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Analyzing alternatives in reverse logistics for end-of-life computers: ANP and balanced scorecard approach☆

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Abstract

Activities in reverse logistics activities are extensively practiced by computer hardware industries. One of the important problems faced by the top management in the computer hardware industries is the evaluation of various alternatives for end-of-life (EOL) computers. Analytic network process (ANP) based decision model presented in this paper structures the problem related to options in reverse logistics for EOL computers in a hierarchical form and links the determinants, dimensions, and enablers of the reverse logistics with alternatives available to the decision maker. In the proposed model, the dimensions of reverse logistics for the EOL computers have been taken from four perspectives derived from balanced scorecard approach, viz. customer, internal business, innovation and learning, and finance. The proposed approach, therefore, links the financial and non-financial, tangible and intangible, internal and external factors, thus providing a holistic framework for the selection of an alternative for the reverse logistics operations for EOL computers. Many criteria, sub-criteria, determinants, etc. for the selection of reverse logistics options are interrelated. The ability of ANP to consider interdependencies among and between levels of decision attributes makes it an attractive multi-criteria decision-making tool. Thus, a combination of balanced scorecard and ANP-based approach proposed in this paper provides a more realistic and accurate representation of the problem for conducting reverse logistics operations for EOL computers.

Keywords: Reverse logistics; Balanced scorecard; Analytic network process; Multi-criteria decision making; Computer hardware industry

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1. Introduction

It has been estimated that about 60 million computers enter the market every year in the USA and over 12 million computers are disposed of every year. Out of these only about 10% are remanufactured or recycled (Platt & Hyde, 1997). The remaining may lead to enormous amount of e-waste to be generated in a few years: 4 billion pounds of plastic, 1 billion pounds of lead, 1.9 million pounds of cadmium, 1.2 million pounds of chromium, 400,000 lbs of mercury, etc. (Silicon Valley Toxics Coalition, 2002). The National Safety Council in a report ranks computers as the nation's fastest-growing category of solid waste by the Environmental Protection Agency (Hamilton, 2001). By 2004, there would be more than 315 million systems ready for disposal as opposed to 21 million obsolete systems in 1998 (Bertagnoli, 2000). According to another estimate, about 500 million computers will be rendered obsolete by 2007 in the USA alone (Hamilton, 2001). With the obsolescence rates on the rise (Blumberg, 1999) an important question that remains to be answered is what can be done to these EOL computers both from economical and environmental point of view. Due to shortening of product life cycles, for products like consumer electronics, the recovery of value from these consumer goods, after use, is becoming a necessity (Hillegersberg, Zuidwijk, van Nunen, & van Eijk, 2001). Several alternatives exist for disposing these EOL computers. Some of the methods for handling the EOL products include temporary storage, recycling the product, disposing of the product via landfills, etc. (Jacoby, Berning, & Diettvorst, 1977). EPA's Municipal Solid Waste FactBook reports that 29 states in USA have 10 years or more of landfill capacities remaining, 15 states have between 5 and 10 years of landfill capacity remaining, and six states have less than 5 years of landfill capacity remaining (Rogers & Tibben-Lembke, 1998). But landfill usage may be a short-term solution to the problem as for example, states like Massachusetts, Minnesota and Wisconsin have either banned or are considering banning the dumping of the computer-related equipment in their landfills (Stough & Benson, 2000). The German Packaging Ordinance of 1991 mandate that industries organize the reclamation of reusable packaging waste, while local authorities continue to handle the collection and disposal of the remaining waste. In Taiwan, proper disposition of computers and electrical home appliances at their EOL phase has been strongly urged by the general public because of the scarcity of landfill space and the hazardous materials contained in these appliances (Shih, 2001). If offsetting of the increasing demand of landfills is to be done, enhanced efforts for recycling are needed, which directly requires the reverse logistics activities (Barnes, 1982). Reverse logistics provide many opportunities to reuse and create value out of this nearly omnipresent asset (Rogers & Tibben-Lembke, 1998).

Industries have started to realize that the reverse logistics can be used to gain competitive advantage (Marien, 1998). An evaluation framework, which incorporates determinants and dimensions of reverse logistics, would be useful in configuring the post-activities associated with the EOL computers. One of the prime issues in this context is the evaluation of the various alternatives faced by computer companies, which seek to undertake reverse logistics activities for the EOL computers. One such approach, with an application of a systemic analysis technique is presented in this paper. This technique evaluates the various dimensions of reverse logistics through an analytic hierarchy network model. There are a number of variables affecting the reverse logistics, some of these are interdependent among each other. Analytical Hierarchical Process (AHP) is one of the analytical tools, which can be used to handle a multi-criteria decision-making problem (Saaty, 1980). However, a shortfall of AHP is that it lacks in considering interdependencies, if any, among the selection criteria. Analytic Network Process