activity (branch)	Type of EMS
	Sweden					
1	1. Checklists 2. LCA	1. LCA	More than 500	Specialist in EMS	Manufacture of motor vehicles, trailers and semi-trailers	ISO 14001
2	1. Interviews 2. Inspections 3. Checklists 4. LCA	1. Descriptive assessment 2. Point estimation method 3. LCA	51–500	Specialist in EMS	Electricity, gas, steam and air conditioning supply	ISO 14001
3	1. Inspections 2. Brainstorming 3. LCA 4. Other (flow analysis)	1. Descriptive assessment 2. Point estimation method 3. LCA	11–50	Specialist in EMS	Wholesale and retail trade; repair of motor vehicles and motorcycles	ISO 14001
4	1. Interviews 2. Inspections 3. Brainstorming 4. LCA	1. FMEA method 2. LCA	51–500	Environmental expert	Manufacture of motor vehicles, trailers and semi-trailers	ISO 14001
5	1. Interviews 2. Inspections 3. Checklists 4. Brainstorming 5. LCA	1. Point estimation method 2. LCA	More than 500	Specialist in LCA	Manufacture of chemicals and chemical products	ISO 14001/EMAS
	Germany					
6	1. Inspections 2. Checklists 3. Screening processes 4. Benchmarking 5. LCA	1. Descriptive assessment 2. LCA	11–50	Specialist in EMS	Manufacture of food products	EMAS
7	1. Screening processes 2. LCA	1. Descriptive assessment	11–50	Specialist in QMS Specialist in EMS	Manufacture of rubber and plastic products	EMAS
8	1. Interviews 2. Screening processes 3. LCA	1. Point estimation method 2. ABC/XYZ method (Pareto or 80/20 method)	51–500	Specialist in EMS	Water transport	ISO 14001/EMAS
9	1. Interviews 2. Checklists 3. Screening processes 4. LCA	1. Descriptive assessment 2. LCA	More than 500	Specialist in EMS	Air transport	EMAS
10	1. Screening processes 2. Benchmarking 3. Mass-energy balance 4. LCA	1. Descriptive assessment 2. Point estimation method 2. LCA	11–50	Specialist in EMS Specialist in EP	Agriculture, forestry and fishing	EMAS

Table 6 Elements of methodology and level of LCA results used by the organisations analysed for identification and assessment of environmental aspects

Question	No. of organisations	Sweden					Germany				
	Elements/results of LCA	1	2	3	4	5	6	7	8	9	10
What elements of LCI methodology are used in your company to identify the environmental aspects?	Functional unit	√	√	√	√	√	√	√	n/a	n/a	√
	Division of the system into unit processes	√	√	√	–	–	–	–	n/a	n/a	√
	Unit process validation by using mass–energy balance	√	√	–	–	–	–	–	n/a	n/a	–
	Allocation procedure	√	√	√	–	–	–	–	n/a	n/a	–
	Cutoff criteria	–	√	√	–	–	–	–	n/a	n/a	–
What kind of results provides the basis for assessing the environmental aspects in your company?	LCI results	–	–	√	–	–	–	–	n/a	n/a	–
	LCIA results for several selected impact categories	–	–	–	–	–	–	–	n/a	n/a	–
	LCIA results for many impact categories (environmental profile)	–	√	√	√	√	√	–	n/a	n/a	√
	Single environmental indicator score	√	√	√	–	–	–	–	n/a	n/a	√

"√"=the element/result is used by the company during identification and/or assessment of environmental aspects

"–"= the element/result is not used by the company during identification and/or assessment of environmental aspects

methodology, the quantitative and qualitative environmental aspects. Representatives of the organisations analysed also agreed and indicated both *complexity of LCA* and *higher costs* as weak points of the technique in comparison with traditional methods of identification and assessment of environmental aspects.

