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Results from survey of demand for life cycle approaches in sustainability decision support: user needs

Deliverable (D9) of work package 6 (WP6) CALCAS project

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Definition of terms

- Life cycle assessment** Compilation and evaluation of the inputs, outputs and the potential environmental impact of a product system throughout its life cycle [ISO 14040:2006].
- Life cycle approach** "A life cycle approach means we recognize how our choices influence what happens at each of these points so we can balance trade-offs and positively impact the economy, the environment, and society. A life cycle approach is a way of thinking which helps us recognize how our selections – such as buying electricity or a new t-shirt - are one part of a whole system of events. A life cycle approach identifies both opportunities and risks of a product or technology, all the way from raw materials to disposal. To do this there is a continuum of life cycle approaches from qualitative (life cycle thinking) to comprehensive quantitative approaches (life cycle assessment studies). People, companies and governments use these various life cycle approaches in anything from day to day shopping, selecting office supplies for the workplace, engineering a new product design, or developing a new government policy." [Fava & Hall 2004]
- Life cycle analysis** Is often used as synonym to life cycle assessment, but is here in this report used to denote any systems analytical method applying a life cycle approach, which does not necessarily adhere to the ISO standard of LCA.

Summary

The report at hand is deliverable (D9) of WP6 of the CALCAS project. The overall objective with this deliverable is to identify decision-making situations, within four main stakeholder groups, where life cycle approaches is considered to play an important role as sustainability decision support. This survey targets the following main groups of stakeholders involved in public and/or private sustainability decision-making:

- Public authorities,
- Business (industry, retailers),
- NGOs (incl. consumer associations), and
- R&D programmers (national funding organizations and research institutes).

This survey has also given some additional input that could benefit the CALCAS-project: stakeholders current use of life cycle approaches and its challenges; and, how stakeholders want life cycle approaches to develop in the future to become more useful in sustainability decision making. The results from this survey will function as input in the final deliverable of this WP (D19) in which we will identify and specify key research lines from a user perspective.

To get relevant information out of users, we have targeted questions to selected stakeholders, using both interviews and questionnaires, so that the answers of the stakeholders groups could be adequately framed. In total, 25 interviews were conducted which was distributed among the stakeholder groups. Unfortunately, the questionnaire did not provide as much information as expected. Although the questionnaire was sent out to 220 stakeholder representatives, the response rate was only 6 percent of which 70 percent represented businesses. Figure 1 shows how the interviewees and the questionnaire respondents are distributed in each stakeholder group.

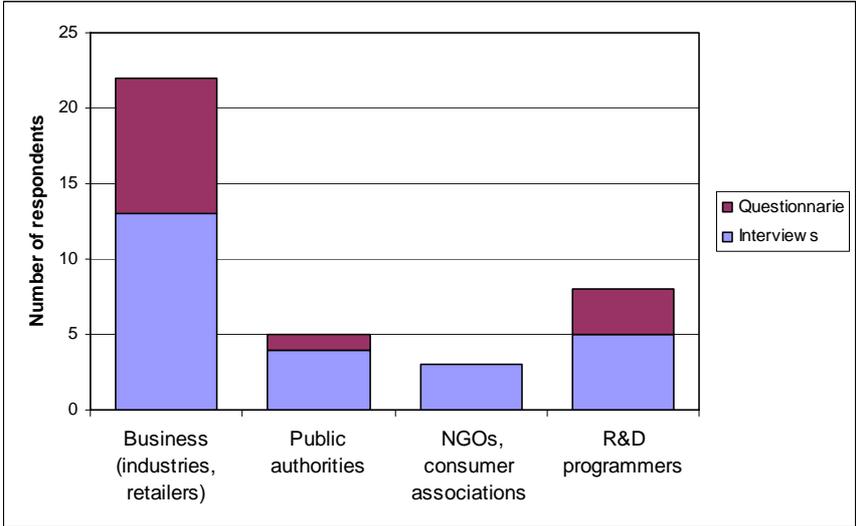


Fig. 1 – Number of respondents in the different stakeholder groups

A strong input from business was received in the form of 13 interviews and 9 questionnaire responses. In contrary, due to lower numbers of both interviewees and questionnaire respondents in “Public authorities”, “NGOs”, and “R&D programmers”, we feel the urge to collect additional data to strengthen and complement the result to the final deliverable (D19) of this WP. We have also seen that the stakeholders’ level of knowledge in life cycle

approaches has affected the amount of input we got. For example, since some of the respondents in public authorities, NGOs and R&D programmers were less familiar with life cycle approaches it has correspondingly made it more difficult for them to comment on, i.e. challenges and future needs of life cycle approaches.

Several strong messages have emerged across the stakeholder groups about the use of life cycle approaches and its challenges, and about future development and visions on how they want life cycle approaches to develop to become more useful as sustainability decision support. One overall conclusion is that participants of this survey often use ISO-LCA as reference approach when defining challenges and future needs of life cycle approaches. This is perhaps not surprising since the methodology itself is one of the most frequently used life cycle approaches across most stakeholder groups represented in this study.

The priority messages regarding life cycle approaches and its challenges are:

- ISO-LCA is considered to be an “expert model” which takes too long time and the results are often complicated,
- too few are interested in the results of a full LCA, and
- difficulties to find methods that meet actors’ needs.

The priority messages regarding future needs and evolution of life cycle approaches are:

- simpler interfaces (adapted to the required application or sector),
- clear standards for data gathering,
- less time consuming models,
- greater transparency,
- integration of economic elements in LCA models, and
- data representative to different levels of resolution (geographical coverage),

The issues specified above comprise a complex mix of requests such as, increased flexibility, accuracy and user-friendliness, which perhaps might be too much of a challenge to incorporate in one system model. This will function as input in the final deliverable of this WP (D19) where we will specify key research lines from a user needs perspective.

Business

First, we were interested to identify in what decision-making situations different stakeholder groups consider the use of life cycle approaches to be important in sustainability decision-making support. The highest share of companies state that life cycle approaches are important to use as sustainability decision support tools in product development (77%). Other particularly important areas of application are support in the selection of raw materials (66%) and choices of technologies (55%). The result from the questionnaires is illustrated in Fig. 2.

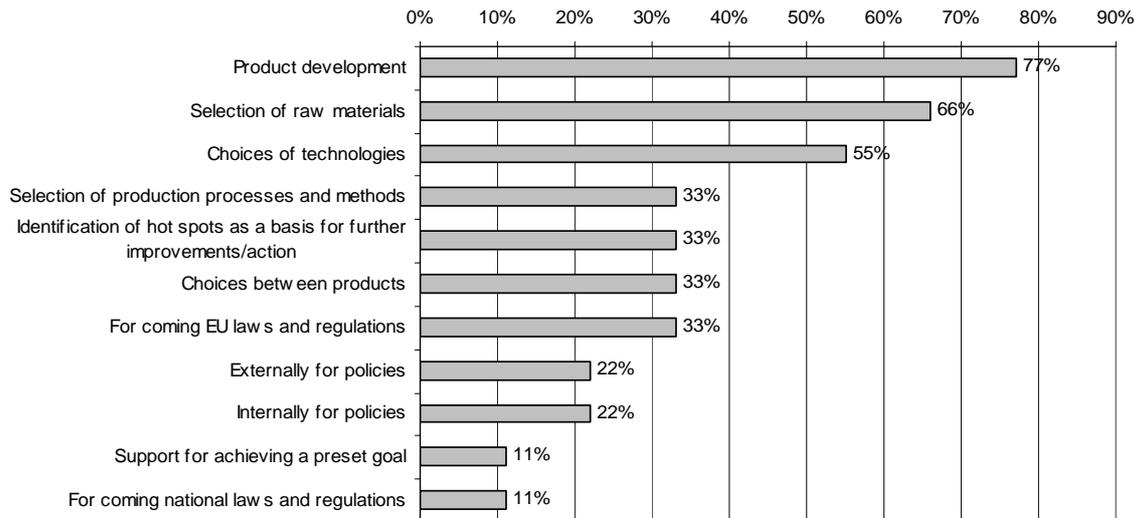


Fig. 2 - Decision-making situations within businesses where life cycle approaches is considered to play an important role as sustainability decision support (relative shares in %, n=9, possible for each respondent to mark all alternatives)

Second, we were interested to identify the challenges that businesses associates with the use of life cycle approaches. One overall conclusion is that participants of this survey often use ISO-LCA as reference approach when defining challenges and future needs of life cycle approaches.

