

SUCCESS CRITERIA FOR IMPLEMENTING SUSTAINABILITY INFORMATION IN PRODUCT DEVELOPMENT

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ABSTRACT

The novel contribution of this article is the result of one group creativity session with product designers in the automotive supplier industry with the purpose of developing success criteria for the implementation of sustainability information. The sustainability information is organized with relevant information from each stakeholder, and may be used to support and strengthen sustainable product development in addition to using traditional product and process data. 79 unique ideas were identified by the group participants, 60 of these ideas being both feasible and relevant for implementation purposes. These 60 ideas were then grouped into nine categories. The ideas generated from the participants range from traditional implementation issues such as management commitment, customer or regulatory demands, and sufficient competence within sustainability issues, to more novel ideas including the development of a task force for sustainable development within the industrial cluster that the case firms are part of. Moreover, increased collaboration with academia was emphasized as important for the successful implementation of sustainability information in firms.

Keywords: sustainability information, sustainable product development, automotive supplier industry, brainwriting, success criteria.

1 INTRODUCTION

Whether firms should consider their social and environmental responsibility and the impact their activities have on stakeholders is no longer up for discussion [1]. The question now is rather how to integrate sustainability issues in day to day decisions and actions, as in product development. Unsustainable consumption, global climate changes, water and air pollution are forcing firms to rethink how they deal with competitiveness and shareholder values. Firms are increasingly facing pressure from government regulations, customer demands, competitors' actions and non-governmental organizations (NGOs) to improve their overall social and environmental performance [1-4].

The automotive industry in particular plays an important role, as there are few industries as large, influential, and diverse [5]. It affects global environmental and social development as its product systems directly and indirectly impact the natural and human environment along all stages of the product life cycle. At the same time, the automotive industry contributes considerably to economic growth and wealth creation and provides personal mobility for millions [4-6]. Today, environmental excellence is considered an order qualifier rather than order winner in the automotive supplier industry.

Within the field of product development, the contribution to sustainability from researchers and practitioners has traditionally been in the development of new tools and methodologies for ecodesign and sustainable product development [7-10]. Less attention has been given to stakeholders' influence and collaboration in product development and the information exchange between them. In seeking to improve product development in the automotive supplier industry, more and relevant information on sustainability issues is needed for day to day decision support. However, sustainability information relevant for product development is not necessarily available within the organizational borders of a firm [7, 11, 12]. Such a wider perspective is challenging as firms may not be willing to share information for proprietary reasons. Moreover, firms themselves may not be aware of which information could be of importance to them.

Sustainability information is defined in this article to be any kind of relevant information that may increase a firm's ability to develop sustainable yet commercially viable products. Sustainability

information explicitly includes information beyond mere internal product and process related data that is increasingly commonly used in product development processes. Such relevant sustainability information may already be readily available in domains such as sustainable supply management, consumer research, stakeholder management programs, or in the public regulations domain. Relevant sustainability information in this respect may be consumer preferences for services and “satisfaction” instead of physical products, competitors’ corporate social responsibility programs, competitors’ products’ environmental performance, suppliers’ labor practices (child labor, forced labor), non-governmental organizations’ “black lists” with environmental claims towards firms or products, financial institutions’ environmental risk checklists for lending, public procurement policies or sustainability expectations from firm stakeholders towards a firm and its products. The use of relevant sustainability information as defined in this article, in addition to regular product and process data in decision making processes is

This article builds on previous research; an earlier exploratory case study [13] and multiple additional case studies performed in the Norwegian automotive supplier industry in 2010 [14]. The exploratory case study was carried out in 2009, with the purpose of investigating if potentially important information remained unconsidered in the product development process by firms. Several significant sources of relevant sustainability information were identified, while some of this information was not used to support product developers in their work. The multiple case studies were valuable input to the theoretical and practical development of how sustainability information may be used, and suggested its relevance for sustainable product development in the automotive supplier industry. By drawing on the results from this previous research, the novel contribution of this article is to present the method used as well as the results of a brainwriting workshop session with product designers from the automotive supplier industry. The purpose of the brainwriting session was to develop success criteria for the use of sustainability information in product development in the automotive supplier industry.

This paper continues by outlining the background of and the theoretical development of a sustainability information framework, followed by a brief presentation of idea generation methods useful to enhance group creativity. Section 3 outlines the research methodology applied, followed by the results of the workshop and discussion of these results.

