

## **BARRIERS FOR IMPLEMENTING ECOINNOVATION IN DESIGN FOR ENVIRONMENT: OUTPUTS OF DIFFERENT ECO-DESIGN PROJECTS**

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### **ABSTRACT**

Barriers for ecoinnovation are quantified in 6 real cases of ecodesign pilot projects. After performing a first viability assessment, between 38% and 56% of the ecodesign strategies were rejected, mainly in Transportation (63%) and Concept (56%) lifecycle stages. Common barriers are economic investment (e.g., new machinery or renewable energy systems) as well as technical constrains (e.g., for using new materials or for improving energy efficiency with new technologies). Social strategies are disregarded if the company personnel believe that the consumer may not value the improvements. For the design of the final prototype, only between 5% and 33% of the proposed strategies were considered by the company. Main barriers include increase of production costs (20%) and low environmental improvement (20%). The inclusion of economic and social indicators in the ecodesign methodology could promote to overcome some of these barriers. More efforts in Transportation, Concept and End of Life stages may be done by encouraging companies to strength their interaction with the value chain suppliers, promoting ecoinnovation and improving communication tools.

### **INTRODUCTION**

Design for Environment (DfE) or eco-design has grown their contribution to sustainable manufacturing during the last decades. This can be observed not only at the business scale but

also at the policy and research ones (Boks, 2006). While labelling, sustainable reporting and marketing show the increasing examples of ecodesign products in the market; laws and standards are developed to establish both methodologies and benchmarking frameworks (e.g. Directive 2009/125/EC (European Council, 2009), ISO 14006 (2011)). This growth can be related to the benefits that ecodesign offers to businesses and products, some of which have been reported in the scientific literature under environmental and economic approaches (Borchardt et al., 2011; Knight and Jenkins, 2008; Plouffe et al., 2011). Moreover, social benefits are embedded in a more sustainable manufacturing and in the diversification of products and markets (i.e., additional decision-making criterion). Notwithstanding these positive effects, ecodesign is being implemented progressively and irregular in different products and sectors as environmental strategies can find implementation barriers. Although some studies has analysed the barriers in companies (Boks, 2006; Theyel, 2000; van Hemel and Cramer, 2002), there is a need for further research in this issue. Moreover, no previous studies have evaluated the barriers of projects where research entities have been involved for assessing ecoinnovation in businesses. Finally, although Life Cycle Assessment (LCA) is a common environmental tool used in ecodesign (e.g., González-García et al., 2011), there is a lack of identifying the barriers from a life-cycle perspective while showing the hotspots as a basis for improvement proposals.

This contribution aims to identify the barriers for ecoinnovation in DfE from a life-cycle perspective in real projects developed in collaboration between businesses and research entities. Six real projects were evaluated in the assessment for including different products (wine box, chair, pergola, jacket, trekking boot and knife) from different sectors. Finally, efforts in the implementation of ecoinnovation in DfE and potential methodological improvements are proposed.

## **MATERIALS AND METHODS**

The combined methodology of Life Cycle Assessment (LCA) and eco-design described in Gonzalez-Garcia et al. (2011) was used for the ecodesign projects. After the identification of the hotspots of the initial product (both quantitative and qualitative assessment), ecoinnovative strategies were proposed for improving the product. These strategies were evaluated during all the process and two selective steps were performed. First, a viability assessment (technical, economic and social) allows the company to select some of the strategies for being evaluated for the new design. Second, the prototype design is defined by the company after the selection of the strategies according to environmental (LCA results) and technical (production process) criteria.

The quantification method of the selection and rejection rates of the ecoinnovative strategies was done at different scales; at the project scale, regarding the step where they are selected (viability or prototype), at the lifecycle scale and at the product scale. Finally, global results were also reported for observing common barriers and differences among sectors. For the viability assessment selection, barriers were categorized in technical, economic and social; while for those barriers rejected in the prototype step, categories were defined according to literature (van Hemel and Cramer, 2002) and the criteria used by companies in: increase of production costs, low environmental improvement, influence on the quality and image of the final product, low development of marketing and communication tools, dependence from suppliers, requirement of materials substitution and incompatibility with other strategies.

