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Evaluating the Sustainability SWOT as a streamlined tool for life cycle sustainability assessment

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Abstract
Purpose From a management perspective, there are two main issues in the life cycle sustainability assessment framework which require further work: (1) the approaches to quicken the resource-consuming inventory and assessment process and (2) the easy-to-understand communication of the results. This study aims at contributing to these needs for quicker and cost-efficient ways to draft strategies that include the life cycle perspective and encompasses all three dimensions of sustainability in an easily communicable way. The focus of the study is on a streamlined, rapid assessment the tool proposed by Pesonen (2007) called the Sustainability SWOT (Strengths, Weaknesses, Opportunities, Threats) and on the empirical testing of whether or not it is understood in the corporate world and if it leads to concrete changes in either strategic- or operative-level activities.
Methods The data for the research were empirically collected from a survey targeted to representatives of organizations having used the Sustainability SWOT within the last 5 years. The primary findings, i.e., the generated changes or improvements, were reflected in the various levels of cooperation in a network (along the value chain, in end users, in the institutional framework).
Results and discussion The results of the analyses of both the usability of the Sustainability SWOT in business as well as the suggested assessment framework leading to any actual changes were promising. It is encouraging that the streamlined approach tailored according to the logic of business decision-makers (i.e., inclusion of the SWOT) is able to find the acceptance and understanding of that vital group. Remarkably, many changes were initiated—not only at an operative level but also at a strategic level and in the entire value chain—by carrying out an exercise such as the Sustainability SWOT.
Conclusions The Sustainability SWOT has proven to be usable and able to generate changes and improvements along the value chain and, in some cases, in the institutional context as well.

Keywords Life cycle perspective · Streamlined assessment · Sustainability · SWOT

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1 Introduction

The life cycle assessment (LCA) community has identified that not only LCAs, but rather also a life cycle-based full sustainability assessment should be an important part of decision-making. Over the years, the discussion has evolved from a pure methodological development of LCA and case studies to a more holistic approach in increasing awareness of false optimization and wrong choices, like the burden shifting within or between each domain (environment, economy, and society) or to the future. Klöpffer has initiated the discussion on the options of how to formulate the procedure to carry out a full sustainability assessment (Klöpffer 2006, 2008; Klöpffer and Renner 2008). Furthermore, as Klöpffer and Ciroth (2011) forecast, "the further development of LCSA [life cycle sustainability assessment] will mainly depend on the improvement of the [individual] life cycle methods," which underlines the fact that all of the pillars of sustainable development are relevant to the final framework. As an intermediate conclusion, a recent report by the Life Cycle Initiative introduced the framework of a life cycle sustainability assessment (LCSA) (Valdivia et al. 2011).

Nevertheless, even though a thorough assessment framework with individual methods has already been proposed and is in the process of being further developed, there are still numerous areas in need of development in order to advance the implementation of LCSA tools. Whilst more research has been undertaken to develop and systematize the individual methods within the framework—namely LCA, life cycle costing, and social life cycle assessment (S-LCA)—less attention thus far has been given to understanding overall management tools of the framework and how these can make a valuable contribution to the assessment. The management tools could in fact be mobilized to complement the life cycle-based methodologies and the accounting and analysis of material flows in order to control, reduce, or prevent the sustainability impacts of a defined life cycle (Pesonen 2005).

By reading current statements from scholars trying to develop the three-pillar interpretation of sustainability from a life cycle perspective, it is noticeable that from a management perspective, there are two main issues which require further work: (1) the streamlined (or "simplified," both of which, in the context of this study and in line with previous studies, are seen as synonymous) approaches to quicken the lengthy and resource-consuming assessment process and (2) the easy-to-understand communication of the results to the stakeholders. For instance, the recently published framework for LCSA demands the "development of more streamlined approaches that analyze the whole picture (instead of looking in high detail only at one aspect)." Klöpffer (2008) also states that "the assessment methods should be simple and not always quantitative.[1]" Finkbeiner et al. (2010) remark additionally that "another challenge is a comprehensive, yet understandable presentation of the results [of an LCSA]." Currently, even though the individual LCSA methods are able to produce a wealth of important information, the entire framework is faced with the challenges of being too difficult to understand and interpret as well as ultimately too difficult to use in decision-making for a non-expert audience. Altogether, this leads to the requirement of having an understandable yet comprehensive presentation technique of LCSA results (Valdivia et al. 2011).

This study aims at contributing to these needs for quicker and cost-efficient ways to make strategic planning that dynamically includes the life cycle perspective and encompasses all three dimensions of sustainability in a visually easily communicable way for all stakeholder groups. The focus of the study is on a streamlined, rapid assessment tool proposed by Pesonen (2007) called the Sustainability SWOT (Strengths, Weaknesses, Opportunities, Threats) and on the empirical testing of whether or not it is understood in the corporate world and if it leads to concrete changes in either strategic- or operative-level activities. The main research questions guide the underlying study: (1) How usable is the Sustainability SWOT in business? (2) Does the suggested assessment framework lead to changes or improvements in life cycle management (LCM)? (3) Does the tool increase understanding of the life cycle perspective?

When structuring the intertextual field around the underlying study, the main contribution is novel approaches to life cycle-based methodologies, which in a way displays progressive coherence around the entire field. Bala et al. (2010), Hochschorner and Finnveden (2003), Liedtke et al. (2010), McAloone and Bey (2009), Schulz et al. (2012) and Valdivia et al. (2011) all agree on the fact that even though LCAs are valuable assessment tools, in some cases, they cannot be used due to lack of time or resources. This has fostered the recent emergence of a branch of studies proposing indicatory management tools with more relaxed data-quality standards that identify sustainability impacts—without being cost or time intensive.