2 ESTABLISHING A SUSTAINABILITY INFORMATION FRAMEWORK AND PREPARING IMPLEMENTATION

The purpose of a sustainability information framework is to specify relevant information that will strengthen and support sustainable product development in firms more than by just using conventional, product and process oriented data. The ensuing sustainability information has been identified through extensive literature search in *Science Direct* and a review of extant scientific literature. Based on more than 95 journal articles from 2000-2010, a review has been made of information that could be relevant for sustainable product development [14]. Stakeholder theory was used as a framework for categorizing and reviewing the different types of sustainability information, and for developing guidelines for using the information. Sustainability information from *internal* (management, employees, unions) and *external* (shareholders, financial institutions, competitors, customers, NGOs, media, government, industry associations, academia, suppliers) stakeholder groups were included to ensure that important information was not omitted. As the relationship between a firm and its stakeholders is characterized by a mutual exchange process of money, goods, information and expectations [15], our scope of interest in this respect was the information and expectation exchange within product development.

The process of going from a general framework to an industry-specific sustainability information framework was carried out through multiple case studies in 2010 [14]. Semi-structured interviews with product designers in the Norwegian automotive supplier industry were conducted to narrow down and customize the guidelines. The results from these interviews are shown in Table 1.

Table 1: Sustainability Information relevant for the Automotive Supplier Industry

Stakeholder	High Importance Sustainability Information relevant for Product Development
Government	Information on mandatory requirements under the End-of-Life Vehicle (ELV) Directive.
	Information on national regulations and priorities within Integrated Pollution

Stakeholder	High Importance Sustainability Information relevant for Product Development
Government	Prevention and Control (IPPC). Information on proactive actions to pre-regulations (new regulations).
NGOs	Information on requirements for environmental certificates managed by NGOs (e.g. ISO 14001).
Supplier	Information on innovation abilities. Information on service, price, quality, cost and delivery. Information on honesty, trust, respect and fairness in corporate or organizational relations (e.g. avoid bribery and corruption). Information on use and volume of hazardous substances in the product or packaging. Information on adherence to international, national and local legislation in addition to voluntary initiatives in sustainability matters (e.g. EMAS, ISO 14000-series). Information on financial situation and stability. Information on use of recyclable materials in products. Information on local labor practices (child labor, forced labor, discrimination, wage issues, working hours, workplace health and safety issues, employee privacy, access to food, water and healthcare). Information on investment in education and employee training programs. Information on adherence to UN's Human Rights Declaration.
Customer	Information on perceived personal benefits from acquiring and using the product. Information on the ability to be engaged in the activity of "doing" with the product, the preference of intelligent products in terms of constitution and functioning. Information on what affects and influences purchase decisions - delaying or avoiding making purchases. Information on preferences for green products from green firms. Information on fashion and trends within the product segment - trend sensitivity. Information on use of current products available on the market or similar products (focus on interface between human health, product/object, monitoring of direct impacts from the product (positive/negative) with respect to social, environmental and economic aspects during use). Information on environmental perception as to the product (i.e. is the product considered better/worse than similar products on the market). Information on environmental pressure towards firm. Information on sustainable and environmental performance requirements relevant to the product. Information on lock-ins and habits. Information on perception of firm image communicated through corporate social performance, responsibility and responsiveness, EMS and voluntary adherence to standards (e.g. EMAS, ISO 14001).
Competitor	Information on communication and marketing material available to the public, including advertisements on web-sites, newspapers, magazines etc.).
Academics	Providing knowledge exchange on sustainability matters. Information on priority settings for new and prioritized research areas, and national and international research calls.
Industry Associations	Information on sustainable technologies. Information on current or pending (up-coming) legislation.
Internal Stakeholders	Information on internal total environmental costs defined as environmental protection expenditure (costs for prevention, disposal, planning, actions, damage repair....) and material flow cost (costs for unutilized materials, energy, capital and personnel...). Information on internal commitment to include service policies that are provided to the customer during the use phase of products (to improve eco-efficiency and prolonged life of product) and to provide update policies. Information on internal freedom of speech, open information in the firm,

Stakeholder	High Importance Sustainability Information relevant for Product Development
Internal Stakeholders	transparency in firm decision making.
	Information on internal investments in environmental technologies.
	Information on internal adherence to requirements of social issues (SA 8000).
	Information on internal adherence to the requirements of ISO 14000-series standardization and EMAS (including Environmental Performance Indicators, Management Performance Indicators, Operational Performance, etc.)
	Information on internal commitment to involve users (stakeholders) in product development to enhance organizational and individual learning.

