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Outsourcing reverse logistics of high-tech manufacturing firms by using a systematic decision-making approach: TFT-LCD sector in Taiwan

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A B S T R A C T

Reverse logistics are increasingly crucial for the supply chain strategy of global high-tech manufacturing firms. As reverse logistics operations are significantly more complex than traditional manufacturing supply chains, many high-tech manufacturers are examining the feasibility of outsourcing reverse logistics activities to third party logistics providers (3PLs) from a strategic planning perspective. Internal resources and capabilities are thus examined from a resource-based perspective to identify which reverse logistics service requirements could be fulfilled in-house or outsourced. Therefore, this work presents a systematic approach using the analytical network process (ANP) not only to investigate the relative importance of reverse logistics service requirements, but also to select an appropriate 3PL. Empirical results based on the case of the TFT-LCD sector in Taiwan indicate that information technology management is of priority concern in reverse logistics services. In addition to providing a valuable reference for manufacturers concerned with service requirements for outsourcing, results of this study significantly contribute to the efforts of 3PLs in evaluating whether they comply with potential customer requirements based on their service capabilities.

1. Introduction

Firms are increasingly interested in recovering used products, especially given a growing environmental awareness and increasing customer expectations of enterprises to dispose of manufactured products safely (Fleischmann, Krikke, Dekker, & Flapper, 2000). Reverse logistics services include product returns, source reduction, recycling, materials substitution, reuse of materials, waste disposal, refurbishing, repair, and remanufacturing (Stock, 1998). Firms can implement effective reverse logistics in daily operations to foster a sustainable competitive advantage and increase revenues in a highly competitive market (Amini, Retzlaff-Roberts, & Bienstock, 2005). Effective reverse logistics focuses on the backward flow of materials from customers to suppliers with the intention of maximizing value from returned items and guaranteeing their proper disposal (Rogers & Tibben-Lembke, 1998; Stock, 1998).

Reverse logistics operations are considered significantly more complex than a traditional manufacturing supply chain (Meyer, 1999; Tibben-Lembke & Rogers, 2002). Such complexity could be owing to the uncertainty of return timing, quantities of return, and the quality of used products returned by customers (Fleischmann et al., 1997). Each return may require various treatments depending on the defective, damaged, and recyclable or repackagable nature of a product (Meyer, 1999). Additionally, forward and reverse logistics differ in the number of origin and destination points. Whereas forward logistics generally refers to the movement of products from one origin to many destinations, the reverse movement of products is the opposite: from many uncertain origins to a specific destination (Fleischmann et al., 1997). Therefore, manufacturing firms require flexible capacity to undertake transportation and warehousing activities in reverse logistics operations.

Reverse logistics concerns itself with how to effectively manage the flow of return products and its associated information flow (Ferguson & Browne, 2001). An efficient information and technology system is essential for facilitating reverse logistics during various product life cycles (Daugherty, Meyers, & Richey, 2002; Ravi & Shanker, 2005). An information technology (IT) system can facilitate the collection of customer information and track the status of returned items (Krumwiede & Sheu, 2002). In particular, globalization enables many high-tech manufacturing firms to have more reverse logistics demand; reverse logistics is further complicated when operating in a multinational setting (Richey, Chen, Genchev, & Daugherty, 2005).High-tech manufacturing firms must thus have an adequately large in-house fleet size as well as warehousing and advanced IT management systems to accommodate this unpredictable and large demand in reverse logistics. High-tech manufacturing firms also require value-added services to implement recycle, repair, and remanufacture activities. Therefore, the reverse logistics service requirements of high-tech manufacturing firms require transportation, warehousing management capabilities, advanced IT

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management, and value-added services to implement complex reverse logistics.