The challenges that have been identified include:

- too time-consuming models (ISO-LCA) for certain situations (i.e. in product development phase),
- difficult to understand and difficulties to integrate whole supply chain in the assessment,
- problems related to find accurate figures to put into the models,
- the available data bases are too narrow and restricted to certain materials like basic chemicals, oil, metals (the respondents did not specify which materials to include), and
- too few customers are interested in full LCA.

The priority messages regarding future needs and evolution of life cycle approaches:

- need for transparency in models,
- methods have to be developed together with the industry, not by the scientists alone,
- develop strategies on how life cycle approaches can be communicated better up and down supply and value chains,
- make consumers understand their role in the life cycle of products,
- include future impacts in the models,
- models need to consider a world without fossil fuels,
- include risk analysis in environmental assessments,
- further developed and improved ability to identify energy efficiency potential,
- increased validity and credibility of simplified life cycle approaches,
- need tools need to be applicable in specific industrial sectors, and
- regional variations in production need to be accounted for in the models.

Here too, there are examples of different requests. For example, to have available methods robust and credible but at the same time able to do a quick assessment, and models flexible enough without developing too many specific tools. These complex challenges will be further analyzed in the final deliverable of this WP.

There are different opinions if LCA should be devoted not only to account for environmental assessments but also enhance full sustainability assessments. Some interviewees doubted the functionality of a “broadening” of the environmental life cycle assessment to consider all sustainability dimensions. On the other hand, many businesses have an interest in expanding the perspective from environmental life cycle assessments to enhance all sustainability pillars in the assessment. Some respondents said that a sustainability assessment based on a life cycle approach could be done in the same system model, while some stated that each sustainability dimension should be assessed in parallel. More specific requests were the proposal of economic and social parameters to include in LCA. The social parameters proposed were working environment and work-related accidents and diseases, plus sick-leave. The economic parameters proposed were socio-economic costs and/or benefits to the society.

Public Authorities

The result thus far suggests that there are differences in the level of knowledge depending on if the respondent represents a regional or a national public authority. Life cycle analysis is not a reference approach on regional level (in one country); rather they use tools such as EIA (Environmental Impact Assessment) and SEA (Strategic Environmental Assessment), which apply to ex ante, i.e. in advance of decisions. Lack of experience in life cycle analysis has made it difficult for them to comment on the matter of this report.

They could however see a potential to use life cycle approaches in activities such as system choice (transport systems), planning choices, and technology choices (waste management). Clearly, there is a gap between a potential use of a concept and actually applying it. We therefore suggest that there is a need for better understanding how life cycle approaches could support their daily activities. Given their current state of knowledge, if life cycle approaches were applied in their activities, it would be important that the models are simple and easy to understand.

National authorities have specified a more detailed input in this survey. The survey has showed that LCA results are used in two different ways:

- in some cases, the respondents have the time to dig into life cycle assessment reports, interpreting them and making up their own mind about the assumptions, methodological choices, results and conclusions, and
- in other cases, the respondents focus on the conclusions presented in the summary. In such cases, they want the conclusions and recommendations to be brief and clear, making it possible to use them, without risk of misinterpretation, in their report to the government.

The results of this survey show (also highlighted in Fava & Hall, 2004) that life cycle analysis is regarded as a useful support in certain decision making situations:

- to make policies more consistent among consumers, producers, material suppliers, retailers, and waste managers and also among different policy instruments (such as harmonising regulations, voluntary agreements, taxes, and subsidies), and

- in purchasing products and services which are “environmentally preferable”, reduce the impact government operations have on the environment and support regional and global markets for “preferable” products and services.

The priority messages regarding future needs and evolution of life cycle approaches:

- interest in including additional economic performance to a larger extent in life cycle approaches, in order to increase the acceptance and, hence, the success of the methods,
- interest in including social effects to a larger extent in life cycle approaches, and
- important that the results are simple and easy to understand.

NGO

As in national public authorities, the respondents do not perform life cycle analysis themselves. They are using the results of life cycle analysis as decision-making support. It is however unclear based on the empirical material in what decision-making situations life cycle approaches are needed. This has to do with the poor questionnaire response from NGOs. Therefore, we are going to collect additional data to strengthen and complement the result to the final deliverable (D19) of this WP.

There is consensus among the respondents of the challenges related to the use of life cycle approaches:

- too expensive methods,
- too few who are interested in the results,
- the methods are not reliable enough,
- difficulties to find methods that meet actors needs,
- the methods are too difficult to understand, and
- lack of knowledge about these methods.

The barriers listed above were also proposed as needs. For example, respondents mentioned that the reliability of models needs to improve and become more adaptable to meet actor-specific needs.

R&D programmers

One national funding organization and three research institutes represent this stakeholder group. Contrary to the funding organization, the institutes have both good knowledge as well as practical experience in life cycle based system tools.

There are some strong messages that have been found across this stakeholder group. The following challenges were unanimously proposed to the use of life cycle approaches:

- too few are interested in the results,
- methods are too time-consuming,
- difficulties to find methods that meet actors needs,
- difficult to understand, and
- lack of knowledge about life cycle approaches.

The priority messages regarding decision-making situations, future needs and evolution of life cycle approaches were:

- develop a model where economic, environmental and social dimensions are included at the same time,

- more research to introduce sustainability parameters in life cycle approaches for all the main mid- and long-term technological and strategic choices such as energy and environment, transport systems, urban policy issues, planning and quality control in the service sector,
- develop reference systems for quantitative knowledge (data), and
- important to include ability for long term sustainability assessments in life cycle approaches.

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1 Introduction

1.1 Background

Sustainable development is often referred to as “meeting the needs of the present generation without compromising the ability of future generations to meet their own needs”. This is a broadly accepted definition worked out by the Brundtland commission (UN 1987). The sustainability concept refers to needs, with positive elements to strive for and negative elements to avoid in society, grouped into three domains; economic, environmental and social. Sustainable development has been adopted as a policy principle by the UN, the EU and many other countries, but it has also become a central notion for many companies, business councils, political parties, NGOs, etc.

Life cycle analysis have matured over the past decades and become part of the broader field of sustainability assessment. As defined in ISO 14040 (Anonymous, 2006a) and 14044 (Anonymous, 2006b), life cycle assessment (LCA) is a “compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle”. The standardization of LCA by ISO (abbreviated to ISO LCA) has been a driving force for the diffusion of life cycle analysis and other life cycle approaches.

The life cycle approach is an increasingly essential part of sustainable development and is now a central theme in the forthcoming Sustainable Consumption and Production (SCP) Action Plan. The SCP action plan can be described as a plan putting into one package the former separate European strategies related to waste prevention, recycling, and the sustainable use of resources as well as the inter-related Integrated Product Policy (IPP). In the IPP Communication, the Commission stated, “LCAs provide the best framework for assessing the potential environmental impacts of products currently available. They are therefore an important support tool for IPP ...” Life cycle approaches also have a potentially key role to provide insights as part of Strategic Environmental Assessments and Environmental Impact Assessments (EIA) as per the related directives within the European Commission and its Member States. Examples of life cycle approach and assessment related recommendations are also clear in a number of European waste and eco-design related directives and proposals.