Moreover, for practical decision-making in early phases, there is a demand for less complicated, thus more widely utilizable, tools in situations in which preliminary analyses need to be made or in which less-than-perfect results can still be considered better than no results at all. Rebitzer and Schäfer (2009) published the results of an industry-specific survey, which demonstrated that LCA as a methodological framework is only understood by little more than a quarter of the respondents and that knowledge about LCA and what it can do is not yet part of mainstream thinking. Also, Jørgensen et al. (2009) studied the industry's ability and willingness to devote efforts in the context of S-LCA. As these studies indicate, it is of interest that the LCA community encourages a discourse with industry decision-makers in order to enable the use of life cycle methods and its vital results in the future as well. The scholars need to understand how well life cycle results are understood in real-life decision-making, what effort might bring life cycle methods closer to real application, and how the life cycle-based thinking can be carried over to strategic choices in businesses and real changes towards a more sustainable course of actions (Finkbeiner et al. 2010).

The paper first discusses the need for streamlined approaches in life cycle-based research and presents a review of the approaches that are currently used, displaying in more detail the status of the current discussion and field of contribution. Second, the paper presents the Sustainability SWOT as a possibility to both streamline the assessment and to represent the results in a straightforward manner. Third, the empirical survey data and methods will be presented

[1] In order not to falsify the citation, it should be mentioned that it continues "…this may be true for finding hot spots, but certainly not for decision-making: If different solutions are proposed, quantitative methods are needed." The context, however, is further discussed in later sections.

after which the results of the study will follow. It brings together the empirical material in light of the theoretical framework to highlight which changes at what stage will be generated. The conclusion sums up the findings of the study and highlights the need for more research in this field.

2 Streamlined approaches in LCSA

In terms of already developed streamlined approaches to life cycle-based assessment methodologies, these relate chiefly to assessing the environmental impacts of a given product system, i.e., LCAs. This is why we will focus primarily—but not exclusively—to reporting on the progress in streamlining the LCA method in particular.

There are three basic levels of LCA (Wenzel 1998):

- A full-scale LCA, quantitative and including new data inventory
- A screening LCA, quantitative using readily available data or semiquantitative
- A matrix LCA, qualitative or semiquantitative

As mentioned previously, a *full-scale LCA* can be both time and resource intensive, which leads to the outcome that they are not always the primary or best action of a company trying to develop its processes or products towards a more sustainable direction. In fact, the inherent complexity of carrying out a full LCA can be hypothesized as standing in the way of a widespread application in the industry and policy-making sectors (Bala et al. 2010). Furthermore, the results of a full LCA can be very complex and difficult to understand for decision-makers either in the industry or in the public sector.

Both *screening* and *matrix LCAs* from Wenzel's division are seen as streamlined approaches in terms of this study. A screening LCA uses mainly quantitative data; however, it is available from readymade databases so that no new inventory calculations are made. In general, streamlined life cycle approaches can be qualitative, quantitative, or semiquantitative. A large number of simplified LCA methods have been developed (for a listing, see, e.g., Baumann and Tillman 2004 or Pesonen 2007). Currently, some streamlined methods for a full sustainability assessment have also been developed. The fields of application for simplified life cycle-based methods are, for example, product development and procurement, more specifically in planning, conceptual design, embodiment design as well as detail design (Baumann and Tillman 2004). Many of these methods are developed for a specific group of products and are not well documented (Hochschorner and Finnveden 2003).

In the literature, it is not the ultimate ambition that the streamlined approaches fully substitute a full-scale assessment in the form of an LCA, for example. Neither is it the ambition to produce material for external communication (McAloone and Bey 2009). Rather, their goal is to illustrate how individually adapted simplified models can at times be useful in providing a reliable, quantitative measure of environmental impact, which may just be what is in order for the purposes of imminent political and economic decisions (Bala et al. 2010). And even with these limitations, these simplified methods give a quick overview of a product's environmental profile (McAloone and Bey 2009). In the corporate context, a more agreeable step-by-step approach has been proposed (Liedtke et al. 2010). The ideal progress of such a gradual analysis would start by carrying out a streamlined analysis, with any of its methods available (see list in Section 2.1). After this, the second and third steps, which would be carried out for a viable selection resulting from a streamlined analysis, could either be a material input per service unit (MIPS) or a full-scale LCA including—the more detailed the assessment becomes—other core indicators as in the streamline first-cut assessment and more exact differentiation. Environmental life cycle considerations are probably best supported by a well-balanced combination of a few approaches (Baumann and Tillman 2004).

When life cycle-based methods, particularly LCAs, are used for decision support, uncertainty is an important issue to be taken into consideration (Huijbregts et al. 2001; Geisler et al. 2005; Lloyd and Ries 2007). Uncertainty, especially in an LCA, can stem from many different sources, e.g., variable, erroneous, misspecified, incomplete, or rounded data; boundary choices; inconsistencies in the goal and scope; allocation principles; time horizon in the impact assessment; inaccurate implementation of relations in the software; etc. (Finnveden et al. 2009). As there are obviously many sources of uncertainty in the method, there has arisen a need to systematically incorporate uncertainty into the assessment. Keeping in mind that a streamlined LCA can increase the uncertainty of the sources, it would be appropriate to try to deal with this issue in the streamlined methods as well. In particular, if a streamlined approach produces quantitative results—such as for instance software-based applications—the results can at first seem very certain. Nevertheless, if only looking at the results, it is often overseen that the actual process behind them is not very transparent. An approach is required which manages uncertainty of all types and does so with transparency, fairness, and competence.