Table 7 Assessment of the usefulness of LCA as a tool used for identification and assessment of environmental aspects in EMS as made by German and Swedish organisations participating in the survey and using LCA for this purpose

Points	Definitely yes 4	Rather yes 3	Rather no 2	Definitely no 1
Strong points of LCA [number of organisations %]				
Possibility of determining the potential impacts caused by the environmental aspects on the basis of a scientifically established and widely accepted impact modelling methodology	57.14	42.86	0.00	0.00
Standardised methodology, included in ISO 14040 s	28.57	57.14	14.29	0.00
Possibility of including the life cycle perspective	57.14	42.86	0.00	0.00
Getting qualitative results (as numbers)	71.43	28.57	0.00	0.00
Covering several elements concerning the environmental aspects (size, frequency and type) using one methodology	57.14	42.86	0.00	0.00
Covering several elements concerning the environmental impacts (scale, severity and duration) using one methodology	42.86	42.86	14.29	0.00
Wide availability of LCA software	14.29	57.14	14.29	14.29
More scientifically sophisticated and credible results	42.86	42.86	14.29	0.00
Possibility of also including indirect environmental impacts (if quantitative)	42.86	28.57	28.57	0.00
Weak points of LCA [number of organisations %]				
Time-consuming analysis	0.00	71.43	14.29	14.29
More difficult and complex methodology, application more difficult	14.29	71.43	0.00	14.29
Higher costs	0.00	71.43	28.57	0.00
Lack of training for environmental managers, on the scope for using LCA to identify and assess environmental aspects which is available on the market	14.29	57.14	28.57	0.00
Lack of possibility to cover quantitative and qualitative environmental aspects via one common methodology,	71.43	0.00	28.57	0.00
Lack of appropriate data concerning environmental aspects (e.g. lack of characterisation factors)	14.29	28.57	28.57	0.00
Total number of companies replying to this question (=100 %)	8 (5 Swedish, 3 Germany)			

4 Conclusions

The organisations studied, regardless of country, are dominated by qualitative and semi-quantitative techniques of assessment and identification of environmental aspects. The methods used for identification and assessment of environmental aspects as shown in the surveys are different from LCA to such an extent that it should be assumed that the organisations involved and their environmental managers are so accustomed to traditional qualitative and semi-quantitative solutions that they would not be prepared for the understanding and adoption of different approaches such as LCA. Another issue studied included forms of validation and verification of the completeness of data collected for identification of environmental aspects. In LCA research, LCI and LCIA analyses typically have a quantitative nature and, therefore, apart from procedural techniques, a series of numerical approaches to the analysis and assessment of data are adopted (Guinée et al. 2002). For example, in the practice of LCA, LCI model and inventory data are often validated by making mass and energy balances of unit processes and any exclusion can be justified and preceded by, e.g. sensitivity analyses. In the case of identification and assessment of environmental aspects in EMS, less emphasis is probably put on quantitative data and their completeness.

The opinions of the companies studied seem to correlate with observations made during the work already undertaken (Lewandowska 2011; Lewandowska et al. 2011) where potential strong and weak points of LCA were discussed in the context of EMS. LCA can be recognised as too time consuming in comparison with less complicated and "quicker" traditional approaches like, for example, point estimation methods. However, the representatives of the organisations analysed declared their readiness to accept that the identification and assessment processes for environmental aspects take even longer, which represents an opportunity for LCA. The strong point of LCA is the higher environmental relevance of the results obtained since environmental impact can be assessed in a more comprehensive way. The use of LCA for the assessment of environmental aspects in EMS would make it possible to assess the problems in the context of the entire environmental profile including several environmental problems. More precise understanding and definition of environmental problems that are precisely defined in LCA would represent a significant novelty for those environmental managers using traditional approaches. In practice, environmental problems are defined in a general sense and rather ambiguously since this level of detail is sufficient in the context of qualitative and semi-quantitative techniques commonly used for the identification and assessment of environmental aspects. Additionally, LCA also permits the inclusion of indirect environmental aspects (if quantitative), which can be especially valuable in organisations using EMAS (Lewandowska et al. 2011). All 85 of the companies analysed indicated a proportion of indirect aspects among the total number of environmental aspects and the survey noted the following results: Germany about 25 %, Poland about 21 % and Sweden about 41 %. The indirect aspects were mostly defined in a descriptive way. If appropriate data was gathered (e.g. for transport processes made by an external logistic company), LCA would enable the enterprises to quantify them so that they could be covered by a common assessment method with direct aspects.

Due to the low return rate, the results obtained may only be applied to the organisations analysed and any generalisations drawn should be treated with caution.

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