1.2 The CALCAS-project

The Co-ordination Action for innovation in Life-Cycle Analysis for Sustainability (CALCAS) was launched in 2006, as a part of the EU 6th Framework Programme, aiming to go beyond the boundaries of ISO-LCA. The general objective of CALCAS is to develop ISO-LCA by:

- “deepening” the present models and tools to improve their applicability in different contexts while increasing their reliability and usability
- “broadening” the scope of life cycle analysis by better incorporating sustainability aspects and linking to neighbouring models, to improve their significance, and
- “leaping forward” by a revision/enrichment of foundations, through the crossing with other disciplines for sustainability evaluation.

The CALCAS-project is structured along three main activity lines; supply of life cycle approaches in sustainability decision support, demand of life cycle approaches in sustainability decision support, and a third activity line linking supply and demand together. The second activity line, “demand of life cycle approaches in sustainability decision support”, is mainly organized in work package 4 (WP4) and work package 6 (WP6). WP4 focuses on both uses and needs for life cycle approaches within governance specifically, while WP6

surveys demand for life cycle approaches for sustainability in a broad and diverse context, as illustrated in figure 1 (next page). The principle of the CALCAS-project is that demand guides supply, not the other way around.

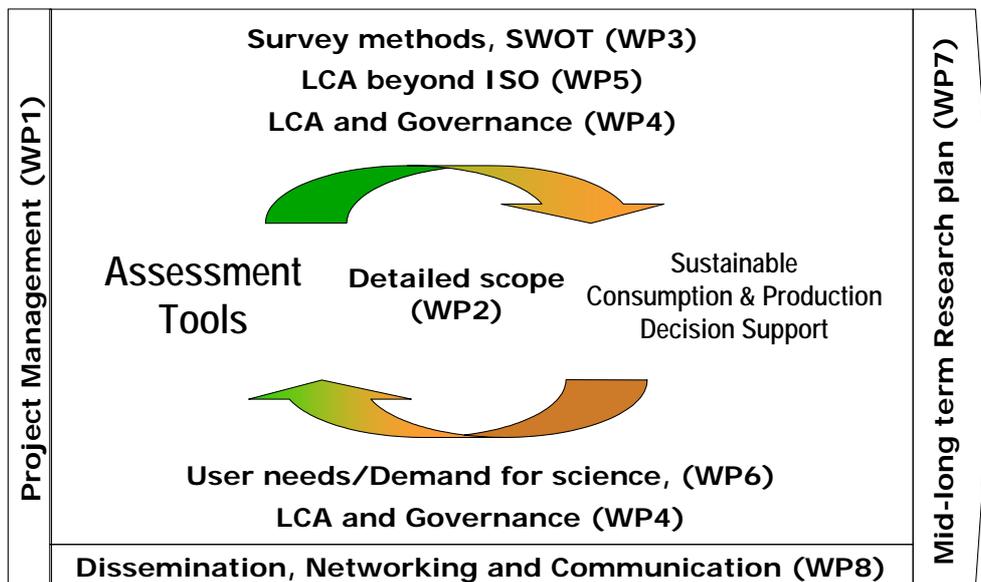


Fig. 3 - Schematic representation of the work packages and their relations within CALCAS

Specific goals or tasks to mend main deficiencies and limitations as indicated are:

- to derive specific models and tools for specific decision situations, including also new applications as for instance in prospective technology assessment,
- to link social mechanisms to technological and physical relations,
- to link micro level choices to macro level sustainability requirements, involving not only environmental but also economic and social sustainability aspects,
- to build a common framework for sustainability evaluation, and
- to link the development of informational tools to the newly emerging modes of governance.

These tasks have partly been accomplished within the CALCAS project as new practical strategies in life cycle analysis. For the other part, tasks will be formulated as research lines and as a roadmap, in terms of a number of research lines and a number of exemplary research programmes for sustainability decision support.

1.3 Addressing user needs

The demand /user needs perspective represents needs, wishes and priorities of different stakeholder groups in the context of using life cycle approaches in sustainability decision-making. Decisions in this context span from high-level strategy choices to detailed technology and product choices each have in common always covering technological consequences in production and consumption chains, from cradle to grave, that is from a life cycle perspective. The life cycle approach provides, in simple or more complex ways, insight in mechanisms and in relevant environmental and/or social and/or economic effects of different types of those choices. Several stakeholder groups in society are involved in decision-making as described above:

- **Governments** in terms of policy making and implementation

- **Citizens, NGOs** and other stakeholder groups involved in public policy development and implementation
- **Firms, as developers** and optimisers products and technologies
- **Research and development organisations** involved in product and technology development
- **Public financing bodies** giving directions to research and development activities
- **Private financing bodies** giving directions to investment decisions on products and technologies
- **Firms as producers** of existing technologies and products
- **Firms, consumers and governments as purchasers** of existing technologies and products.
- **Retailers and funding organisations** as key organisations for creating new products and markets.
- **Business associations**, as coordination groups for discussion on sustainability options and policies.

The overall question of the CALCAS-project is how life cycle approaches better could support stakeholders in making decisions that is preferable from a sustainability perspective with prime focus regarding choices on technologies and products.

1.4 Objective of the report

The overall objective with this deliverable is to identify decision-making situations among some stakeholder groups, involved in sustainability decision making, where life cycle approaches is considered to play an important role as sustainability decision support. This survey targets the following main groups of stakeholders involved in sustainability decision-making:

- Public authorities,
- Business (industry, retailers),
- NGOs (incl. consumer associations), and
- R&D programmers (national funding organizations and research institutes).

This survey has also given some additional input that could benefit the CALCAS-project: stakeholders current use of life cycle approaches and its challenges; and, how stakeholders want life cycle approaches to develop in the future to become more useful in sustainability decision support. The results from this survey will function as input in the final deliverable of this WP (D19) in which we will identify and specify key research lines from a user perspective.

1.5 Other studies addressing user needs

In planning the interviews and the questionnaire, a brief literature survey was carried out to get additional insights into relevant ways of formulating questions and discussion topics. Only very recent studies (1-2 years) were of interest here, in order to gain awareness of the state-of-the-art of use patterns of life cycle approaches.

Most of the surveys analysed were carried out in industry. Three selected studies are shortly referenced here (section 1.5.1-1.5.3). These were judged as being the studies most useful to the scope of the CALCAS survey, thus helping to frame the survey. In addition, a study carried out mainly in connection to WP 4 of CALCAS but also developed with input of WP 6 partners is referenced (section 1.5.4), as being highly relevant to, and feeding into, the overall user needs perspective.

Relating to public sector needs, it is worth mentioning here the report on product information needs for the environment performed in the framework of the IPP process (Anonymous, 2006). Recent systematic survey-type studies in the broad CALCAS sense were not identified in this brief survey.

The survey in WP 6 goes beyond the studies listed as it tries to cover the three dimensions of sustainability.

1.5.1 UNEP/SETAC Life Cycle Initiative [summary from: Thiesen et al, 2007]

From August to November 2006, the Secretariat of UNEP/SETAC Life Cycle Initiative carried out a stakeholder consultation on businesses applications of life cycle approaches. The purpose of the consultation was to get an up-to-date understanding of the challenges and needs of business working with life cycle approaches. The stakeholder consultation was aimed at understanding five main questions:

- How are life cycle approaches applied by business?
- What are the motivation and driving forces for business to work with life cycle approaches?
- How are interactions along the supply chain managed?
- Which needs and challenges are business experiencing, when applying life cycle approaches?
- What knowledge, perception and expectations do businesses have of the Life Cycle Initiative?

The response indicated that life cycle approaches have several applications in business:

- to identify opportunities to improve environmental performance;
- to identify opportunities to reduce costs;
- to document performance;
- to evaluate different alternatives; and
- to get information about the product which other approaches and tools cannot give.

The main driving forces for businesses to work with life cycle approaches were identified:

- ability to create better market opportunities;
- ability to achieve cost reductions and improvements of efficiency;
- improve business reputation or support image through applying a front-runner approach in order to lower the impacts of the product produced and improved performance, compared to other similar products; and
- commitment to improve environmental performance.