The purpose of this article is the development of success criteria for the use of sustainability information in product development in the automotive supplier industry. In order to develop such criteria, we decided to tap into the knowledge of the people working with product development in the automotive supplier industry and let them come up with ideas on how this can be made to work in practice. An additional motive for involving product designers at this stage was also to create engagement, excitement, and a sense of ownership of the proposed solutions.

To facilitate the generation of ideas (quantity and quality) it was decided to arrange a workshop focusing on idea generation. Organizations that work with creativity often encounter problems like lack of persistence and a tendency to premature criticism of ideas that are generated within groups. Brainstorming and brainwriting are perhaps the best known methods of idea generating that overcome the above mentioned obstacles [16-20]. Brainstorming involves oral sharing of all ideas that come into mind without evaluation or criticism of the generated ideas. Despite its popularity, brainstorming as a technique has encountered problems with low productivity (unwillingness to share ideas), free-riding, and social loafing (my ideas are not important), production blocking (verbal traffic jams) and downward comparison (the lowest performers in the group become the standard) [16, 18, 19].

Brainwriting is a technique that overcomes many of the problems frequently encountered in brainstorming. Brainwriting facilitates exposure to others' ideas and at the same time provides for the opportunity to attend to one's own ideas [18]. As opposed to the oral sharing of ideas in brainstorming groups, brainwriting involves silent writing and sharing of ideas in groups. Brainwriting is also typically a more structured and constrained process. At the same time, a sense of competition and social pressure is induced by participants frantically passing around notes to each other. This is believed to generate even more ideas. The relatively low knowledge of brainwriting as a useful idea-generating technique in organizations may be due to the fact that managers are inclined to leave their comfort zone in order to experiment with alternative approaches, if they are aware of the fact that alternative approaches exist [16].

Productivity is the main objective of brainstorming and brainwriting sessions, however, idea quality is considered to be just as important. Quality within creativity is by many researchers defined as a combination of originality (to which degree an idea is innovative and novel) and appropriateness (to which degree an idea is relevant to the topic and is feasible) [16, 17]. Other quality criteria may include *relative advantage* ("the degree to which an innovation is perceived as being better than its precursor"), *compatibility* ("the degree to which an innovation is perceived as being consistent with the existing values, needs and past experiences of potential adopters"), *complexibility* ("the degree to which an innovation is perceived as being difficult to use"), *observability* ("the degree to which the results of an innovation are observable to others") and *triability* ("the degree to which experimentation is possible before adoption") [16]. Overall, the quality criteria for brainstorming and brainwriting are somewhat vague and include to a great extent subjective judgements.

Due to the many limitations and obstacles associated with the brainstorming method, we decided to conduct a brainwriting idea-generation workshop in our research project. As the brainwriting method also was new to the product designers, one of the benefits of the workshop was organizational learning for the firms involved. The following section describes the brainwriting method that was used during the workshop.

3 RESEARCH METHODOLOGY

The initial selection of the automotive supplier industry as case was made because the industry is highly competitive, is international, and has global supply chains and highly demanding customers

[21]. In addition, the automotive industry is also relatively developed in terms of environmental and sustainable performance due to pressures from government, NGOs and customers [4, 22], which is also important when performing research on sustainability related problems [23].

Little research examines the use of sustainability information in product development, let alone the implementation issues related to the successful use of such information in firms. We chose a case-based approach with workshop session and interviews to shed light on the implementations issues. Prior to conducting the research, a research protocol including brainwriting guidelines and an interview protocol was developed based on the identified sustainability information. The research protocol was pretested and piloted with academic faculty to help ensure the validity of the protocol.

The main purpose of the brainwriting session was to generate high quality ideas as to how sustainability information use in product development can successfully be implemented in firms. The brainwriting 6-3-5 method involves 6 people writing 3 ideas in 5 minutes. Among the workshop participants were also interviewees from the initial process of mapping potentially relevant sustainability information. The participants hold competence within product design and development, research and development, purchase, and logistics. The reason for inviting different competences to the workshop was to stimulate creativity through the presence of different professional backgrounds, knowledge and experience [16].

