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DEVELOPING, EVALUATING AND ASSESSING ECO-INNOVATIONS BASED ON LIFE CYCLE ASSESSMENT AND QUALITY MANAGEMENT APPROACH

Hildenbrand, J., Gremyr, I., Raharjo, H. and Sarasini, S. Chalmers University of Technology.*

**Environmental System Analysis, Chalmers University of Technology, 412 96 Göteborg, Sweden. E-mail: jutta.hildenbrand@chalmers.se*

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ABSTRACT

Eco-innovation is seen as a way to contribute to better environment and increased competitiveness. Two problems related to eco-innovations are lack of support for their development and for assessment of their environmental impact. For the first problem one way forward is to integrate sustainability in established toolkits such as quality tools. Turning to the second problem life cycle assessment is well suited if developed to support early stages of development. This paper aims to develop a framework supporting development, evaluation and assessment of eco-innovations based on quality management and life cycle perspectives.

INTRODUCTION

Eco-innovations (EIs) can be described as "new products and processes which provide customer and business value but significantly decrease environmental impacts" (James, 1997: 53). Two areas related to EIs that are in need of more research and developments are tools supporting development of EIs and tools to evaluate actual environmental impact of the EI.

A commonly argued approach to create management support for sustainability is to integrate environmental sustainability into existing engineering practices (Angell and Klassen, 1999). An area in which management support in the form of practices as well as tools is established is Quality Management (QM). A core principle in QM is customer focus; expanding the customer concept to include other stakeholders and society is a means to integrate sustainability considerations with QM (Garvare and Johansson, 2010).

Life Cycle Assessment (LCA) is an approach to evaluate environmental impact of EIs. Arguments are that LCA is a widespread approach to quantify environmental impacts throughout a life cycle (Baumann and Tillman, 2004; Brunklaus et al., 2012). However, LCA requires a rigorous assessment and is most often applied on already developed products (Poudelet et al., 2012). For EIs, LCA is needed in a stage were quantitative details of an offer is not yet available. Hence, an LCA approach applicable in innovative stages is needed. Addressing the shortage of practices and tools for EIs, the purpose of this paper is to develop a framework supporting development, evaluation and assessment of eco-innovations based on quality management and a life cycle perspective.

METHOD

The project is based on state-of-the art reviews of three fields (EI, QM, and LCA) to create a framework for development, evaluation and assessment of EIs. The framework integrates "a number of different works on the same topic, summarizes the common elements, contrasts the differences, and extends the work" (Meredith, 1993). The framework is based on a set of principles linked to practices supportive of EIs.

RESULTS

The underlying principles linked to EI, LCA and QM are elaborated on in the next section, before introducing the framework of practices proposed.

Underlying principles

The first principle is that companies should 'aim to collaborate with diverse stakeholders in order to generate ideas for EI'. This is concluded as literature on EI point to the criticality of collaborations with stakeholders such as key suppliers, competitors, science partners (universities, research institutes, etc.) to get valuable input in terms of knowledge and other resources. It has further been argued that input from diverse stakeholders contribute to more radical innovations (Liyanage, 1995; Baiman et al., 2002).

Second, 'EIs should be both developed and assessed based on life-cycle thinking', as a useful evaluative component of the design process. As argued earlier a complete LCA is infeasible at an innovative stage, due to lack of detailed knowledge of the resulting product. The principles underlying LCA, referred to as life cycle thinking, are still applicable. In short, the life cycle thinking encompasses a systems view on the product and an awareness of environmental impacts throughout the life cycle of a product. Having applied life cycle thinking will nevertheless be a means of addressing actual environmental impact and prepare for more comprehensive LCA in later design stages.

The third principle based on a QM approach is that a 'focus on stakeholders' needs, and translation of those into EI characteristics, must be maintained throughout the design process'. This principle is aligned to two core principles of QM being customer focus and continuous improvements (Dean and Bowen, 1994), and supports the need to assess and ascribe value to different stakeholder needs and demands. The notion of continuous improvement is integrated in this principle by pointing to a continuous process, which is also applied in environmental management (Burström von Malmborg, 2002).