2.1 Currently used streamlined approaches

Some previously used methods for streamlined sustainability assessment from a life cycle perspective are qualitative, streamlined, or simplified LCAs in the form of life cycle influence matrices, software tools, LCA-derived proxies, rules of thumb, hot spot analysis, combination tools, LCA as a creativity tool as well as life cycle thinking, Environmental Sustainability Assessment Tool (ESAT), sustainability matrices, etc. From this nonexhaustive list, it becomes apparent that there exist a number of life cycle approaches, both analytical and creative, for all stages of product development (Pesonen 2007; Baumann and Tillman 2004). However, the majority of these approaches do not assess full sustainability; rather, they remain in the field of environmental impacts. The strengths and weaknesses of these different approaches are presented in Table 1.

2.2 Sustainability SWOT as a streamlined approach

The study's main contribution is the presentation and evaluation of an assessment tool in the form of a Sustainability SWOT (Pesonen 2007). The Sustainability SWOT (Fig. 1) is an analytical tool combining two well-known methods: the basic SWOT tool, a strategic business planning process in matrix form, and LCA, which calculates the environmental impacts of a given product system. It is able to integrate all aspects of sustainability into one assessment matrix efficiently. The Sustainability SWOT can be used as a product-level assessment of an organization's main product or product groups, the core requirement being that a life cycle can indeed be modeled. After having a life cycle at hand, the present and future sustainability impacts (environmental, social, economic) for each life cycle stage will be mapped and complemented with a qualitative valuation of their significance. Visually, the life cycle stages are presented above the SWOT matrix. In the SWOT matrix, the life cycle stages of each impact can be identified through respective symbols or color legends (see Fig. 1). The number of symbols (from one to three) indicates the significance of the impact in question.

The specific features of a Sustainability SWOT include, firstly, the consideration of all three dimensions of sustainability as well as the coverage of the main life cycle stages in one model, as has been suggested in the general framework of LCSA. Additionally, the features of the tool include a qualitative or semiquantitative valuation of the significance level of the found sustainability impacts. The tool is able to communicate the most important factors through the three-level valuation indicator. Moreover, a rough, preliminary qualitative sensitivity analysis is possible in this context by looking at the future changes as the opportunities and threats of the model. Finding the most significant sustainability impacts and sensitizing these can add value in the form of a qualitative sensitivity analysis. This streamlined approach is particularly relevant within the industry and policy-making sectors, in which decisions with potentially large environmental and economic consequences are often made with limited time and financial resources, and in which the decision-making process often cannot wait for the results of full LCAs (Bala et al. 2010). In the case that at least the hot spots can be found in the beginning of the assessment, these can be further emphasized in extended, more detailed analyses.

In practice, the use of the Sustainability SWOT follows a clear structure as follows:

1. Identification of product life cycle stages
2. Identification of sustainability impacts from all three perspectives (environmental, social, economic)
   (a) Now
   (b) In the future—year *X*
3. Significance assessment of the sustainability impacts
4. Compilation of the Sustainability SWOT

Figure 1 exhibits a fictional Sustainability SWOT, which was drafted for biodiesel to depict an example case. On the top of the figure, the life cycle of the product has been visualized from raw material production to the use phase (biodiesel in this case has been expected to have no significant impacts after it has been used). The strengths, weaknesses, opportunities, and threats have been outlined for this hypothetical case in order to visualize how the tool is able to communicate the relevant issues during the life cycle of this product.

As a tool for business decision-making, the Sustainability SWOT fosters learning and cooperation. General experience shows that the assessment of sustainability cannot be treated merely within the community of experts. Rather, in order to attain credibility and effect changes towards sustainability, it is essential to involve an extended community with different perspectives (Elghali et al. 2007). The Sustainability SWOT is ideally formed as a cooperative brainstorming effort by both business and sustainability experts. Drafting a Sustainability SWOT together with sustainability experts can be a powerful learning experience about the complexity of sustainability for the business decision-makers, as it is able to present an overall, though simple, picture of the entire product life cycle summarizing the most important sustainability aspects. Moreover, a SWOT is an easy-to-read and familiar tool for business people. The framework is designed to meet the requirements of the extended peer community with different perspectives by incorporating stakeholder concerns in decision-making, to guide the private sector and include the implications of the wider institutional community as well. However, we must also keep in mind at this point Klöpffer's (2008) writings, in terms that though the streamlined tool can be used to aid decision-making, it should not be used as a comprehensive method, but as a first-cut approach instead.

3 Target groups of LCM

In terms of the generated changes as a result of using the Sustainability SWOT, these can be analyzed in light of the industrial network theory as a possible framework for understanding the extended focus of sustainability management and the need to manage sustainability issues beyond a single organization. A division of possible target groups of life cycle management, based on the industrial network theory, has been suggested by Pesonen (2005) and can be