The participants were asked to write down 3 ideas in 5 minutes with concise and complete sentences on blank work sheets containing a problem statement. After 5 minutes, the worksheets were then passed on to the person on the right, unedited. Now, the session was repeated. The participants were free to use the ideas already written on the passed on sheets as triggers, or to ignore them as the sheets changed hands, as the exposure to other ideas is cognitively stimulating, and a positive sense of competition and social pressure between group members may be achieved by passing on the sheets this way [16]. The process of writing ideas and passing sheets was continued until all the work sheets were completed.

After the idea generation phase was completed, the work sheets were shared among the participants and the ideas were briefly discussed. After a clarifying session, the participants were given three points for ranking the three most important ideas that had come up during the session.

In order to verify the results, two additional interviews with product designers were performed after the workshop. New ideas to facilitate the implementation process were not identified during the interviews; the interviews did however to a great extent verify the results from the brainwriting session. Moreover, interview records from previous interviews with the same people on implementations issues were reviewed to complete the picture. Field notes were written up sequentially during the brainwriting session and during the interviews in order to record relevant discussions and comments from the participants.

4 RESULTS AND DISCUSSION

The ideas generated in the workshop, were coded and analysed in a tabular. The purpose of the coding process was to group ideas into logic categories. We used an inductive approach to develop the categories, i.e. developing and deriving categories from the material by means of generalization; observation – result – rule [23]. The success criteria identified were also reviewed in light of the additional semi-structured interviews conducted and the field notes from the workshop session. This process was repeated several times in order to ensure correct coding of the data into appropriate categories.

The workshop session was successfully completed with the generation of a total of 111 ideas. Some of the ideas were however overlapping or very similar but using different wording. The numbers of unique ideas calculated by excluding repetitive ideas were found to be 79. Simply generating a large number of unique ideas was not the main purpose of the brainwriting session. We also wanted to generate high quality ideas, i.e. ideas that were truly novel, useful and effective for implementing sustainability information [16, 17]. To this end, feasibility and effectiveness for implementation were considered most important. Hence, a coarse assessment to this effect to this was carried out.

Table 2 summarizes the main success criteria for implementing sustainability information in product development, as proposed by the participants in the brainwriting session. The success criteria ranked as most important during the workshop are presented first. The complete list of results may be shared with other researchers upon request.

Table 2. Main success criteria for implementing sustainability information in firms

Main success criteria according to idea categories	Number of ideas within category	Number of feasible ideas	Number of ideas relevant to the topic
1. The use of sustainability information must be driven by management commitment.	15	15	14
2. The use of sustainability information must be linked to economic performance and shareholder value within the firm.	9	9	3
3. The use of sustainability information must be driven by (new) stricter requirements from public authorities.	16	14	10
4. Academia must be a driving force for the use of sustainability information by passing on and communicating information and new developments within research, and up-coming requirements relevant to product development.	9	7	6
5. The use of sustainability information must be driven by customer demands and requirements.	11	10	9
6. The use of sustainability information must be driven by the establishment of an in-firm task force for sustainability issues.	3	3	3
7. The use of sustainability information must be driven by the establishment of a task force for sustainable development within the industrial cluster for exchange of experience and knowledge.	4	4	4
8. The use of sustainability information must be integrated in existing internal procedures and work processes.	7	7	6
9. The successful use of sustainability information is dependent on high internal competence on sustainability issues.	5	5	5
Total numbers	79	74	60

During the workshop, it was noticed that the quality and novelty of the ideas dropped as the workshop session proceeded. There was also a tendency to not coming up with new ideas, but only making minor contributions to previous ideas as time passed. Nevertheless, we consider 79 unique ideas as a good result. 74 of the ideas were considered feasible, that is, possible to implement. 19 of the ideas were during the analyzing process, not considered relevant for implementing sustainability information. Ideas that were ruled out during this process typically included concrete actions for making the firms themselves more sustainable, for example to reduce energy usage. One plausible reason for this confusion might be that working with sustainability issues is quite new to many product designers. For this reason, differentiating between implementing sustainability information and concrete sustainability actions on firm level might be difficult for them.

4.1 Management commitment (1)

Management commitment is always important when introducing something new to organizations. What management does, not what it says, quickly becomes the accepted norm in firms. The participants emphasized the will and determination on management level to invest in sustainable solutions as an important signal in this respect, for example by giving product designers time to invest in the search for relevant sustainability information. It will also be essential that sustainability issues are made part of all management meetings, and that concrete product improvements and results with regards to sustainability are demanded on such meetings as part of continuous improvements in the firms, as continuous improvements are the backbone of all activities in the automotive industry. The idea of linking management bonuses to sustainability achievements also came up as a way of to ensuring management commitment. Previous research in the electronics industry concerned with the

dissemination of ecodesign information in firms has also identified good management commitment and support as an important success factor [24].