A framework of practices

Based on the principles outlined above, a five-step framework of practices (Figure 1) has been developed to guide designers and developers in developing and assessing eco-innovations. In the following brief summaries of each of the five steps of the framework of practices is presented.

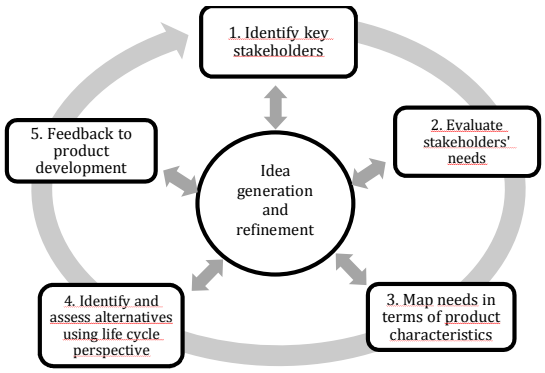

Figure 1: Key practices for our proposed framework (Sarasini et al. 2013)

1. Identify key stakeholders

To identify stakeholders that can either be affected by, or affect, the EI, three guiding questions are proposed: *who is affected; who can contribute; and what is their influence*? Addressing these questions helps in identifying stakeholders, analyse whether they support or oppose the EI, and reflect on what relevant resources they control. One way of mapping their influence is to assess it in relation to the product life cycle stages.

2. Evaluate stakeholders' needs

Having identified stakeholders, this practice moves into evaluating their needs in relation to the EI. A guiding question at this step is: *what are stakeholders' needs in terms of the overall functionality of the product or process*? The needs identified are likely to be of a diverse nature and include similar, as well as contradictory, needs.

3. Map needs in terms of products characteristics

The aim of the third step is to identify critical product characteristics that can satisfy the stakeholders' needs. There are two guiding questions: *how can needs be translated into functional specifications*; and *which product characteristics affect critical functional specifications*? Support for this step can be found e.g. in Quality Function Deployment.

4. Identify and assess alternatives using life-cycle perspective

Having identified potential product characteristics, a range of alternatives of EI characteristics is derived based on environmental assessment. A guiding question for this practice is: *which alternatives provide the greatest environmental improvement from a life cycle perspective*? Support for this practice can be found e.g. in simplified and streamlined LCA.

5. Feedback to product development

The environmental assessment addressed in step four helps to identify 'hotspots', which are aspects of the product life cycle with high environmental impact. It also makes trade-offs between different types of impact visible. In step five this information is fed back to the design team that may choose to develop a particular product or to restart the cycle if more information is needed. In a second cycle new stakeholders might be identified, some of which might become innovation partners given their expertise in a particular area.

DISCUSSION

This paper presents the first step in outlining a framework for development, evaluation and assessment of EIs based on QM and life cycle perspectives. A second step is to refine our

ideas based on practical applications of the framework as well as feedback from scholars. The frameworks presented build on previous research and attempts to create synergies between EI, LCA and QM. The key idea is to expand on established QM tools in a way so that it can support development of EIs. Later, LC thinking is applied to assess the environmental impact of the EIs to ensure that options most environmentally benign are developed. The framework places demands on practitioners to involve external stakeholders in early stages of development. A key issue to achieve this is to establish a view on sustainability considerations as creating opportunities rather than imposing constraints (Angell and Klassen, 1999). In the framework proposed this is supported e.g. by the use of life cycles to generate alternatives EIs, thus being part of a creative phase in developing EIs.

CONCLUSIONS

We propose that EIs would benefit from considering and involving diverse stakeholders early in the design process. To support the development of the EIs we suggest integration of sustainability considerations in existing QM practices. Last, by continuously applying a LC perspective the EI can be assessed for its environmental impacts throughout its development.

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