Table 1 Summary of streamlined approaches for life cycle-based assessments

	Description	Sustainability perspectives			Qual./Quant.	Based on case-specific data
		Envir.	Soc.	Econ.		
Hot spot analysis (Wallbaum and Kummer 2006, as cited in Bienge et al. 2010)	Elaboration of the most relevant ssues or phases influencing resource use in the life cycle/value chain	x			Quant.	x
Sustainability hot spot analysis (Bienge et al. 2010)	Elaboration of the most relevant factors or phases influencing resource use, further environmental and social impacts in the life cycle/value chain	x	x	(x)	Qual./quant.	x
Life cycle thinking	Conceptual application of life cycle-based methods	x	(x)	(x)	Qual.	x
Streamlined LCA	Preliminary, shortened LCA either qualitatively or by using readymade databases	x			Qual./quant.	(x)
7-Step approach to environmental improvement through product development (McAloone and Bey 2009)	Systematic and creative 7-step approach to identify the company's potential for creating synergy between environmental improvement and business creation	x	(x)	(x)	Qual.	x
Rules of thumb	Simple design rules based on experience from "ordinary" quantitative LCA studies, which repeatedly reveal the same environmental impact source (e.g., reduced environmental impact in transportation through lower weight)	x			Qual.	
LCA-derived proxies	Simple, easy-to-measure metrics evaluate a product with respect to its critical environmental properties. A well-known proxy is MIPS (Schmidt-Bleek 1994), calculating material weight	x			Quant.	x
Socio-ecological impact matrix, ecomatrix (Belz 2005)	Analytical tool in matrix form exhibits social and ecological problems of a life cycle: on the *x*-axis are the stages of life cycle and different ecological and social dimensions on the *y*-axis	x	x		Qual.	x
MET matrix (Brezet and van Hemel 1997)	Analytical tool in matrix form, covering main life cycle stages on the *x*-axis and main environmental impacts on the *y*-axis (material, energy, toxicity)	x			Qual./quant.	x
MECO matrix (Wenzel 1998)	Analytical tool in matrix form, covering main life cycle stages on the *x*-axis and main inputs and outputs on the *y*-axis (material, energy, chemicals, others)	x			Qual.	x
Software tools	Software packages allowing quick execution of an LCA through built-in large material and databases. Often only cradle-to-gate data.	x			Quant.	
Artificial neural network (ANN) modeling (Park et al. 2001)	"learning by example," used to perform preliminary environmental assessments. Based on what is known from existing products, ANN models are "trained" to model a new product	x			Quant.	
Combination tools (e.g., eco-functional matrix, QFD-LCA)	Combine, e.g., LCA with assessment of other aspects (e.g., technical aspect, cost), without going into too much detail	x	(x)	(x)	Quant.	x
Life cycle design structure matrix (LC-DSM) (Schlüter 2001)	Different life cycle stages are both on the *x*- and *y*-axis and the relations	x			Quant.	x

Table 1 (continued)

	Description	Sustainability perspectives			Qual./Quant.	Based on case-specific data
		Envir.	Soc.	Econ.		
	between all stages are noted in the matrix					
Environmentally responsible product assessment matrix (ERPA) (Graedel and Allenby 1995 as cited by Baumann and Tillman 2004)	Semiquantitative LCA, 5×5 matrix, one dimension is the life cycle stages and the other is environmental concern; total environmental responsibility is the sum of the matrix element values.	x			Semi-quant.	x
ESAT (Schulz et al. 2012)	Software tool using life cycle inventory data for rapid estimation of the environmental and economic performance of different water servicing scenarios which are further prioritized by interactive multicriteria analysis	x		x	Quant.	
Reverse LCA (Graedel 1998, as cited by Baumann and Tillman 2004)	Begins with the ideal environmental impacts of a product and works backward to determine the physical design satisfying them	x			Qual.	x
Carbon footprint e.g., Wiedmann and Minx 2008)	Same system boundaries and FU than LCA, but only one impact category	x			Quant.	x
Simplified GWP algorithm (Bala et al. 2010)	Calculates GWP for the most important phases in the product life cycle	x			Quant.	(x)
Simplified differences modeling (Bala et al. 2010)	Comparing recycling systems, takes into account only the differences that occur in one system vs. the other	x			Quant.	(x)

applied in this context. The target groups are approached in terms of where the visible changes are occurring (Fig. 2). The first level of changes occurs within the organization itself (intraorganizational); thus, the organization is the target group. The second level of changes can be visible in the industrial network, either in the inter- (partnerships) or multiorganizational (networks of organizations) networks. Here, the target groups are, in addition to the organization itself, also its partners within the industrial network, which would stimulate the idea about shared responsibility. In order to be able to control the entire network, the dominant actors of a network have to take responsibility of other network partners, especially their suppliers and subcontractors. Any individual organization in an industrial network has usually limited influence and control over the entire network. For example, when the product reaches the main contractor in the production chain, many of the crucial environmental decisions have already been made earlier in the value chain. An active cooperation with suppliers and subcontractors increases the main contractor's control and information about the whole value chain and reduces the risks associated with the environmental burdens of the products (Pesonen 2005).

The third level of changes would occur in the group of the product's final users, i.e., consumers. The changes are primarily initiated through the promotion of the sales and consumption of sustainable products over conventional products and through supporting the correct use and disposal of the products (e.g., eco-labels, user guidelines, maintenance and repair services connected to the products, product take-back programs, and disposal schemes offered to the consumers). Finally, the highest level of changes will occur in the institutional context, with opportunities to mold the regulative or infrastructural framework. The institutional context of the network, i.e., the last target group, refers to those external institutions, NGOs, or other stakeholders who have an influence on the operation of the network. The goals of life cycle management in transforming the institutional context are either to promote the production, sales, and consumption of sustainable products; to prevent the production, sales, or consumption of competing conventional products by changes in legislation; or to create infrastructure for more sustainable products or service concepts (Pesonen 2005). As Hoffman and Woody (2008) say, “at the highest level you should gain (and maintain) a seat at the table when future regulations are being designed, always keeping in mind that credible action will give you a greater leverage in that process.”