4.2 Economic performance (2)

Linking the use of sustainability information to economic performance and shareholder value within a firm is a reliable way of ensuring management focus. The participants emphasized that managers on all levels dominantly focus their priorities and activities on the performance indicators they are evaluated against. Consequently, developing financial indicators linked to sustainable product development performance (product improvements) and indirectly the use of relevant information (process improvement) came up as ideas to ensure priority. Literature suggests that sustainability may create financial value for a firm through increased revenues and lower costs. Revenues may be enhanced through increased sales due to improved firm reputation, and costs may be lowered due to process and product improvements [1]. As such, performance indicators clearly demonstrating the economic value of sustainability as an area of priority will be important.

4.3 Stricter governmental requirements (3)

Still, many firms regard sustainability issues as a hindrance instead of a competitive advantage. Such a view is often accompanied by a strong belief that firm level sustainability actions (e.g. the development of more sustainable products) can only follow from stricter governmental requirements and demands. Indeed, this view was overall shared by the participants. As firms struggle to keep track of new regulations on national and international level, the participants came up with the idea that implementing the use of sustainability information would be easier if the firm has easy access to up-to-date information on regulations. Relevant information could be made available from newsletters or specific websites. To further motivate firms to use sustainability information and improve their sustainable product development practices, it was also suggested to establish governmental national prizes for “best in class” on sustainability issues. A corresponding “black list” for poor performers in sustainable product development was also emphasized to further motivate firms. The “best and worst in class” lists could for example be determined based on auditing and self-reporting.

4.4 Academia (4)

Academia as an important driving force for providing general sustainability information to firms was suggested during the idea generating phase and during discussions. Firms find it hard to keep up to date with all new and up-coming regulations that potentially could be relevant to sustainable product development. Moreover, firms seldom have the required resources or competence to keep track of all relevant regulations. As a result, several ideas as to how academia could help firms in this context came up during the workshop: 1) establish industry specific websites with important sustainability information and news, 2) arrange sustainability related courses for industry partners, 3) establish an industry cluster task force for sustainable development for exchange of ideas, information, and lessons learned, and 4) initiate sustainability related research projects where knowledge development, and creation based industry needs are focused. It is important to emphasize that information potentially provided by academia will be general in its form. There is a lot of information specific to firms regarding customers, competitors, and suppliers that is unavailable to academia. Thus, this will be a job for the firms themselves or the consultants they hire.

4.5 Customer demands (5)

Not surprisingly, customer demands and requirements for more sustainable products were considered important with regards to implementation of sustainability information. The additional interviewees went even further by emphasizing that all changes in the automotive supplier industry must be driven by customer demands. A total of 9 unique, feasible and relevant ideas were identified in this category. The workshop participants made an important point by emphasizing the fact that customer requirements and demands can be altered and modified through closer customer collaboration, information and competence building. Ideas like pointing out feasible improvements in functionality, quality and competitiveness (added value), or by demonstrating the potential for reduced costs and price reductions for the customer through sustainable product development, are also expected to make the customer more receptive towards changing contractual requirements in favour of sustainability requirements. Being proactive, firms can negotiate and implement more sustainability requirements in

future contracts to gain more right to decide which suppliers, materials, and substances to use and consequently be able to make a bigger impact. This is in line with other researchers who suggest that a firm's ability to minimize its environmental impacts during product design is often dependent on the firm's capability to manage supplier relationships [25].

In spite of the many implementation ideas in relation to customers and the high emphasis on customers in the workshop discussions, we notice that internal factors such as management commitment and linking the use of sustainability information to economic performance were in sum ranked higher. One plausible explanation could be that firms unconsciously have a higher degree of influence on the use of sustainability information than they will admit. It is always easier to point to external factors like regulations, customers, or academia for the implementation and use of information, than making the actual in-firm changes themselves. On the positive side, this result indicates that the firms themselves are in the driving seat and influence to a great extent whether the implementation of sustainability information is successful or not.

