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Life cycle costing for innovations in product chains

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Abstract

The paper indicates how a few innovative actions of companies to reduce emission in the chain of products save costs of pollution control and even provide net benefits for companies in some cases. Costs and savings in the chains of products are assessed with a decision support model by comparing compliance and preventative corporate strategies regarding the far-reaching emission reduction. Ten cases are presented: tomatoes, an animal fat, a vegetable spread, a washing powder, a men's shirt, an office armchair, a kitchen block, a television set, a copier, and a car. The costs of pollution control can in several cases be avoided or reduced through focused actions in the life cycle, including changes in suppliers, adaptation of the manufacturing process and in consumers' behaviour. A distinction is made between consumption of the short-cycle and durable products. For consumption of the short-cycle products, the high compliance costs and the cost-saving innovations are usually found in the primary steps of supply (e.g. agriculture in food and mining of minerals) and in disposal (e.g. packaging). For consumption of the durable products, the high compliance costs and cost-saving innovations are mainly found in manufacturing of some components, during use of products because of electricity and fuel use and disposal of voluminous products.
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1. Introduction

The life cycles of products evolve in a framework of demands for health and environmental qualities. The demands are posed by various stakeholders such as authorities, companies and social organisations and address every step in the life cycle of a product, i.e. raw materials supply, manufacturing, distribution, use and disposal. The stakeholders who suffer from hazards posed to health and environmental quality, the victims, demand at far reaching emission reduction. The industries response to the demands is largely focused on process adaptation due to regulations, whereas more emission reduction, at lower costs are expected in theory to be achievable by broadening the scope of responses towards all steps in the life cycle of products [1]. In the paper, we underscore this expectation with empirical cases that cover large part consumption. It is pinpointed that anticipation of the demands enables companies to introduce cost-effective innovations. In addition, it is argued that the anticipating companies are capable of accommodating the strict victims' demands in their business, moving far beyond the regulations, provided that it is assured what issues are really demanded and can be implemented and companies are free to act efficiently in the chain. Moreover, the overall costs of the anticipation actions are so low that they hardly influence consumers' prices.

We present actions of several companies regarding the far reaching emission reduction in the life cycle for ten products that are exemplary for private consumption. We show that innovative actions reduce emission control costs to a negligible level and can also provide commercial benefit as a side effect of the innovation. Firstly, several costing methods are

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discussed (Section 2), then a model for life-cycle costs is presented (Section 3), followed by ten cases of life-cycle management (Section 4) and the conclusions (Section 5).

2. Assessment methodologies

The stakeholders' demands for emission reduction cover many different issues such as health risks, pollution, nuisance, resource degradation, and durability and so on. For management, it is uncertain which demands will become so powerful that the issue will be implemented by citizens' actions and eventually by regulations [2]. Many methods are developed to assess environmental impacts in the life cycle of products for regulatory purposes and to support companies' decision making about product improvement, which is presented in another volume of this journal [3]. Just to recapitulate, one can find the methods that use a ratio of a current situation with a demanded one (distance to target), or compare a situation with a reference value (reference); some methods address the inputs (like area, fuel or material use per unit of service), others use the outputs (from a single indicator like entropy up to hundreds emissions) and several apply the socio-economic issues of environmental qualities. The latter type links environmental qualities in physical terms with socio-economic values.

A comprehensive review from the mid-nineties shows more than fifty methods to link environmental qualities with socio-economic values like costs of companies or value added in a chain of activities [4]. New methods emerge, like methods to assess probability that public opinion influences managerial decisions [5], choice based on experts' and on public' views independent of each other [6] comparison value added with indexed environmental impacts [7]. The development of methods is not only a playground of scientists, but it is intended to support managers and policymakers in their difficult decisions about costly investments although it must be acknowledged that all methods are essentially normative judgments.

We only address the methods that aim to translate the demands for emission reduction into the costs of companies. These methods are presented under names such as Total Cost Assessment, Full Cost Accounting, or Total Costs of Ownership. We call them Life Cycle Costing because it is most common in managerial literature [8–10]. The Life Cycle Costing (LCC) is used in companies' decision making on major investments and life cycle of products. It is a tool in Life Cycle Management, which is an application of life cycle thinking in management towards sustainable production and consumption [11]. LCC covers assessments of costs in all steps in the life cycle during the lifetime of products. The methods define the main cost factors (also called cost drivers) including the costs connected with the demands that are not expressed in product price on the market. The unpriced demands can be the cost of emission reduction to attain high environmental qualities, or option values for natural resources and other social interests. LCC includes depreciation of investments, operational costs, allocation of overheads to a product or service (activity-based costing) and sometimes even infrastructure and related services that are needed to comply with demands.

Several approaches to LCC can be found, each with several methods. One approach is to value available environmental qualities in monetary terms (contingent valuation). The contingent valuation for LCC is estimated by a few of methods. One method is to relate the effects of emissions with the costs of health care, based on valuations of impact on labour health [12]. Another one relates the effects of emissions on environmental qualities to the willingness to pay for environmental quality [13]. Yet another method links depletion of natural resources with depreciation of the commercial value of natural resources [14]. The difficulty in using the contingent valuation is the weak theoretical foundation because valuation of common goods is highly imperfect, like the monetary value of environment.

The second approach addresses the companies' risks connected with regulations and liabilities that can be imposed by customers and citizens such as the cost to obtain permits, charges, costs of environmental management, insurance and penalties as well as the possible costs of damaged image and disturbed working relations and so on [15,16]. The approach received much support in the United States but it is hardly used in Europe and Asia, possibly because the liabilities presently cover only a very small percentage of all costs connected with environmental quality, whereas the risks of liabilities in the future can only be expected by radical change of local laws and legal practices, which is uncertain.

Finally, there is a scenario approach aiming to compare the current costs and the costs to comply with the demanded environmental qualities in physical terms such as percentage emission reduction [17–20]. The disadvantage is uncertainty about implementation of the demanded emission reduction. The major advantage of this methodology above the others is that the cost figures are real-life assessments based on engineering practices, which makes it possible to validate the costs and effects for specific companies, branches and regions. Hence, the method is close to the managerial practices of companies. The methodological difficulty with calculations is the sensitivity of costs with respect to the demanded emission reduction because an additional reduction strongly increases the costs. But the problem is solvable as it is shown below albeit with additional assumptions.

There are many points of criticism about LCC, such as difficulty to validate the choice of issues that are address in the costing because representation of the demands is disputable. The results of assessment are also debated because of poor data transparency and a bias caused by outdated figures. There is no simple solution except control by experience, second opinion and by several methods. Despite the limitations, the LCC is an important tool for decision making in companies because it indicates how to progress, thereby supporting development and introduction of the innovations that accommodate economical and environmental aims.

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