Solutions and barriers by management of the supply chain were also identified:

- interaction with suppliers and customers to get data for their assessments
- improvement of performance of other stakeholders in the supply chain in order to reduce the overall impact of the product; and
- interactions along the supply chain were seen as difficulties because of differing priorities of a company and its suppliers and customers, or lack of resources. In addition, some companies felt that they have a rather limited influence on their suppliers, as they are of minor strategic or economic importance to the supplier.

The needs and challenges that business experiences when applying life cycle approaches:

- difficult to get other departments and the management level of the company involved;
- the life cycle terminology and concept can be difficult to understand;
- the tools which can be used, are seen as too complicated and detailed;
- the results should be detailed enough to show a clear picture, but on the other hand, not too much information should be communicated, as this may create an “information overload”;
- resources (time and money) will often be a limiting factor when conducting a quantitative life cycle assessment;
- the market is not requesting the products with the improved performance, and that the key market driver is costs;
- the variety of tools was seen to be a hindrance, as it complicates the comparison of performance across companies, when each is using a different method; and
- Life Cycle Thinking and approaches are seen as a concept that is rather difficult to communicate to consumers, both to make the communication simple enough, but still to keep the detail

1.5.2 Centre for Environmental Assessment of Product and Material Systems: Management of Sustainability Issues Industry - A stakeholder perspective [summary from: Swanström & Cerin, 2006]

On the behalf of Centre for Environmental Assessment of Product and Material Systems at Chalmers University of Technology (CPM), Lennart Swanström (ABB Corporate Research) and Pontus Cerin (IVL Swedish Environmental Research Institute) investigated how companies and their stakeholders, perceive the economic, environmental and social benefits from using systems and tools such as LCA, environmental management systems (EMS), occupational health and safety management systems (OHSMS), environmental product declarations (EPD) and sustainability reports (SR). The study was conducted as a questionnaire embracing actors in industry, with ABB as the focal company, the financial sector and academia. Some of the main findings from this study were:

- all stakeholder groups, except from one stakeholder group, perceive that the use of systems and tools for managing sustainability issues result in higher environmental and social performance for the company and its products;
- a majority of all respondent groups think that is not likely that the economic performance of the company automatically improves through managing sustainability issues;
- it is vital for ABB and for manufacturing industry in general to implement a product focus when addressing the environmental aspects of the organisation. Environmental performances of ABB’s products and services are what the customers request since it affects their own operations;
- indications are provided from the larger firms of one respondent group that they do not care much for initiatives like carbon neutral companies and plants (unless driven by marginal cost cuts), which currently is well perceived among industrial actors – firms and perhaps especially consultants – and NGOs. The negative stance simply arises because these initiatives will oftentimes not come anywhere near to generating the business needed to cover the additional costs involved and the major environmental gains lies in product improvements;
- all respondent groups in industry and the financial sector perceive that companies provide their business stakeholders with requested information and do not see the systems and tools for analysis and communication as being too resource consuming;

- environmental/sustainability managers feel that the driving forces for working with environmental/sustainability issues have shifted from management programs towards legislation and awareness in society;
- environmental and sustainability managers currently sees management commitment as an increased main obstacle for working with environmental and sustainability issues;
- LCA data is demanded by customers to the same extent as for six years earlier and there has been a small increase in using LCAs in marketing, but line managers as well as sustainability managers believe LCA provides less competitive advantage than before;
- the voluntary initiatives taken by industry and other actors in society on environmental and social aspects are expected by some Academia Accounting-&Investments respondents to become transformed into mandatory demands and regulations ahead;
- it is important to note that in general it is very difficult and resource consuming (high transaction costs) for company stakeholders to retrieve a good picture from the outside in regarding the internal management of environmental and social issues and the resulting outcome in environmental, social and economic performances;
- the responses from Finance SRI Advisors indicate a need for comparable and reliable indicators that show how companies' environmental and social performances affect their economic performances and describe the strategic management thereof – e.g. how dependent are company revenues on carbon emissions and child labour and what strategies are taken to address the associated business risks.

1.5.3 Life cycle related eco-labeling of construction products - planners' interests and needs on LCA data and tools [Klinge et al, 2006]

This master thesis called “Most architects pursue environmentally friendly designs by profession” is written by Martina Klinge, Udo Jeske, and Liselotte Schebek, from the Forschungszentrum Karlsruhe GmbH, Institute for Technical Chemistry, Department of Technology-Induced Material Flow. It is an online-survey that addresses planners' views on LCA and the demand for lifecycle cost and environmental data. Some main finding from the thesis:

- strong request for tool integration into the usual workflow;
- comparatively few architects use tools and checklists for environmental decisions;
- software developers who are interested in supporting environmentally sound decisions of architects by LCA should recognize that the dominating interest is costs. Tools providing costing data should be harmonized with those providing environmental data;
- there should be a common database to serve tool developers to feed design tools with necessary environmental data; and
- planning tools run short if they're not comfortably integrated into the usual workflow

1.5.4 Life Cycle Approaches in European Companies: the influence of internal and external drivers on the application of life-cycle tools [Neumann, 2007]

Corporate environmental awareness across industries and in various regions worldwide is rising as businesses find themselves faced with environmental claims of regulators and business clients. While in earlier studies legal certainty and avoidance of liability are stressed as primary reasons for implementing EMSs and using life-cycle approaches, more recent studies state that improving corporate environmental protection strategies, better resource management, environmental interest of consumers and product-related environmental problems play a major role. This survey showed that companies are influenced by internal and external drivers to almost the same degree and that a multitude of factors influences

businesses' decision to adopt life-cycle approaches. According to the surveyed companies, external factors triggering the application of life-cycle approaches are mainly market and regulatory drivers, while internal factors are mainly ecological product-related considerations. Contrary to the initial assumptions, companies denoted direct economic and financial reasons to be relatively irrelevant. Further, the survey revealed that companies use life-cycle approaches systematically for specific applications as improving environmental performance of products and supply chain management. Product optimization is thus the prime purpose. Goals of improving competitiveness and environmental image as well as checking challenges of future environmental legislation indicate anticipative application patterns. In contrast to that, strategic applications as goal definition and the application within EMSs are much less relevant.

1.5.5 Making Product Information Work for the Environment [Anonymous, 2006]

The report was written as part of a Working Group within the IPP process. The mandate of the group was to identify what information is needed by which stakeholders throughout the supply chain, which tools exist to fulfil these needs and where there are gaps, and how these gaps could be filled and the demand for environmental information about products increased. The overall, underlying assumption was that various drivers are needed to promote environmentally well-performing products in the market.

The analysis carried out by the Working Group pointed out some needs and case for action on environmental product information – as a policy priority at EU level. The key policy conclusions stated in the report are:

- Product information (of the right kind) can be used in a powerful combination with other tools to deliver environmental improvement.
- In ideal conditions, this would enable and stimulate the market to operate efficiently and competitively to deliver the goals of IPP and sustainable production and consumption.
- Under present conditions, the market on its own is unlikely to deliver – the barriers in the field of product information are steep and the drivers are weak.
- The investment of effort on product information could be very cost-effective in delivering improvement, compared with 'traditional' regulatory mechanisms – but this depends very much on using the right frameworks and influences.
- It will need leadership and action at a government level (both at EU level and in Member States) to improve the frameworks for product information and to unlock the potential to drive environmental improvement.

2 Approach of this study

2.1 Direct sources

This survey includes interviews with key actors as well as a broad survey in the form of questionnaires to stakeholders.