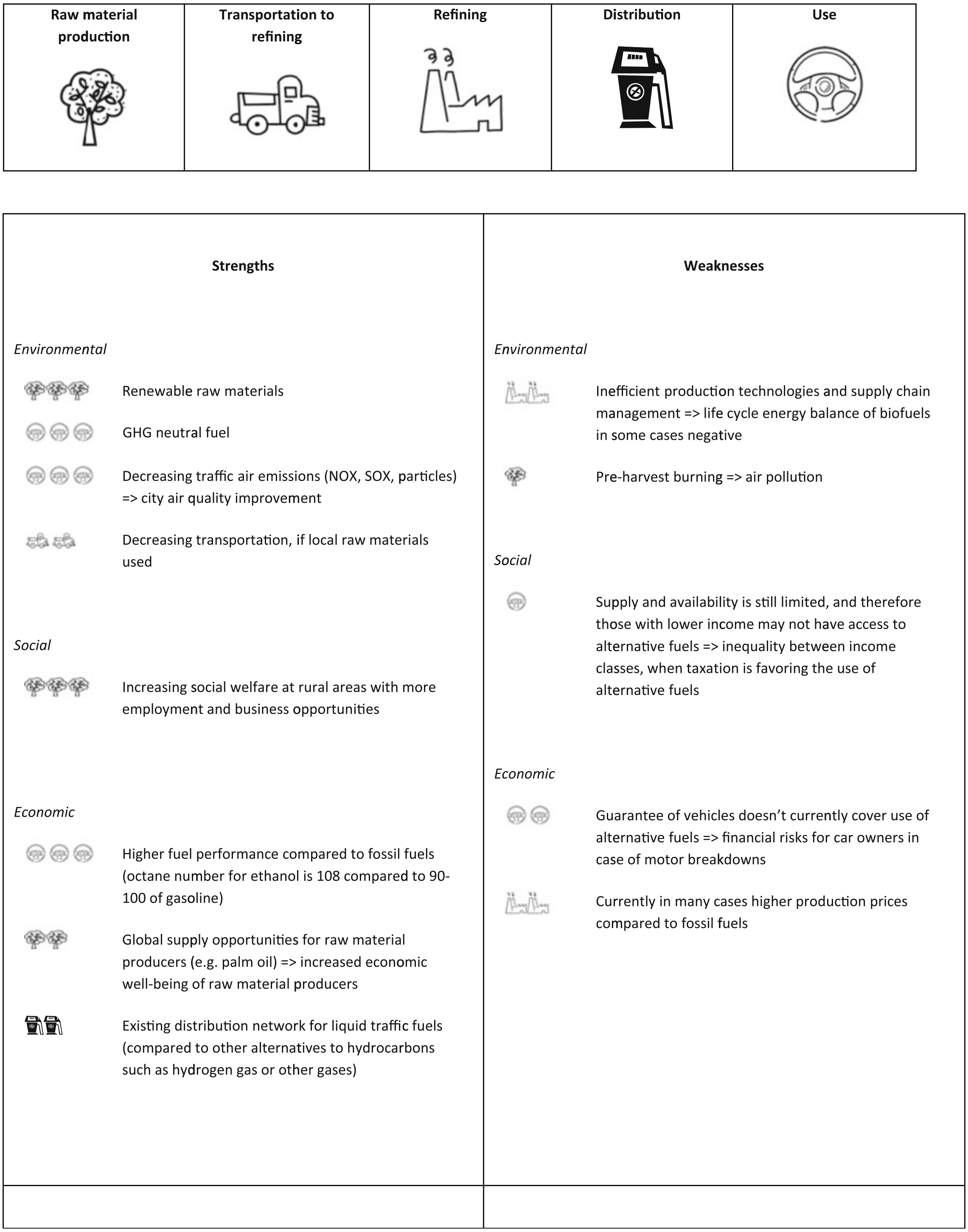

Fig. 1 Exemplary Sustainability SWOT for biodiesel

4 Data and methods

The data for the research were empirically collected from a survey given in December 2011(see Table 2 for survey questions). The Sustainability SWOT has been used within the last 5 years in a total of 111 organizations. Representatives from all these organizations were approached within the context of this study in order to assess the tool. Only 89 of these 111 representatives received the survey, due to maternity leaves, resignations, etc. The final sample size was 29 (33 % response rate). The survey consisted of seven main questions, out of which two aimed at eliciting background

Opportunities	Threats
Environmental	*Environmental*
Larger scale, more efficient production => increasing eco-efficiency of biofuels life cycle environmental impacts	Biodiversity concerns related to imported raw materials from some areas
Social	*Social*
Moving raw material production and employment south => better life quality of poor areas	Use of plants (e.g. corn, plant oils), which could be used for nutrition, for energy production => sufficiency of food in poor areas
	Bad working conditions in raw material production, if not regulated and controlled (e.g. working hours, child labor, unfair compensation)
	Good availability of cheap clean fuel => more traffic => more public investments in road infrastructure => unequal share of public spending
Economic	*Economic*
Support for increasing use of biofuels in (European) legislation => license to operate secured	No interest from car owners to switch to alternative fuels
Decreasing production prices with economics of scale and learning (80 % decrease in production costs of Brazilian bioethanol since 1980) => increasing price competitiveness	No interest from the car industry to develop biofuel vehicles => no demand for biofuels
Improved technologies enabling use of new raw materials (e.g. wood based raw materials in Fischer-Tropfs technologies) => more efficient raw material production => increasing price competitiveness	Availability of raw materials
Integration of biofuel production to existing industries (e.g. forest or oil industry) => synergy benefits	Import barriers for biofuels to protect import country's own (fossil) fuel production
Changes in fuel taxation favoring biofuels	
Possibilities for decentralized raw material and fuel production => increasing energy self-sufficiency for regions => independence from possible global energy crises and price fluctuation	
Economic use for abandoned farm lands	
Markets for byproducts from fuel production (e.g. protein feed for animals) => increasing efficiency in raw material use => increasing price competitiveness	

