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A holistic approach for selecting a third-party reverse logistics provider in the presence of vagueness

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Abstract

Growing environmental concerns have motivated businesses to carefully assess the environmental impact of their products and services at all stages of a life-cycle. Reverse logistics plays an important role in achieving "green supply chains" by providing customers with the opportunity to return the warranted and/or defective products to the manufacturer. An efficient reverse logistics structure may lead to a significant return on investment as well as a significantly increased competitiveness in the market. In order to ensure efficiency, many organizations outsource their reverse logistics activities by engaging third-party logistics providers that implement reverse logistics programs designed to gain value from returned products. The selection of third-party providers is a crucial step in initializing reverse logistics related practices. This study aims to efficiently assist the decision makers in determining the "most appropriate" third-party reverse logistics provider using a two-phase model based on artificial neural networks and fuzzy logic in a holistic manner. A numerical example is also included in the study to demonstrate the steps of the proposed model.

Keywords: Reverse logistics; Artificial neural networks; Fuzzy analytical hierarchy process; 3PLs selection; Multiple criteria decision-making

1. Introduction

Over the past few decades, increased competition caused by globalization and rapid technological advances have motivated firms to improve efficiency in supply chain management. Increasing efficiency in reverse logistics operations such as the recovery of the returned products is one way in which businesses attempted to maintain and increase competitiveness in the global economy. Reverse logistics, which is usually delegated to the customer service function, is the customer return of warranted or defective products to their supplier (Meade & Sarkis, 2002) and may include the packaging, shipping and backhauling the materials to a central collection point for either recycling or remanufacturing (Guide, Jayaraman, Srivastava, & Benton, 2000).

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Reverse product movement cannot be controlled by most logistics systems due to lack of equipment. Transportation, storage and/or handling of returned goods have different characteristics compared to outgoing goods both in terms of complexity and cost of required operations. That is, in majority of the cases, reverse logistics operations tend to require more sophisticated and problem specific approaches than their forward counterparts with higher distribution costs. Moreover, handling the returns can be considered as a major issue when the following symptoms occur: the arrival rate of returns is larger than the processing or disposal of the items, large amount of returns inventory held in the warehouse taking up space and other storage costs, unidentified or unauthorized returns, lengthy cycle processing times, unknown total cost of the returns process, and loss of customer confidence in the repair activity (Schwartz, 2000).

Due to above mentioned complexities, many businesses prefer allocating their resources to core competency areas and choose to outsource their partial or overall reverse logistics processes to third-party logistics providers (3PLs). Utilizing 3PLs in a closed-loop supply chain is also effective in ensuring sustainability since efficient reverse logistics services enable businesses with the opportunity to increase their profit margins, to differentiate their services from those of the competitors, to attract new clients to these services, and to enhance their status in the global supply chain network. On the other hand, if returns are not handled effectively, that is, when returned assets are not processed quickly or completely, considerable value may be lost. Hence, it is important to select an efficient third party logistics provider to partner with the organization in the reverse logistics process.

To this end, this study addresses the need for a decision making tool to assist managers in determining the most appropriate 3PL(s) by using an integrated conceptual framework combining artificial neural networks and fuzzy logic. The paper is organized as follows: Literature review on reverse logistics systems is presented in Section 2. Section 3 offers a brief introduction to the 3PLs evaluation techniques for the integrated conceptual framework and is followed by a numerical example given in Section 4. Section 5 concludes the study and summarizes its findings.

2. Literature review

2.1. Reverse logistics: definition and significance

Reverse logistics is a relatively new research topic. The few studies on the topic focus on a variety of issues in reverse logistics including production planning and inventory control in remanufacturing, facility location decisions, vehicle routing, resource allocation and flows. Among these, Fleischmann et al. (1997) reviewed proposed mathematical models for 3PLs selection while addressing the implications of emerging reuse efforts. Moyer and Gupta (1997) surveyed the literature on environmentally conscious manufacturing practices, recycling and the complexities of disassembly in the electronics industry. Spengler, Püchert, Penkuhn, and Rentz (1997) developed a mixed-integer linear programming model for recycling of industrial by products which is applied to the German steel industry. Sarkis (1998) presented a model which takes systemic and hierarchical relationships into account for decision and environmental factors in organizations. Later, Sarkis (1999) suggested a two-stage methodology that integrates managerial preferences to help evaluating quantitative data for the purpose of selecting an environmentally conscious manufacturing (ECM) program. Carter and Ellram (1998) reviewed the literature on reverse logistics and suggested some critical factors in the reverse logistics process. The authors identified four environmental forces from four different parties, namely, the government, the suppliers, the buyers, and the competitors emphasizing the importance of having a sincere shareholder commitment and top management support for the continued success of a reverse logistics program. Furthermore, Gungor and Gupta (1999) presented the development of research in environmentally conscious manufacturing and product recovery (ECMPRO) and provided a state-of-the-art survey of the published work in this area by subdividing the literature in categories, and outlining a framework.

Dowlatshahi (2000) described eleven insights for successful implementation of reverse logistics from the existing literature and published case studies. Knemeyer, Ponzurick, and Logar (2002) proposed a qualitative methodology to examine the key factors in successful design and implementation of a reverse logistics system for end-of-life computers. Krumwiede and Sheu (2002) reviewed current industry practices in reverse logistics highlighting the main issues and processes that need to be addressed in reverse logistics. De Brito, Flapper,