2.1.1 Interviews with key actors

In an effort to reach this objective, the interviews were used to gain understanding about key actors' practices in sustainability decision-making. As guidance in this process, questions were formulated covering the following main areas of interest:

- How are the concepts "Sustainable Development", and "Sustainable Consumption and Production" envisioned or applied in your organisation?
- For what purposes are decision support methods for "Sustainable Development" used for product-related assessments and decisions today, and what are the needs and wishes for the future?
- What aspects are covered and what are the main priorities within the three dimensions: economic, environmental, social - today - and what are the needs and wishes for future development of decision support methods?
- How are the three dimensions combined with each other and integrated in decision processes today, and what are the expectations, needs and wishes for the future?

Information relevant for the study's objective to frame user needs was then collected from the interviews.

As it is rather important to do interviews in one's mother tongue, the selection of interviews was made partly based on languages represented in the WP6 team. Interviewees were approached in the Germany, Italy, Sweden, and the U.K, as well as institutions on the European level. A limited number of interviewees were chosen from each of the stakeholder groups as outlined in Table 1; some special consideration was taken when key actors in each group were identified. For public authorities we acknowledged that life cycle approaches are crosscutting; in many countries, life cycle approaches are being integrated, or under consideration for integration, in several sectors of public administration.

Table 1: List of organisations that were selected

Public authorities	Business (industry, retailers)	NGOs (incl. consumer associations)	R&D programmers (European Technology Platforms, national funding organizations, etc.)
European Commission	ABB (Italy)	EESC (European Economic and Social Committé)	DG Environment
Director General of Emilia Romagna Region	ABB (Sweden)	Forum for the Future	ENEA
German Federal Environmental	AkzoNobel	WWF	FORMAS

Agency			
Swedish EPA	Bayer Material Science		ISIS (Institute of Studies for the Integration of Systems)
	Boots		MISTRA
	Dow Europe GmbH		
	GlaxoSmithKline		
	Hennes & Mauritz		
	Innospec		
	InterfaceFlor		
	Marks & Spencer		
	Novamont spa		
	Unilever		

2.1.2 Questionnaires to stakeholders

The questionnaires covered the same subjects as the interviews and were designed based on the input from the interviews. The questionnaire has more specifically functioned as both a complement to the results derived from the interviews and an additional approach to gain information that further could support the results from the interviews.

Given the rather diverse nature of stakeholders involved, the questionnaire has been partly common for all stakeholders, partly customized to fit the specific stakeholder interests. As a large number of stakeholders could be reached, additional care was taken into compiling send lists, which covered all relevant types of stakeholders and diversity within each stakeholder group. Within each stakeholder group, we targeted among others these key actors:

- representatives for companies considered particularly proactive in life cycle approaches and companies considered not so proactive (Business),
- IPP network managed by the European Commission and its informal counterpart, the "Informal IPP network", as it is normally their role to coordinate and disseminate life-cycle issues to other domains of public administration in their respective Countries. (Public authorities), and
- the EEB, the umbrella organisation for NGOs (NGOs), and
- representatives of the EU Technology Platforms (TP), (R&D programmers)

3 Results and discussion

3.1 Data gathering

In total, 25 interviews were conducted which were distributed among the stakeholder groups as shown in figure 2. Unfortunately, the questionnaire did not provide as much information as expected. Although the questionnaire was sent out to 220 stakeholder representatives, the response rate was only 6% of which 70% represented businesses. Figure 2 shows both how the interviewees and the questionnaire respondents are distributed in each stakeholder group.

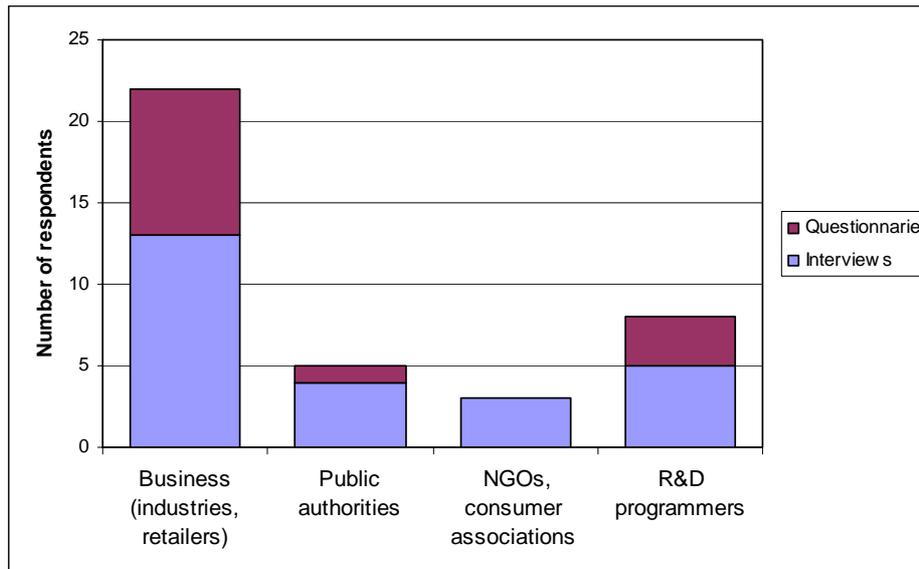


Fig. 4 – Number of respondents in the different stakeholder groups

A strong input from business was received in the form of 13 interviews and 9 questionnaire responses. In contrary, due to a low number of both interviewees and questionnaire respondents in “Public authorities”, “NGOs”, and “R&D programmers”, we feel the urge to collect additional data to strengthen and complement the result to the final deliverable (D20) of this WP. We have also seen that the stakeholders’ level of knowledge in life cycle approaches has affected the amount of input we got. For example, since some of the respondents in Public authorities, NGOs and R&D programmers were less familiar with life cycle approaches it has correspondingly made it more difficult for them to comment on, i.e. challenges and future needs of life cycle approaches.

3.2 Business

3.2.1 The use of life cycle approaches and its challenges

All companies represented in this survey have practical experience with the use of life cycle approaches such as checklists, environmental indicators, screening LCA, Life Cycle Inventory (LCI), Life Cycle Cost (LCC), full-scale Life Cycle Analysis (ISO), and Product Sustainability Assessment (PSA). The majority of life cycle approaches assess environmental impact but some also assess social and/or economical impact of products. The impact categories used in the methods vary a lot and, of course, different industrial sectors generate different impacts.

First, we were interested to identify decision-making situations where life cycle approaches is considered to play an important role in sustainability decision support. A list of decision situations was included in the questionnaire and respondents were asked to identify in which of these situations life cycle approaches is important as decision-making support. An additional field was added in the questionnaire because we did not want to limit the respondents in his/her answers. However, no respondent stated an additional decision-making situation in the questionnaire. Fig. 3 presents the results from the questionnaire (see next page).

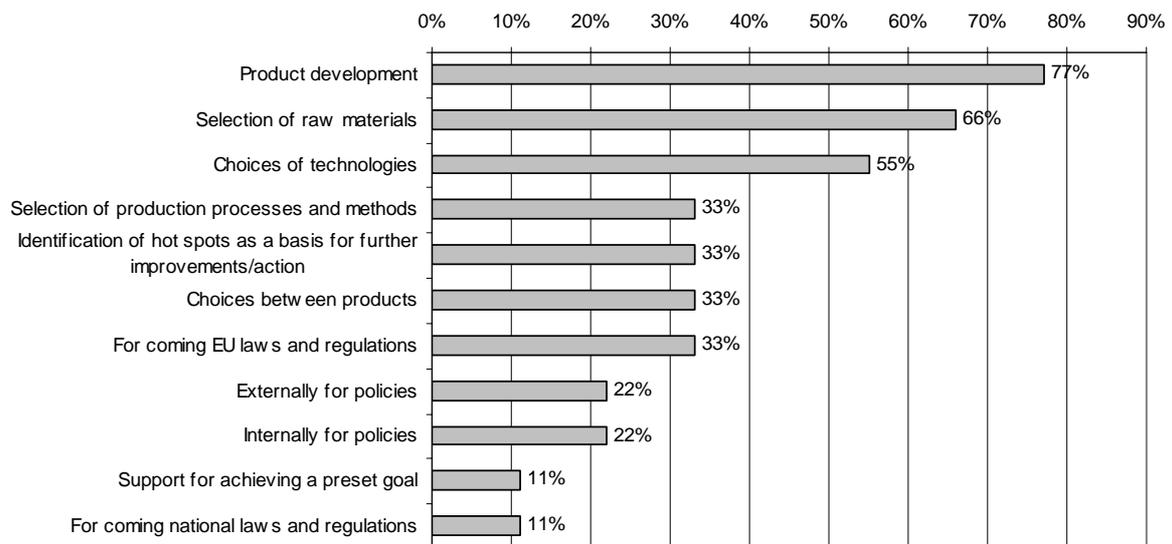


Fig. 5 - Decision-making situations within businesses where life cycle approaches is considered to play an important role as sustainability decision support (relative shares in %, n=9, possible for each respondent to mark all alternatives)

The result shows that most respondents think that life cycle approaches are important as decision-making support in product development (77%). Other particularly important application areas are as decision support to selection of raw materials and choices of technologies. It is important to stress that the results presented in figure 3 are based on nine respondents.