Fig. 1 (continued)

data (size of the organization and sector). The other five questions related to four main themes. The most emphasized question (with eight subquestions) concerned whether or not *actual changes* had occurred as a result of using the Sustainability SWOT in terms of (a) investments in technology or production processes, (b) investments in personnel, (c) investments in product development, (d) redefinition of corporate strategy, (e) changes in the supply chain, (f) new communication to the user base, (g) participation in the policy-making process, or (h) any other changes. In addition to giving a binary yes/no answer, the respondents were able to detail the actual changes in an additional comments section. The other questions related to a *general assessment of the tool* (rated from 4=worst to 10=best), its *target audience* (multiple response) as well as its *novelty value* (yes/no), each of which was complemented by an additional field for writing

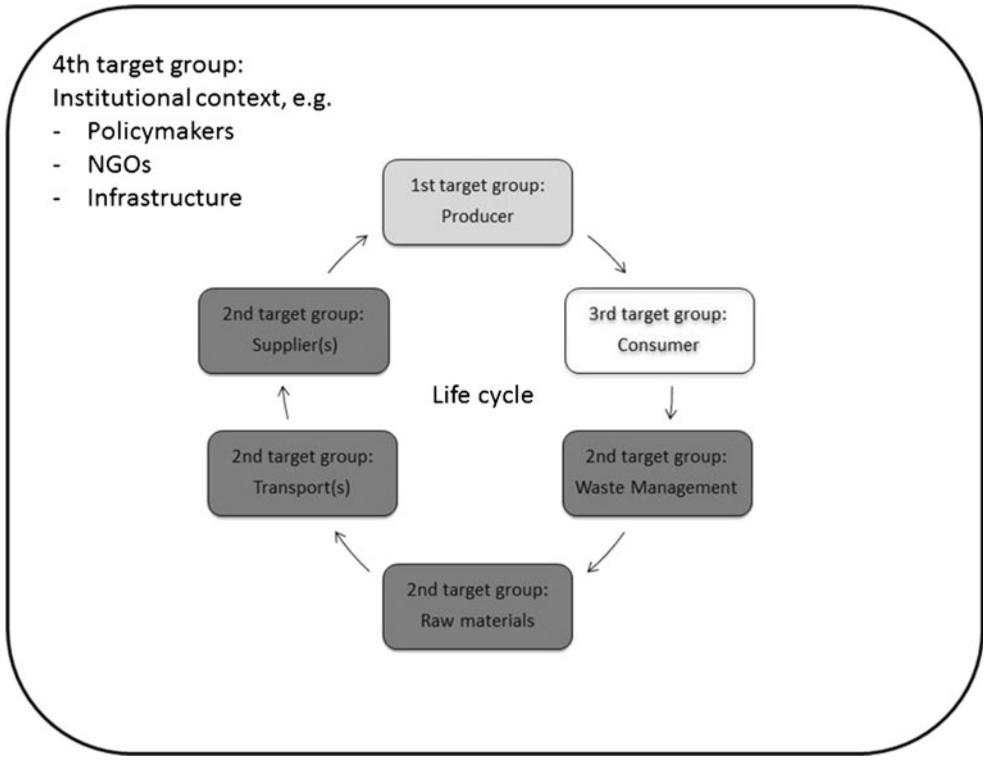

Fig. 2 Target groups of material flow management (modified from Pesonen 2005)

comments. Even though the sample size was small, a narrow statistical analysis was conducted. This included mainly the calculation of means and modes, but also testing if the background data had any impact on the willingness to execute changes as a result of using the Sustainability SWOT (e.g., if certain sized companies are more willing to invest in personnel or if certain sectors are unable to make any changes). The comments were analyzed further by means of content analysis in order to get an idea of the kinds of changes that were implemented.

The focus of the research is to find all concrete improvements or investments that result from using the Sustainability SWOT. The primary findings, i.e., the generated changes or improvements, will be reflected in the various levels of cooperation in a network. This aims at finding out if a model like the Sustainability SWOT can indeed lead to changes along the value chain, in end users or even in the institutional framework. Additionally, the general usability of the tool will be assessed to ascertain whether or not it can be implemented in practice as a streamlined tool for using life cycle-based methods and presenting results in a comprehensible and visually understandable manner.

5 Results and discussion

The first set of results reveals in a rough quantitative manner how the respondents valued the tool and if any concrete changes occur by using the Sustainability SWOT. The average grading of the tool was an 8 on a scale from 4 (worst) to 10 (best), which is encouraging. The quite consistent grading (standard deviation=1) indicated a positive reaction. The tool was able to provide some new information to 45 % of the respondents, with the primary additional value being in the systematic approach of drafting the situation and including more than one angle. Taking into consideration that the focus group was mainly mid- or senior management, it is quite striking to discover that the mere *awareness* of the system's life cycle is able to provide new information to this level of employees. This indicates that prior to using the tool, the focus group has been rather ignorant about life cycle-wide impacts.