4.6 Task force establishment (6, 7)

The establishment of an in-house task force for sustainability issues in future development projects can be used to drive the implementation of the use of sustainability information according to the product designers. The use of teams in organizations is a good way of ensuring that sustainability issues are given the necessary attention, support, and practical assistance in projects, especially in a starting-up period. In regard to this category, the designers also emphasized that such a task force should be established at all geographical locations of the firms, that academia should be used to elevate the overall sustainability competence of the task force, in addition to the importance of management commitment to the task force by asking for and demanding sustainability related results. The same ideas also emerged in relation to the establishment of an industrial cluster task force, where in addition, possible synergies due to sharing of information, and working with the same issues were emphasized by the group. According to literature, the use of task forces is not new, and several positive effects by engaging in such teams may be identified: 1) assigning a collective responsibility may avoid "fire fighting", 2) involving everyone affected ensures that any solutions found and actions taken are acceptable to everyone in the project, 3) time can be saved as the work is carried out cross-functionally and not sequentially by each department, and 4) organizational culture and work climate can be improved through wide involvement [26].

4.7 Integration into existing processes (8)

Another important success criterion identified for the use of sustainability was to make sustainability information part of the already existing work processes and procedures through check lists for design reviews and gate models, and to make the information part of the internal product design meetings. The adaption to existing firm processes could be made possible by applying for internal investment funds to complete the change. One should also make a point of documenting all projects and activities concerning sustainability actions to facilitate focus on continuous improvements within the organization. Internal audits to verify that sustainability information is actually being used in product development should also be performed. Literature on success factors for ecodesign implementation also underlines integration of environmental issues into existing product development processes as important [27].

4.8 Sustainability competence (9)

The product designers also emphasized competence on sustainability as important for the successful implementation of sustainability information in product development. The use of "sustainability champions" with special education and training to help co-workers in their sustainability work was suggested by the participants. Another suggestion was to use firm intranet to educate and elevate sustainability competence within firms. Moreover, the firms could apply for new research projects through national competence building programs. The use of champions or experts is a well-known method for implementing changes in organizations [27].

5 CONCLUSION

The starting point of this research project was to develop success criteria for the implementation of sustainability information. As the automotive industry is under growing pressure from both public

governments and customers to develop more sustainable products, the use of sustainability information as defined in the article is expected to support and strengthen firms' product development processes. The information can be used in addition to traditional product and process data in decision making processes in product development, but also other operations as i.e. procurement and production is expected to be effected by the use of it.

To prepare implementation process in the automotive supplier industry, a brainwriting workshop was arranged. 79 unique ideas to help implementation were identified by the participants, 60 of these ideas were considered to be both feasible and relevant. The ideas included traditional implementation aspects as management commitment, customer or regulatory demands and sufficient competence within sustainability issues. It was emphasized by the participants in the workshop that it was essential that the guidelines were included in the already existing work processes and procedures to be used. This includes design review meetings, gate models and internal audits to ensure and verify that the guidelines actually are being used. Other more novel ideas generated included linking the guidelines to economic performance and shareholder value. A good business case that clearly demonstrates the connection between sustainability aspects and economic figures will help ensure commitment also from different management levels. Perhaps the most novel ideas were in connection with the development of a task force for sustainable development within the industrial cluster that the case firms are part of, as well as connecting this task force with academia to generate synergistic effects. Learning from other firms through "lessons learned" and best practices is always fruitful, and when this is linked with increased collaboration with academia, a powerful moment of force to "push" firms towards sustainability is established.

Based on the results of the research project, we highly recommend firms to start the implementation process of sustainability information by using the success criteria as presented. The use the criteria is expected to facilitate the implementation process, and the subsequent use of sustainability information is expected improve the sustainability performance of products. A future research path we hope to follow is to investigate the effectiveness and success of the criteria during implementation in automotive supplier firms.