Second, we were interested to identify the challenges that businesses associates with the use of life cycle approaches. One overall conclusion is that participants of this survey often use ISO-LCA as reference approach when defining challenges and future needs of life cycle approaches. Some consider the methodology to be complicated and impractical quantitative analysis. This is due to a combination of factors according to some; too time-consuming models, difficult to understand and difficulties to integrate whole supply chain in the assessment, and perhaps the most frequently mentioned problem related to data. This challenge is divided in:

- problems related to finding accurate figures to put into the models,
- the available data bases are too narrow and restricted to certain materials like basic chemicals, oil, metals (the respondents did not specify which materials to include)

Another challenge with the use of life cycle approaches that is mentioned is a lack of interest. One opinion is that lack of executive buy-in hinders further use of the methods. Another opinion relates to lack of interest in results from full LCA within external stakeholders. The

reason why many companies are involved using life cycle approaches is that customers demand some sort of sustainability information. Some of the participants in this survey have acknowledged that customers do ask for environmental information, but they only request some specific environmental parameters of a product. Because customers only seldom ask for a full LCA, the consequence is that some companies choose to use simplified models that only concern limited environmental evaluations or chose not to use them at all.

3.2.2 Life cycle approaches – Development and needs

More than half of the business representatives included in this survey thinks that the life cycle approaches they use today do not fulfil their needs (question asked in both the interviews and questionnaire). One consequence of this is the development and use of so-called simplified life cycle approaches, which are used to describe life cycle approaches that are typically developed in-house. The term “simplified” originates from the ISO-LCA, which by many respondents are considered a complicated and impractical quantitative analysis. Although the ISO-LCA is not explicitly mentioned as quantitative analysis this could be found implicitly in the 14040 standard, witnessing phrases like “the compilation and quantification of inputs and outputs”, “evaluating the magnitude” of impacts, and the central role for the functional unit, the “quantified performance of a product system” [ISO 14040:2006]. A full life cycle assessment as described in ISO 14040 requires the collection of a lot of data and choices must be made with respect to system boundaries, allocation, and impact categories. In certain situations within businesses, a full LCA would require more time than is available. This is where the simplified life cycle approaches come in hand. These in-house methods are capable of doing environmental life cycle analysis in little time focusing on the particular impacts of greatest relevance to the organization and use qualitative instead of quantitative data. Our survey shows that some industries apply these in the production development phases where time is a key factor. The reason: a detailed analysis is considered too time-consuming for application on new products due to the phase in which some industries deliver new products onto the market. The use of simplified life cycle approaches was regarded by many as very useful because they could stop or change the development of a product. This makes them functional in contrary to models that are more complex in the same situation. An expressed need from some of the business representatives is to increase the validity and credibility of these simplified approaches used for example in the product development phase. This indicates perhaps contradictory research lines: how to make methods robust and credible but at the same time do a quick assessment.

Another expressed need originates from the fact that users need tools for life cycle analysis to be applicable in specific industrial sectors. It is however recognized that the production of so many specific tools is not feasible, but if the tools are not sector specific they are not thought by some to be very useful. There is also a need to include regional variations in production in the models. Such variations can change the results in the models, and might generate a misleading overall message about advantages and disadvantages of certain production processes. These are requests that require flexible models.

According to some respondents, the tools are also needed to become more user-friendly. This request includes not only simplifying the interface of the tools but also integrate application-oriented examples to show how system models could be applied. In addition, there is also a need to improve the availability and accuracy of data along with an update of the average industrial data. The range of data should also be expanded to not only account for certain basic materials like chemicals, oil, metals (the respondents did not specify which materials to

include). However, combining flexibility, accuracy and user-friendliness in a model is perhaps too much of a challenge.

Another important issue is to develop methods that make it easier for companies to manage supply chain communication in a life cycle analysis. Some respondents recognized that data collection from actors in the supply chain sometimes could be difficult because of a reluctance to share data. One respondent mentioned a quite functional strategy to involve actors in the supply chain in the data collection. The strategy was to involve farmers in collecting data. This was thought to be functional if data of one environmental aspect is communicated, but it was thought to be impossible to collect data for a full LCA.

Other identified user needs include:

- need for transparency in models
- methods have to be developed together with the industry, not by the scientists alone
- models need to consider a world without fossil fuels,
- include risk analysis in environmental assessments, and
- further developed and improved ability to identify energy efficiency potential.

3.2.3 Linking life cycle approaches to sustainability

Many businesses also have an interest in expanding the perspective from environmental life cycle assessments to enhance all sustainability pillars in the assessment. Some said that a sustainability assessment based on a life cycle approach could be done in the same system model, while some stated that each sustainability dimension should be assessed in parallel. Other, more specific requests were the proposal of economic and social parameters to include in LCA. The economic parameters proposed were, socio-economic cost and/or benefits to the society and ability to compare cost effectiveness of different technologies/products. The social parameters proposed were working environment and work-related accidents and diseases, plus sick-leave. The fact that those parameters were pre-specified provide an uncertainty since respondents may have marked mark alternatives which if they were not pre-specified not might have been mentioned.

Some interviewees doubted the functionality of a “broadening” of LCA to consider all sustainability dimensions. Although it stands clear that many companies wish for a higher level of acceptance regarding sustainability and the full triple bottom line approach the sustainability considerations are usually accounted for in the context of Corporate Social Responsibility (CSR) and are largely environmental. However, there are examples of life cycle approaches that combine, for example, environmental and social aspects. Here a detailed assessment of environmental aspects is complemented with some social indicators.

3.3 Public Authorities

3.3.1 The use of life cycle approaches and its challenges

In this survey, one part of the respondents represented regional public authority. They mostly use EIA (Environmental Impact Assessment) or SEA (Strategic Environmental impact Assessment) to give guidance on environmental issues, not to make decisions that are binding. Some see a strong need to support public administrations/authorities in evaluations related to single intervention/choice on the territory, because public administrations do not have available tools usable in the initial phase of proposal and definition of interventions.

The tools they use, EIA and SEA, apply to ex ante. Therefore, they are seen as quite far from what is needed in order to perform life cycle assessments. However, EIA should not be ruled out completely. Heijungs et al (2008) mention that, in certain situations, there are good reasons to choose EIA instead of a life cycle perspective. For instance, a producer can choose between two places to build a certain facility, and the transport distances with the rest of the supply chain are comparable, an EIA may provide more accurate and faster answers than a full systems analysis.

Although the representatives of regional public authorities have a good overall knowledge of life cycle approaches, the experience with the use of life cycle approaches is very limited. The respondents think that life cycle approaches are still quite unknown among their colleagues. Some say, the reason why they do not use LCA is that it is not considered a reference approach in the legislation process. Respondents could see the potential of life cycle approaches and the related applications in the public authorities' activity regarding, for example, system choice (transport systems), planning choices, and technology choices (waste management).