Summing up the results of the changes as a result of using the Sustainability SWOT (question 6), 57 % of the respondents made at least one change in their activities (either through technological investments, personnel investments, product development, redefinition of strategy, supply chain changes, user communication, public decision-making, or any other investments or changes). By average, the respondents reported to having made changes in more than three different change categories (note that the “no answers” have been ignored in calculating the averages). Thus, according to the results, changes have occurred in the previously mentioned activities, but based on the data, it is impossible to assess how many projects have indeed been initiated (there might be several projects in, for example, product development).

Table 2 Survey questions and results

Question	Answer
1. What is the number of personnel in your organization?	1–9 (10 %), 10–49 (7 %), 50–249 (21 %), 250 or more (41 %), no answer (21 %)
2. In which sector is your organization active?	Manufacturing (21 %); accommodation and food-service activities (17 %); electricity, gas, steam, and air conditioning supply (10 %); construction (10 %); professional, scientific, and technical activities (7 %); arts, entertainment, and recreation (7 %); other service activities (7 %); public administration and defense; compulsory social security (3 %); wholesale and retail trade, repair of motor vehicles, and motorcycles (3 %); activities of extraterritorial organizations and bodies (3 %); no answer (21 %)
3. Which overall grading (4=worst to 10=best) would you give the Sustainability SWOT?	8
4. Did you learn anything new?	Yes (45 %), no (27 %), not able to say (21 %)
5. What would be the best target audiences?	Entire personnel (48 %), senior management (45 %), customers (41 %), partners (41 %), midmanagement (34 %), investors (17 %) public decision-makers (14 %), entire society (14 %), NGOs (7 %), media (3 %), consultants (3 %)
6. Did the results of the Sustainability SWOT encourage you in the following issues:	
a. …investments in technology or production processes?	Yes (21 %), no (59 %), no answer (20 %)
b. …investments in personnel?	Yes (17 %), no (62 %), no answer (21 %)
c. …new product development?	Yes (21 %), no (55 %), no answer (24 %)
d. …redefinition of corporate strategy?	Yes (28 %), no (52 %), no answer (20 %)
e. …changes in the supply chain?	Yes (14 %), no (55 %), no answer (31 %)
f. …communications to the users?	Yes (21 %), no (45 %), no answer (34 %)
g. …participating in public decision-making?	Yes (14 %), no (59 %), no answer (27 %)
h. …or in any other investments or changes?	Yes (10 %), no (52 %), no answer (38 %)

However, the second and perhaps more revealing set of results arises from a closer look at the magnitude of changes as well as if changes are transferable along the supply chain or to the customer base. These are collected from the additional comment fields of the survey, in which the respondents were asked to detail exactly which changes had been put into effect. They were classified based on the LCM target group division by Pesonen (2007) and further organized based on their level of impact (strategic vs. operative). Readdressing the actual changes occurring as a result of using the Sustainability SWOT, these can be further classified into being either strategic or operative (Table 3).

The most tangible changes occur within the organization itself. The strategic-level changes within the organization had primarily and explicitly an environmental focus (environmental strategy, environmental impact included in the strategy, energy efficiency aims on a strategic level), but some could also be seen as having a sustainability view (sustainability strategy and its introduction to the personnel, redefinition of the entire strategy, general awareness). One of the generated changes was still at a relatively universal level (general awareness); however, all the others were either very specific and tangible, requiring financial inputs, or had an impact on the entire corporate strategy (except for energy efficiency being added as a strategic aim, these strategic changes were not detailed further to indicate the level of impact this kind of tool could have). The most tangible and immediate changes were, e.g., process changes, personnel changes, and introduction of a quality and management system. Looking further to the operative changes, some consequences were detected on the social side as well (safety investments, toxic substances substitution). Naturally, the social problem areas in Finland can be quite different from those in other developed or even developing countries. As 41 % of the respondents were from large enterprises, which could be estimated to have international activities, it would become more of a requirement to also emphasize social assessment in these organizations. Moreover, the increasing level of globalizing supply chains makes it important for the smaller, even micro-level organizations, to include the social aspect in the assessment. This of course still requires work from the social impact assessment methodology and should currently be discussed case by case within the organizations, depending on the actual social impacts they are facing. Further, the intraorganizational, operative changes included in particular energy-saving devices or process efficiency investments, which can be further traced to the economic aspect of sustainability as well, in addition to the environmental sustainability.

However, there are also concrete changes along the value chain. Within partnerships or networks of actors, there are both strategic and operative changes. These cannot necessarily be exclusively categorized into either one, but many

Table 3 Changes within the network target groups

Changes	Network target groups			
	Intraorganizational MFM	Network target groups	Consumers	Institutional context
Strategic-level changes	•Changes in the planning process	•More aggressive focus on responsible suppliers	•The Swan eco-label	•Raising issues in labor market organizations
	•Adding personnel dedicated to environmental strategy	•Creating disclosure profile for communicating for partners, improving transparency in responsible business	•Sustainability fact sheet for customers	•Understanding that policy-level coopera-tion includes opportunities and risks
	•Introducing sustainability strategy to personnel •Quality and management system	•Focus on cooperation	•Sustainability is highlighted in all communications •New solutions to customer with improved Sustainability SWOTs	
	•General awareness		•User-oriented product concepts	
	•Environmental impacts of the entire life cycle are particularly included in strategic decision-making •Energy efficiency becoming strategic aim in product development •Redefinition of corporate strategy in the entire organization		•Creating disclosure profile for communicating for partners, improving transparency in responsible business	
Operative changes	•Energy-saving devices	•Initiating audits for raw material suppliers	•Improving energy efficiency of the products	
	•Substitution of toxic substances in the production process	•Clear instructions about product quality	•Water use optimization	
	•Safety investments	•Finding practical business concepts with a partner		
	•Efficiency of the processes	•Demanding recycled materials from supplier		
	•Electric motors			
	•Investments in environmentally friendly operations			

of the issues relate to both inter- or multiorganizational target groups. Focusing more on sustainable or responsible suppliers as well as demanding certain issues (recycled materials, product quality) and auditing the suppliers have become recognized outcomes of the process. The compilation of lists of requirements or instructions for procurement, which can be openly communicated to the partners or to the network, makes the business-to-business activities between companies more transparent, fairer, and certainly more motivating for suppliers to view their own operations. In terms of strategy, the use of a standardized disclosure mechanism has been initiated in one organization, which ultimately leads to the inclusion of the end users as a target group. The disclosure mechanism is targeted at both partners and customers to increase transparency in the field of conducting responsible business.

