Implementation of Reverse Logistics in the Determination and Formulation of Product End-of-Life Strategies

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Abstract: The existing end-of-life (EOL) strategies, which can reduce the negative impact of products in the environment, across a wide range of products, are presented. Additionally, several product characteristics that may influence in a great or in a small extent the choice of the final selected EOL strategy and its successful implementation are specified.

Keywords: End-of-life strategies, reverse logistics, product design.

1. INTRODUCTION

Traditionally, product design and manufacturing, supply chains and inventory control lead from raw materials to the end-customers. Nowadays, increasing amounts of end-used products during their life-cycle are moving back in the chain, so companies and
government have to manage reverse logistics according to the existing end-of-life options for reused or discard products.

Starting from the electronic products and expanding now to all products the challenge is to apply the optimal treatment method in order to fulfill one or more possible targets. Some of these targets are:

- minimization in the use of hazardous materials,
- maximization of recycled land filling materials or reduction of land filling quantities,
- minimization of the involved costs,
- maximization of the profit that can be obtained from EOL handling of the products.

2. HANDLING END-OF-LIFE PRODUCTS

2.1. REVERSE LOGISTICS AND END-OF-LIFE STRATEGIES

Reverse logistics is considered to be the management of returned materials and products, where there may exist some value to be recovered. It differs from waste management that refers mainly to the actions of collecting, handling products or materials that are supposed to be discarded [3]. It includes the actions of product restoration, reduction or reuse of materials, facilitation of recycling and disposal of waste in an environmental friendly way [2]. Reverse logistics can be treated as a part of sustainable development since it targets to the exploitation of processes and guarantees that consumers use and reuse efficiently and effectively all the included value of a product. Reverse logistics, concerning sustainable development, is involved in three different roles, environmental, economical and social.

In this study, reverse logistics is regarded as a multidimensional process that involves a number of decisions such as incentives for product or materials returns, the determination of the best EOL strategy for each product or group of products, that is both economically and technically feasible and optimal, number and location of take-back centers, transportation and storage, assembly, recycling or final disposal and a number of other decisions. The EOL product strategies include the activities associated with strategic planning in a variety of different products, ranging from their collection, their further treatment actions and the examination of the associated impacts to all actors involved and the environment.

A general description of reverse logistics procedure concerning EOL products is outlined in the following graph:
The main priority, in most cases, is to minimize the environmental burden by the non-used electronic products and moreover, concerning the product designers and manufacturers, to examine carefully the used materials ([1], [7]). A general hierarchy ranking from the above-mentioned alternative actions according to their environmental impact, the required energy and the related costs is depicted in Figure 2:
2.2. PRODUCT CHARACTERISTICS IN RELATION WITH THE FINALLY SELECTED EOL STRATEGY

Previous studies ([4], [5], [6]) and the special features of electronic products were used, based on environmental, social or economical criteria, to determine the product characteristics that influence the successful implementation of the finally selected strategy during the reverse process of an EOL product. Also, product characteristics can be proved particularly meaningful since they can be used to classify products to the appropriate EOL strategy.

The product characteristics, which have been chosen for further examination through this initial examination, are grouped in 5 general sectors. These sectors and theirs specific characteristics are summarized in the following Table:

<table>
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<tr>
<th>General Sectors of Characteristics</th>
<th>Detailed Definition of Characteristics in Each Sector</th>
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| **Technical and technological features** | - Functional complexity  
- Technology life cycle  
- Materials – number of materials used  
- Time and effort required for the cleaning and elaboration of the materials before their use  
- Size, color and weight of the product  
- Redesign options |
| **Economic, marketing and management issues concerning the behavior of a product in a market** | - Existing channel for product distribution  
- Policy of product pricing  
- Product marketing  
- Marketing of available used products and materials  
- Size of the market  
- Customers’ behavior  
- Company’s organization and future plans  
- Repurchase options in the same or a different market (suppliers, customers, commitments)  
- Profit from the reused or remanufactured product  
- Wear-out product life (from its entrance in the market till the end of its useful life when it becomes an obsolescent product)  
- Production planning  
- Inventory control |
| Environmental impact | - Environmental load and cost of incineration  
|                      | - Environmental load and cost of disposal  
|                      | - Environmental load and cost of recycling without elaboration of an EOL product  
|                      | - Environmental load and cost of recycling of an elaborated EOL product or from certain parts of it  
|                      | - Management of hazardous materials  
|                      | - Management of scrap material during product design  
| Disassembly procedure| - Existing infrastructure  
|                      | - Existing installations  
|                      | - Demanding labor hours  
|                      | - Demanding cost  
|                      | - Availability of adequately trained personnel  
|                      | - Number of different parts or modules of parts  
|                      | - Number and categories of conjunctions between different parts or modules of parts  
|                      | - Disassembly steps  
|                      | - Quality control of the final disassembled parts  
|                      | - Recovered materials from returned items  
| Other reverse logistic issues | - Duration of product life cycle  
|                      | - Responsibility for the management of the EOL products  
|                      | - Legislation at National or EU level  
|                      | - Profit through the implementation of reverse activities (collection, management and recycling of EOL products)  
|                      | - Use of information technology to reduce the involved uncertainties  
|                      | - Timing and quantities of returns  
|                      | - Balance between demands and returns  

**Table 1: Initial list of Product Characteristics’ to be examined regarding their influence in the successful implementation of any EOL Strategy**

The next step includes a more extended investigation for the possible characteristics that have to be examined, based in real case-studies and measurements. The mathematical estimation of the importance of each of these characteristics and the examination of their behavior in real applications in order to rank them one by one or in groups according to their significance in the successful implementation of the applied EOL strategy in each case.
3. CONCLUSIONS AND FURTHER RESEARCH

In most companies, possible strategies for the evolution of EOL actions are lacking or could be enhanced. Therefore, it is necessary to systematically develop certain methodologies in order to incorporate EOL concerns into product development and manufacturing before the product entry in the market. Improvements in early stages of a product’s design can reduce the negative impacts of EOL products and the optimal implementation of the appropriate applied EOL strategy that is chosen. Also, the choice of the EOL strategy should be based on the products’ technical characteristics and other related parameters as existing transport channels for the EOL products and available infrastructure and facilities for their processing.

In this direction, the combination of technology evolution, legislation and competitive pressure has developed the issue of reverse logistics and the management of returned or used products as a vital subject for companies, consumers and countries.

The aim of this analysis is to present the current status and to propose some possible actions. In the future, the target is to help product designers to improve the final characteristics of their products, waste collectors or recyclers, to improve their processes concerning the selection and management of products after the completion of their life cycle and decision makers to develop efficient and realistic end-of-life systems.

4. REFERENCES