Public authorities at national level are also represented in the survey stating that they occasionally use life cycle approaches such as ISO-LCA, Life Cycle Costing (LCC) and Cost Benefit Analysis (CBA). However, there is a large difference in the need for life cycle approaches. Here to, participants of this survey use ISO-LCA as reference approach when defining challenges and future needs of life cycle approaches.

In some cases, the respondents have the time to dig into life cycle assessment reports, interpreting them and making up their own mind about the assumptions, methodological choices, results and conclusions. In such cases, the tradition of LCA practitioners to deliver reports with a great deal of information is valuable. The LCA practitioner should not apply weighting across impact categories but leave this part of the interpretation to the public authority. However, in other cases, the respondent focuses on the conclusions presented in the summary. In such cases, they want the conclusions and recommendations to be brief and clear, making it possible to use them, without risk of misinterpretation, in their report to the government. Here, it is essential that the LCA practitioner does all of the interpretation, including assessing the relevance of different scenarios and uncertainties, and also including implicit or explicit weighting across impact categories.

The result of this survey shows (also highlighted in Fava & Hall, 2004) that LCA results are regarded as useful support in certain decision making situations:

- make policies more consistent among consumers, producers, material suppliers, retailers, and waste managers and also among different policy instruments (such as harmonising regulations, voluntary agreements, taxes, and subsidies).
- purchase products and services which are “environmentally preferable”, reduce the impact government operations have on the environment and support regional and global markets for “preferable” products and services.

Some respondents are aware of the fact that different life cycle assessments sometimes contradict each other. This is a sound attitude, since the results of life cycle assessments depend on subjective methodological choices.

A low rate of actual application of life cycle approaches in national public authority is observed. ISO-LCA is considered by some to be an “expert model” which takes too long a time and the results are often complicated with many decision makers not able to interpret the

results. The results may be difficult to communicate to the general managers and ministers. Results that are more communicable are therefore considered useful.

3.3.2 Life cycle approaches – Development and needs

Since representatives of national authorities occasionally use life cycle approaches, they have requests on how they think that life cycle analysis should develop to become more useful in decision-making. It is important that the results are simple and easy to understand; one should communicate what is included in the study, and also what is excluded. Some think that more systems analysis is required for the assessment of strategic use of energy resources. Natural resources are thought to become more important to integrate in the future because of resource scarcity.

3.3.3 Linking life cycle approaches to sustainability

There seems to be an interest in including additional economic performance to a larger extent in life cycle approaches, in order to increase the acceptance and, hence, the success of the methods. This is related to putting a cost on the degradation of the environment. Otherwise, it has been stated that environmental problems are not going to be solved.

The representatives of national authorities also voice a request to include social effects of possible decisions; however, it was not specified what type of effects they want to include. A barrier to use models as decision-support is because choices at present are supported mainly by economic considerations and evaluations. Therefore, they state that there is a need to push for the integration of environmental and social aspects in order to make sustainable decisions.

3.4 NGOs, consumer associations

3.4.1 The use of life cycle approaches and its challenges

NGOs typically are involved in public debate and public policy making on sustainability. They can potentially be involved in specifying the ultimate demand for analysis, in a basic sense asking for and supplying “the right life cycle analysis”. Unfortunately, NGOs have been poorly represented in this study, since it includes three NGO interviewees only.

Two of the NGO respondents have a good knowledge of life cycle approaches, some even with practical experience in methods such as Eco-Efficiency, LCA (ISO), CBA and, CSR. Although the organizations represented do not use the methods themselves, their knowledge is needed in order for them to interpret the results coming out of them. This has made them aware of the strengths and weaknesses of the methods. Based on this knowledge they specified what they think pose challenges for further use and development of the methods:

- too expensive methods,
- too few who are interested in the results,
- the methods are not reliable enough,
- difficulties to find methods that meet actors needs,
- the methods are too difficult to understand, and
- lack of knowledge about these methods.

The reliability problem, concerns systems models in general. The reason: when using a system model like ISO-LCA the answer will differ depending on what model and assumptions you build the analysis on. This may not be a barrier for further application but it is certainly recognized as a problem. A supplier of such information could potentially use his/her position to manipulate results. This makes it important to have transparency in the assessments. It is

also important that the receiver of the result must have knowledge on how to interpret them and have in mind that the result can vary with different assumptions and methods. Standardization of models was not thought to be a guarantee; rather what matters are to communicate the underlying assumptions.

3.4.2 Life cycle approaches – Development and needs

Some of the barriers listed in section 3.4.1 were also proposed as needs. Although not being that specific, respondents mentioned that the reliability of models needs to improve and become more adaptable to meet actors specific needs.

3.4.3 Linking life cycle approaches to sustainability

Unanimously, the respondents state that the most important driving forces for the development of life cycle approaches that enhance all three pillars is customer demand. Therefore, a key element of the developments of methods could be to influence customers voluntarily, by knowledge and by value based normative incentives. If they are asking for information, companies will have to supply it.

3.5 R&D programmers

3.5.1 The use of life cycle approaches and its challenges

The organizations represented in this stakeholder group include national funding organizations and research institutes. Although the European Technology Platforms were approached with questionnaires, no responses were forthcoming. Unfortunately, the national funding organizations have only one representative in the survey. The funding organization had no experience with life cycle approaches. By contrast, the research institutes covered in this survey have both good knowledge in system tools as well as practical experience of them including LCA and life cycle cost (LCC). With a generally high knowledge, the research institutes specified some general reasons that they think would act as a barrier for the use of the methods. It was mentioned that too few are interested in the results, methods are too time-consuming, difficult to understand, and lack of knowledge about life cycle approaches. Unfortunately, no responses were forthcoming from the European Technology Platforms although they were approached with questionnaires.

3.5.2 Life cycle approaches – Development and needs

Although the national funding organization is not involved in the use of system tools, they identified a need within their own organization. The idea mentioned was to develop a method with a life cycle approach to evaluate the sustainability of incoming applications.

3.5.3 Linking life cycle approaches to sustainability

The research institutes came up with many interesting aspects regarding an expansion of life cycle based environmental assessments of technologies/products to enhance the full sustainability concept. A key factor mentioned for satisfying complete sustainability evaluations is to develop a life cycle approach where economic, environmental and social dimensions are included at the same time. They also request more research to introduce parameters of sustainability in life cycle approaches for all the main mid- and long-term technological and strategic choices. It is necessary with a first model or system capable of orienting the choices in the starting phase. Then, using a not over-refined tool, that is, and agreed standard at European level, capable to provide guidance and parameters in order to apply sustainability assessments in a life cycle approaches in extended and repeated ways.

These methods were thought to be functional in areas of energy and environment, transport systems, urban policy issues, planning and quality control in the service sector. Some of the precondition for the development of such models is thought to be development of reference systems for quantitative knowledge (data). Other characteristics that are thought to be of importance in a sustainability life cycle approach is the ability for long terms assessments.

4 Conclusions

There are several strong messages that have emerged across the stakeholder groups about; the use of life cycle approaches and its challenges; and, future development and visions on how they want life cycle approaches to develop to become more useful in sustainability decision support. One overall conclusion is that participants of this survey often use ISO-LCA as reference approach when defining challenges and future needs of life cycle approaches.

The priority messages regarding life cycle approaches and its challenges are:

- ISO-LCA is considered to be an “expert model” which takes too long time to carry out and the results are often complicated
- too few who are interested in the results, and
- difficulties to find methods that meet actors needs.

The priority messages regarding future needs and evolution of life cycle approaches:

- simpler interfaces (adapted to the required application or sector),
- clear standards for data gathering,
- less time consuming models,
- greater transparency,
- integration of economic elements in life cycle approaches, and
- data representative to different levels of resolution (geographical coverage).