## RESULTS AND DISCUSSION

### *Common barriers for ecoinnovation*

On average, 54% of the proposed strategies are considered viable from the technical, economic and social point of view. Main barriers are due to technical constraints (~46%), such as incompatibility with the current production chain or difficulties for implementing innovative programs (e.g., Collection program of out of use products for material recycling). Economic barriers (~31%) are mainly related to strategies that need investment (e.g., new machinery or renewable energy systems). Finally, customer negative perception is the most common social barrier (~23%). Main barriers in the final selection are related to an increase of production costs (22.5%) or low environmental improvement (20.8%), while incompatibility within strategies and avoiding materials substitution are the least common.

Regarding the sectors analyzed, more strategies were proposed for the urban furniture project (45), where energy was consumed during the use phase, followed by the furniture and kitchenware sectors. The lowest number of strategies was proposed in the packaging sector. The selection rate for the prototype design was the highest in the kitchenware product (33,3%), while the lowest in products tied to design constraints (i.e., furniture with only 5%).

Table 1. Selected strategies and identified barriers by step and ecodesign project.

	Chair	Knife	Trekking Boot	Pergola	Wine woodbox	Jacket	Average
Proposed strategies	39	33	25	45	16	26	31
<b>Viability assessment</b>							
Selected strategies	17	17	11	26	10	16	16
Technical barriers (%)	52,4	38,9	64,3	43,8	33,3	45,5	46,3
Economic barriers (%)	28,6	22,2	28,6	37,5	33,3	36,4	31,1
Social barriers (%)	19,0	38,9	7,1	18,8	33,3	18,2	22,6
<b>Prototype design</b>							
Selected strategies	2	11	5	12	3	5	6
Low environmental improvement (%)	17,6	37,5	0,0	23,1	28,6	18,2	20,8
Incompatibility with other strategies (%)	0,0	0,0	0,0	23,1	0,0	0,0	3,8
Affectation of the product quality and image (%)	29,4	12,5	14,3	15,4	14,3	9,1	15,8
Low development of communication tools (%)	17,6	12,5	0,0	7,7	14,3	27,3	13,2
Avoiding materials substitution (%)	17,6	0,0	14,3	7,7	0,0	9,1	8,1
Increase of production costs (%)	17,6	25,0	42,9	7,7	14,3	27,3	22,5
Dependence from providers (%)	0,0	12,5	28,6	15,4	28,6	9,1	15,7

### *Barriers from a life-cycle perspective*

Concept, Materials and Use were the lifecycle stages where more strategies were proposed in contrast to Transportation. When analyzing viability, 60% of the strategies regarding Packaging (with the lowest barriers number) and Use (with no social barriers) stages were selected. However, Transportation (37.5%) (with no economic barriers) and Concept (44.1%) (mostly due to technical barriers) had the highest rejection rates. For the prototype design,



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Material and Processing (~26%) ecoinnovative strategies were the most selected as more compatible and that provide some production cost reductions. No strategies were finally applied regarding End-of-life, by avoiding company's responsibility of this stage, and only 6% of the Transportation strategies were finally applied, due to the low environmental improvement associated. Finally, most strategies are applied in the cradle-to-gate lifecycle stages (~20%) than in the gate-to-cradle ones (~11%).

### CONCLUSIONS

Technical, economic and social barriers are common in the development of ecodesign projects. Although usually LCA is used for an environmental assessment, the integration of economic and social indicators in the ecodesign methodology may be key drivers for overcoming some of the barriers (i.e., cost-benefit analysis of a strategy that requires investment). Notwithstanding the development of eco-labeling, the low development of communication tools is an important barrier (13.2% in the final selection), although some communication pathways are low-cost (i.e., business website). Communication should be promoted as a way to include both customers and stakeholders of the value chain in the sustainable behavior of the products. This fact is also important for the lifecycle stages where fewer strategies are finally implemented. Transportation and End of Life stages are the lifecycle stages where less ecoinnovative strategies are applied. Efforts in this area should be done in incorporating the stakeholders of the value chain (e.g., suppliers) as well as incorporating extended responsibility (i.e., end of life).

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