Chapter XVI
A Data Envelopment Analysis Approach for Household Appliances and Automobile Recycling

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ABSTRACT

Rapid technological developments are leading to a significant decrease in the demand for old technology products. As a result, old technology products are rushed to their end-of-lives (EOLs) even though they still function properly and have the ability to satisfy stated needs. It is therefore important to find environmentally and economically benign ways to handle this accumulating waste to regain the value added to such products and to reduce the environmental damage. However, EOL recovery options are not always economically justifiable due to the complexity and uncertainty involved in the process. To reduce these setbacks, it is crucial to perform an analysis prior to taking any action and rank the products according to the importance of their EOL processing outcomes. To this end, this chapter proposes a data envelopment analysis (DEA) algorithm to determine the technical efficiency of end-of-life processing of household appliances and automobiles depending on various tangible and intangible performance criteria.

INTRODUCTION

Advanced manufacturing technologies coupled with increased desire of customers to acquire the newest products have transformed highly technical products into time-sensitive items. With each technological enhancement, demand and need for old technology products diminish. As a result, such products are rushed to their end-of-lives (EOLs) even though they often function properly and are able to satisfy stated needs.

The severity of the problem increases as the advancement of countries increase, since the market for technological products tends to be larger in advanced nations. The population of a country is an additional factor that contributes to the size of the market, and hence the severity of the problems caused by EOL products. Thus, the United States, being one of the wealthiest nations in the world with its over 300 million residents, provides an appropriate environment for EOL product management case studies.

Automobiles are one of the most common products that are recycled in industry. The economics of their EOL processing operations has been well studied in the literature. Furthermore, in the United States, as reported by ARC, an average American family owns half a dozen major appliances (AHAM, 2007). For instance, 88.81 million households in the U.S. own at least one refrigerator and 18.19 million households own more than one refrigerator, corresponding to approximately 100% of the overall households in the United States with refrigerators (Table 1).

This fact, coupled with environmental regulations and increasing public awareness, has started to motivate many organizations and researchers to seek environmentally benign ways to manage highly technical EOL products.

As is well known, every EOL product is potentially hazardous to the environment if not handled properly. On the other hand, if proper actions are taken, there is a significant potential for savings in energy usage, virgin material usage, and reduction in air pollution, water pollution, and consumption. Among the proper actions, recycling, remanufacturing, reuse, and proper disposal are accepted as the most common and efficient ways for EOL processing.

However, economically benign ways of these actions remain a challenge for governmental and industrial organizations. Thus, it is crucial to perform some sort of decision analysis prior to taking any action and rank the products based on the importance of their EOL processing outcomes. To achieve this, various criteria can be employed, such as: scarcity and resale price of the materials content of the EOL product, difficulty level and cost of EOL processing activities, frequency of disposal, potential environmental damage of the EOL product, and so forth.

To this end, in this chapter, we propose a data envelopment analysis (DEA) algorithm to determine the technical efficiency of EOL processing of household appliances based on the above mentioned tangible and intangible performance criteria.

BACKGROUND

Data envelopment analysis is a widely applied methodology for evaluating relative efficiencies of a set of decision making units (DMUs). DEA can embody multiple outputs and inputs without a priori weights and allows introduction of both quantitative and qualitative data in different units.

Due to the above mentioned advantages, DEA has become a very popular tool among both academicians and institutions that are seeking ways to compare similar entities depending on quantitative results.

Sarkis (1999) proposed a two-stage methodology to integrate managerial preferences and environmentally conscious manufacturing (ECM) programs. In a subsequent paper, Sarkis and Cordeiro (2001) investigated the relationships