The request specified above compromises a complex mix of requests such as, increased flexibility, accuracy and user-friendliness, which perhaps might be too much of a challenge to incorporate in one system model.

4.1 Business

The highest share of companies state that life cycle approaches is important to use as sustainability decision support in product development (77%). Other particularly important application areas of application are to support to selection of raw materials (66%) and choices of technologies (55%).

One overall conclusion is that participants of this survey often use ISO-LCA as reference approach when defining challenges and future needs of life cycle approaches.

The challenges that have been identified include:

- too time-consuming models for the situation posed (i.e. product development phase)
- difficult to understand and difficulties to integrate whole supply chain in the assessment
- problems related to find accurate figures to put into the models,
- the available data bases are too narrow and restricted to certain materials like basic chemicals, oil, metals (the respondents did not specify which materials to include), and
- too few are interested in full LCA.

The priority messages regarding future needs and evolution of life cycle approaches are:

- need for transparency in models,
- methods have to be developed together with the industry, not by the scientists alone,
- develop strategies on how life cycle approaches can be communicated better up and down supply and value chains,

- make consumers understand their role in the life cycle of products,
- include future impacts in the models,
- models need to consider a world without fossil fuels,
- include risk analysis in environmental assessments,
- further developed and improved ability to identify energy efficiency potential, and
- increased validity and credibility of simplified life cycle approaches,
- need tools need to be applicable in specific industrial sectors,
- regional variations in production need to be accounted for in the models, and
- Some of the requests suggest some contradictory research lines, i.e., how to make methods robust and credible but at the same time do a quick assessment? or, how to make flexible models without developing so many specific tools?

There are different opinions if LCA should be devoted not only to account for environmental assessments but also enhance full sustainability assessments. Some interviewees doubted the functionality of a “broadening” of the LCA to consider all sustainability dimensions. In the contrary, many businesses have an interest in expanding the perspective from environmental life cycle assessments to enhance all sustainability pillars in the assessment. Some respondents said that a sustainability assessment based on a life cycle approach could be done in the same system model, while some stated that each sustainability dimension should be assessed in parallel. More specific requests were the proposal of economic and social parameters to include in LCA. The social parameters proposed were working environment and work-related accidents and diseases, plus sick-leave. The economic parameters proposed were, socio-economic cost and/or benefits to the society.

4.2 Public Authorities

The result this far suggests that there is differences in the level of knowledge depending on, if the respondent represent regional or national public authority. Life cycle approaches is not a reference approach on regional level (in one country); rather they use tools such as EIA (Environmental Impact Assessment) and SEA (Strategic Environmental Impact Assessment, which apply to ex ante. Lack of experience in the life cycle approaches has made it difficult for them to comment on the matter of this report.

They could however see a potential to use life cycle approaches in activities such as system choice (transport systems), planning choices, and technology choices (waste management). Clearly, there is a gap between a potential use of a concept and actually applying it. We therefore suggest that there is need for better understanding how life cycle approaches could support their daily activities. Given their current state of knowledge, if life cycle approaches were applied in their activities, it would certainly be of importance that the models are simple and easy to understand.

National authority has specified a more detailed input to our study. The survey has showed that LCA results are used in two different ways:

- in some cases, the respondents have the time to dig into LCA reports, interpreting them and making up their own mind about the assumptions, methodological choices, results and conclusions.
- in other cases, the respondents focus on the conclusions presented in the summary. In such cases, they want the conclusions and recommendations to be brief and clear, making it possible to use them, without risk of misinterpretation, in their report to the government.

The result of this survey shows (also highlighted in Fava & Hall, 2004) that life cycle analysis is regarded as useful support in certain decision making situations:

- to make policies more consistent among consumers, producers, material suppliers, retailers, and waste managers and also among different policy instruments (such as harmonising regulations, voluntary agreements, taxes, and subsidies), and
- in purchasing products and services which are “environmentally preferable”, reduce the impact government operations have on the environment and support regional and global markets for “preferable” products and services.

The priority messages regarding future needs and evolution of life cycle approaches:

- interest in including additional economic performance to a larger extent in LCA in order to increase the acceptance and, hence, the success of the methods,
- interest in including social effects to a larger extent in life cycle analysis, and
- it is important that the results are simple and easy to understand.

4.3 NGOs

It is unclear based on the empirical material in what decision-making situations life cycle approaches are needed. This has to do with the poor questionnaire response from NGOs. Therefore, we are going to collect additional data to strengthen and complement the result to the final deliverable (D19) of this WP.

There is consensus among the respondents of the challenges related to the use of life cycle approaches:

- too expensive methods,
- too few who are interested in the results,
- the methods are not reliable enough,
- difficulties to find methods that meet actors needs,
- the methods are too difficult to understand, and
- lack of knowledge about these methods.

The barriers listed above were also proposed as needs. For example, respondents mentioned that the reliability of models needs to improve and become more adaptable to meet actors specific needs.

4.4 R&D programmers

Two national funding organizations and three research institutes is represented in this stakeholder group. Except for the funding organizations, all respondents have practical experience in using life cycle approaches.

There are some strong messages that have been found across this stakeholder group (stated by the research institutes). The following challenges were proposed to the use of life cycle approaches:

- too few are interested in the results,
- methods are too time-consuming,
- difficulties to find methods that meet actors needs,
- difficult to understand, and
- lack of knowledge about life cycle approaches.

The priority messages regarding future needs and evolution of life cycle approaches:

- develop a model where economic, environmental and social dimensions are included at the same time.
- more research to introduce sustainability parameters in life cycle approaches for all the main mid- and long-term technological and strategic choices such as energy and environment, transport systems, urban policy issues, planning and quality control in the service sector,
- develop reference systems for quantitative knowledge (data),
- important to include ability for long term sustainability assessments in life cycle approaches.

5 References

Anonymous, 2006, Making Product Information Work for the Environment, Final Report of the Integrated Product Policy Working Group on Product Information, Delivered to the European Commission and the IPP Regular Meeting 15 November 2006.

Fava J. and Hall J., 2004. Why Take A Life Cycle Approach, UNEP – Life Cycle Initiative

Heijungs R., Huppes G. and Guinée J., v1, 20 March 2008, A SCIENTIFIC FRAMEWORK FOR LCA, Deliverable D15 of the CALCAS project, CML

ISO 14040:2006, Environmental management – Life cycle assessment – Principles and framework, Swedish Standards Institute (SIS)

Klinge M., Jeske U. and Schebek L., 2006, Lifecycle-related eco-labelling of construction products - planners' interests and needs on LCA data and tools", PowerPoint-presentation from Technikbedingte Stoffströme 2nd International Conference, June 28-30, 2006, Egmond aan Zee, "Quantified Eco-Efficiency Analysis for Sustainability"

Neumann, Kristina (2007): Life-Cycle Approaches in European Companies: The influence of internal and external drivers on the application of life-cycle tools. Master's Thesis, Institute for Ecological Economy Research (IÖW), Berlin/Heidelberg/Germany, and the Environmental Policy Research Center (FFU) of the Freie Universität Berlin/Germany, Berlin, 2007. [Internet: http://www.ioew.de/home/downloaddateien/Life-Cycle_Approaches.pdf., Accessed January, 2008].

Report from 4th Green Chemistry and the Consumer symposium, 2007, Measuring Green: Green performance indicators across the chemical product lifecycle, King's Manor, York, UK on the 28th June 2007

Swanström L. and Cerin P., 2006, Management of Sustainability Issues in Industry – A stakeholder perspective, CPM- Centre for Environmental Assessment of Product and Material Systems, Chalmers University of Technology, Gothenburg, Sweden

Thiesen J., Valdivia S., Sonnemann G., Fava J., Swarr T., Jensen A. A. and Price E., 2006, Understanding Challenges and Needs: A Stakeholder Consultation on Business' Applications of Life Cycle Approaches, UNEP

United Nations (UN), 1987, Report of the World Commission on Environment and Development