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The dynamic design of a reverse logistics network from the perspective of third-party logistics service providers

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Abstract

Traditionally, product returns have been viewed as an unavoidable cost of doing business, forfeiting any chance of cost savings. As cost pressures continue to mount in the competitive logistics industry, a growing number of third-party logistics providers (3PLs) have begun to explore the possibility of managing product returns in a more cost-efficient manner. However, few studies have addressed the problem of determining the number and location of repair facilities where returned products from retailers or end-customers were inspected, repaired, and refurbished for redistribution. To fill the void in such a line of research, this paper proposes a mixed-integer programming model and a genetic algorithm that can solve the reverse logistics problem involving the location and allocation of repair facilities for 3PLs. The usefulness of the proposed model and algorithm was validated by its application to an illustrative example encountering 3PLs offering value-added services.

Keywords: Reverse logistics; Genetic algorithm; Third-party logistics

1. Introduction

As of 1999, the total value of returned merchandise was $62 billion, representing $10–15 billion in losses to retailers in the United States (US), while the cost of handling these product returns was estimated to be $43 billion a year (ReturnBuy, 2000). Indeed, the cost of handling product returns usually comprises 4.5% of all logistics cost in the US (Min et al., 2005). Also, product returns accounts for between 1% and 35% of sales, depending on the industry (Stock, 2001; WERC Sheet, 2003). Faced with the mounting costs of managing product returns, many third-party logistics providers (3PLs) have begun to consider mapping the process of reverse logistics involving product returns and creating opportunities for cost savings and service improvements. As a matter of fact, a vast majority (91%) of the 3PLs surveyed by Lieb (2000) reported including product returns as their key service offerings. Thus, 3PLs that offer value-added services such as repair, remanufacturing, repackaging, and relabeling were overwhelmed by the scope and

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complexity of repairing and sending returned products back to their distributors or end-customers. In an extreme case, Rogers and Tibben-Lembke (1999) reported that an average return rate for the magazine publishing industry was 50%, while catalog retailers experienced a range of 18–35% return rate. In mail order, return rates of ladies' clothing lines could reach 60% (Wheatley, 2002). Despite these alarming return rates, most companies do not give adequate attention to product returns until product returns get out of control. Indeed, Guide and Van Wassenhove (2003) observed that handling product returns were not considered a company's core "value-creating" business and therefore most companies often passively accept product returns. Such passive handling of returned products in fast clock-speed industries (e.g., personal computers) could erode the commercial value of products rapidly because the reverse logistics processes could slow the customer response time and shorten product life cycles. As a matter of fact, the value to be recovered from returned products was estimated to be in excess of $50 billion in the US alone (Guide et al., 2003).

With ever-rising costs of product returns and dwindling profit margins, the optimal handling of product returns can be a competitive differentiator since a 3PL can save a substantial amount of transportation, inventory, handling, and warehousing costs associated with product returns. Indeed, Shear et al. (2003) noted that handling costs associated with product returns could reach $50 per item and could be three times higher than outbound shipping costs. In addition, they observed that product returns often reduced current assets due to lower inventory values for returned products, increased short-term liabilities due to required repairs and refurbishment, lengthened order cycle time due to reshipment of ordered items, and decreased sales revenue due to lost sales. As such, those 3PLs that are willing to implement an optimal strategy of handling product returns can bring in millions of dollars of potential cost savings. Typically, a product return involves the collection of returned products at designated regional distribution centers or retail outlets, the transfer and consolidation of returned products at centralized return centers, the asset recovery of returned products through repairs, refurbishing, and remanufacturing, and the disposal of returned products with no commercial value. The product return process entails the determination of the number and location/allocation of repair facilities for returned products in such a way that total reverse logistics costs (e.g., warehousing and transportation costs) are minimized, capacity of repair facilities are fully utilized, and the convenience of customers who return products is maximized. By nature, the product return process is more complicated than forward logistics operations due to the presence of multiple reverse distribution channels (direct return to manufacturers versus indirect return to repair facilities), individualized returns with small quantities, extended order cycles associated with product exchanges, and a variety of disposition options (e.g., repair versus liquidation). Recognizing the inherent complexity of the product return process, this paper develops a mathematical model and its solution procedure that can optimally create the reverse logistics network linking repair facilities, warehouses, and manufacturing facilities.

2. Relevant literature

In a broader sense, reverse logistics refers to the distribution activities involved in product returns, source reduction/conservation, recycling, substitution, reuse, disposal, refurbishment, repair, and remanufacturing (Stock, 1992). As shown in Table 1, reverse logistics differs significantly from

Table 1
Comparison between reverse and forward logistics

	Reverse logistics	Forward logistics
Quantity	Small quantities	Large quantities of standardized items
Information tracking	Combination of automated and manual information systems used to track items	Automated information systems used to track items
Order cycle time	Medium to long order cycle time	Short order cycle time
Product value	Moderate to low product value	High product value
Inventory control	Not focused	Focused
Priority	Low	High
Cost elements	More hidden	More transparent
Product flow	Two way ("push and pull")	One way ("pull")
Channel	More complex and diverse (multi-echelon)	Less complex (single or multi-echelon)

Source: Adapted and modified from Shear et al. (2003), "The Warehousing Link of Reverse Logistics."