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REFERENCES

- [1] Epstein, M.J. *Making sustainability work - Best Practices in Managing and Measuring Corporate Social, Environmental and Economic Impacts*, 2008 (Greenleaf Publishing).
- [2] Delmas M., Toffel M.W. Stakeholders and environmental management practices: an institutional framework. *Business Strategy and the Environment*, 2004, 13(4), 209-222.
- [3] Madsen H., Ulhoi J.P. Integrating environmental and stakeholder management. *Business Strategy and the Environment*, 2001, 10(2), 77-88.
- [4] Kantz, O. Volvo's holistic approach to environmental strategy. *Corporate Environmental Strategy*, 2000, 7(2), 156-169.
- [5] Orsato, R.J., Wells P. The Automobile Industry & Sustainability. *Journal of Cleaner Production*, 2007, 15(11-12), 989-993.
- [6] Koplin, J., Seuring S. and Mesterharm M., Incorporating sustainability into supply management in the automotive industry - the case of the Volkswagen AG. *Journal of Cleaner Production*, 2007, 15(11-12), 1053-1062.
- [7] Baumann, H., Boons F., and Bragd A. Mapping the green product development field: engineering, policy and business perspectives. *Journal of Cleaner Production*, 2002, 10(5), 409-425.
- [8] Ilgin, M.A., Gupta S.M. Environmentally conscious manufacturing and product recovery (ECMPRO): A review of the state of the art. *Journal of Environmental Management*. 2009, 91(3), 563-591.
- [9] Karlsson, R., Luttrupp C. EcoDesign: what's happening? An overview of the subject area of EcoDesign and of the papers in this special issue. *Journal of Cleaner Production*, 2006, 14(15-16), 1291-1298.

- [10] Hauschild, M., Jeswiet J., and Alting L. From Life Cycle Assessment to Sustainable Production: Status and Perspectives. *CIRP Annals - Manufacturing Technology*, 2005, 54(2), 1-21.
- [11] Foster, C., Green K. Greening the innovation process. *Business Strategy and the Environment*, 2000, 9(5), 287-303.
- [12] Srivastava, S.K. Green supply-chain management: A state-of-the-art literature review. *International Journal of Management Reviews*, 2007, 9(1), 53-80.
- [13] Aschehoug S.H., Boks C. and Storen S. A framework for identification of environmental information among stakeholders, in *EcoDesign 2009 - 6th International Symposium on Environmental Conscious Design and Inverse Manufacturing*, Sapporo, Japan, Desember 2009.
- [14] Aschehoug S., Boks C. Sustainability Information in Product Development – the Case of Automotive Supplier Industry, in *APMS 2010, Internation Conference on Advances in Production Management Systems*, Cernobbio, Italy, October 2010.
- [15] Andersen B., Fagerhaug T. *Performance Measurement Explained. Designing and Implementing Your State-of-the-Art System*, 2002 (ASQ Press, Milwaukee).
- [16] Heslin, P.A. Better than brainstorming? Potential contextual boundary conditions to brainwriting for idea generation in organizations. *Journal of Occupational and Organizational Psychology*, 2009, 82(1), 129-145.
- [17] Rietzschel, E.F., Nijstad B.A. and Stroebe W. Relative accessibility of domain knowledge and creativity: The effects of knowledge activation on the quantity and originality of generated ideas. *Journal of Experimental Social Psychology*, 2007, 43(6), 933-946.
- [18] Paulus, P.B., Yang H.-C. Idea Generation in Groups: A Basis for Creativity in Organizations. *Organizational Behavior and Human Decision Processes*, 2000. 82(1): 76-87.
- [19] Leggett Dugosh, K., Paulus P.B. Cognitive and social comparison processes in brainstorming. *Journal of Experimental Social Psychology*, 2005, 41(3), 313-320.
- [20] McGlynn, R.P., et al. Brainstorming and task performance in groups constrained by evidence. *Organizational Behavior and Human Decision Processes*, 2004, 93(1), 75-87.
- [21] Handfield, R., Sroufe R., and Walton S. Integrating environmental management and supply chain strategies. *Business Strategy and the Environment*, 2005, 14(1), 1-19.
- [22] Thun, J.-H., Muller A. An empirical analysis of green supply chain management in the German automotive industry. *Business Strategy and the Environment*, 2010, 19(2), 119.
- [23] Karlsson, C. *Researching Operations Management*, 2009 (Taylor & Francis).
- [24] Boks, C. The soft side of ecodesign. *Journal of Cleaner Production*, 2006, 14(15-16), 1346-1356.
- [25] Darnall, N, Jason G.N., and Handfield R. Environmental management systems and green supply chain management: complements for sustainability? *Business Strategy and the Environment*, 2008, 17(1), 30-45.
- [26] Andersen, B. *Business Process Improvement Toolbox*, 2007 (ASQ Press, Milwaukee).
- [27] Johansson, G. Success dactors for integration of ecodesign in product development - a review of state-of-the-art. *Environmental Management and Health*, 2002, 13(1), 98-107.

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