The results of the survey indicated clearly that, in addition to the previously mentioned disclosure mechanism, an increasing amount of initiatives was taken with a focus on the consumers, primarily through marketing efforts, certification, or other communications. On a strategic level, the changes were both in communication (sustainability disclosure and marketing mechanisms) and more sustainable product development, in which customer orientation stretched into strategic product concept development. On an operative level, the customer' perspective was included both through increasing the energy and water-use efficiency of the product systems.

To a lesser extent, some respondents also reported having had an impact on the policy level. It is noteworthy that these companies, who are becoming more active at the policy level, had a personnel total of 50 or above (thus were within the two highest classes regarding number of personnel). Smaller companies often have an implicit view that they are inherently unable to participate at the policy-making level. However, participation at a regional level and in a focused manner, or through a coalition of businesses, might be efficient and appropriate (Hoffman and Woody 2008).

Testing whether the size or sector of the company had any impact on the initiated changes resulted in negative findings. Even though actual statistical testing with a small sample size is discouraged, it becomes evident from cross-tabulating the survey results that there was no significant difference within the different size groups (micro, small, medium, large[2]) in terms of the generated changes. This means that small and larger companies were equally prone to initiate changes as a result of using the Sustainability SWOT.

Additionally, there was no impact from the different sectors in terms of which changes were generated. Ten different sectors were represented in our sample, and it seems that most of them were able to initiate some sort of change (except for "Arts, entertainment and recreation," "Wholesale and retail trade, repair of motor vehicles and motorcycles" as well as "Public administration and defense, compulsory social security," which represented 13 % of the entire sample).

In terms of the audiences of the Sustainability SWOT, the primary group is the personnel of the organization itself, primarily the upper or midmanagement. However, other target groups along the value chain were also named important, for instance, the customers and partners. The target groups of the Sustainability SWOT, as estimated by the respondents, can be separated conveniently within the LCM target group division. The primary target group was indeed the intraorganizational network (in either mid- or senior management, or the entire personnel). However, the industrial network as a target group was also emphasized through partners in general (41 %). An equally important target group was seen to be the end users (41 %).

6 Conclusions

The results of the analyses of both the usability of the Sustainability SWOT in business as well as the suggested assessment framework leading to any actual changes were promising. The tool is easy to use and understand, and the results are visually easy to communicate. Its systematic procedure and inclusion of several important angles were seen as beneficial. Keeping in mind that the LCA community is faced with the fear of having its methods understood only by a small subset of industry professionals, it is encouraging that the streamlined approach tailored according to the logic of business decision-makers (i.e., inclusion of the SWOT) is able to find the acceptance and understanding of that vital group. Though it does not follow the strict guidelines of impact assessment, be they environmental, economic, or social, it is able to communicate the significance of a life cycle perspective to businesses and allow them to take into consideration issues along the value chain. In this sense, the tool can be seen to increase the understanding of the life cycle perspective.

Moreover, the concrete changes not only within the organizations themselves but also along the value chain and within the institutional context signal first of all that based on a streamlined sustainability assessment, there are adjustment possibilities. Even by using a quick streamlined method like the Sustainability SWOT, business decision-makers are able to detect points to be optimized if sustainability and life cycle perspective are regarded. Secondly and more importantly, these findings have indeed led to changes in the case organizations. It is remarkable how many changes have been initiated—not only at an operative level but also at a strategic level—by carrying out an exercise such as the Sustainability SWOT. A question for further management studies remains in describing the process of how the Sustainability SWOT is able to generate changes in the entire value chain.

Any life cycle-based method has its share of uncertainty. The Sustainability SWOT tool is able to incorporate this uncertainty into the assessment process through presentation of the results and through its dynamic features. An approach that manages uncertainty of all types with transparency and competence is required. In full-scale LCAs, more precise uncertainty methods such as a Monte Carlo simulation can be carried out, but in a streamlined method, the inclusion of uncertainty should, in fact, be streamlined. The tool includes future possible opportunities and threats and takes these with a differing significance into consideration, i.e., how likely these are to occur. The presentation does not restrict itself to only one path, but allows a consideration, on different probability levels, of several different views of the future.

In this article, we propose the use of a Sustainability SWOT as a streamlined method for the life cycle sustainability assessment. The call for streamlined methods in the field has been formulated several times by scholars, and the underlying proposal is meant to be one possibility in the approaches. In this paper, we have discussed the usability as well as the capability of a Sustainability SWOT to generate changes towards

[2] Enterprise size according to employee amount defined by the European Commission: micro, <10 employees; small, 10–49 employees; medium, 50–249 employees; large, ≥250 employees.

sustainability not only in the organization itself, but in the entire value chain. The Sustainability SWOT has proven to be usable and able to generate changes and improvements along the value chain and in some cases in the institutional context as well.

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