Many manufacturing firms that lack either the resources or capabilities to manage complex networks effectively outsource all or a portion of their reverse logistics to third party logistics providers (3PLs) to ensure an efficient reverse logistics process (Krumwiede & Sheu, 2002). Companies that purchase reverse logistics services from 3PLs can reduce up to 10% of annual logistics costs. High-tech companies have reduced inventories and increased field engineering productivity by as much as 40% through appropriate handling of reverse logistics (Minahan, 1998). 3PLs have thus become indispensable in reverse logistics, as return operations require a specialized infrastructure, including tasks such as supporting customized information systems to monitoring shipments and retrieving data (Ko & Evans, 2007). Outsourcing represents a strategic decision for manufacturing firms to achieve a competitive advantage (Espino-Rodriguez & Padron-Robaina, 2006). Therefore, this work addresses the outsourcing of reverse logistics service activities for high-tech manufacturing firms from a strategy planning perspective.

Thin-film transistor liquid-crystal display (TFT-LCD) technology is adopted in a diverse array of electronic products owing to their increasing popularity (Lin, Chen, & Huang, 2004). First invented in the early 1960s, the TFT-LCD sector has expanded rapidly in recent years, providing indispensable devices in the commercial production of notebooks, computers, and televisions (Katayama, 1999). As is widely anticipated, TFT-LCD reverse logistics requirements will increase even further. Taiwan manufactures more than 40% of the global supply of TFT-LCDs, becoming the largest supplier worldwide in 2004 (Hung, 2006; Su, Hung, Cheng, & Chen, 2006). Therefore, the TFT-LCD sector is adopted as a case study in this work to investigate its reverse logistics service requirements.

Reverse logistics can be used as a strategic tool in industry (Rogers & Tibben-Lembke, 1998). Strategic planning involves identifying reverse logistics goals and specifying long-term plans to achieve them. A more strategic approach is needed to reverse logistics management (Daugherty et al., 2005). Therefore, this work develops a systematic decision-making approach for practitioners of reverse logistics in industrial marketing. Reverse logistics service requirements are then analyzed using this approach, in which the resource-based view (RBV) provides the theoretical foundation for determining which reverse logistics service requirements should be fulfilled in-house or outsourced after examining internal resources and capabilities. This work is thus exploratory in nature. The outsourcing evaluation framework based on RBV adopts the analytical network process (ANP) not only to investigate the relative importance of service requirements, but also to select an appropriate 3PL.

2. Reverse logistics

Reverse logistics encompasses logistics activities: from used products no longer in use to recycled products for reuse in the market. Restated, reverse logistics involves planning, implementing, and controlling an efficient, cost effective flow of raw materials, in-process inventory, finished goods, and pertinent information from consumption to retrieval of the product value or proper disposal (Rogers & Tibben-Lembke, 1998). Reverse distribution activity could determine company survival because businesses thrive based on how they respond to external and internal changes and adjust to remain competitive, especially in light of increasingly stringent environmental regulations (Jayaraman, Patterson, & Rolland, 2003).

Reverse logistics activities differ from traditional logistics ones (Carter & Ellram, 1998; Tibben-Lembke & Rogers, 2002). Fleischmann et al. (1997) indicated that reverse logistics is not necessarily a symmetric picture of forward distribution. Table 1 summarizes the difference between the reverse logistics and forward logistics adapted by Tibben-Lembke and Rogers (2002). Many studies have also

Table 1
Differences in forward and reverse logistics.

Forward	Reverse
Forecasting relatively straightforward	Forecasting more difficult
One to many transportation	Many to one transportation
Product quality uniform	Product quality not uniform
Product packaging uniform	Product packaging often damaged
Destination/routing clear	Destination/routine unclear
Standardized channel	Exception driven
Disposition options clear	Disposition not clear
Pricing relatively uniform	Pricing dependent on many factors
Importance of speed recognized	Speed often not considered a priority
Forward distribution costs closely monitored by accounting systems	Reverse costs less directly visible
Inventory management consistent	Inventory management not consistent
Product lifecycle manageable	Product lifecycle issues more complex
Negotiation between parties straightforward	Negotiation complicated
Marketing methods well-known	Marketing complicated
Real-time information readily available	Visibility of process less transparent

Source: Tibben-Lembke and Rogers (2002).

suggested that reverse logistics activities are more complex to manage than forward logistics activities (Amini et al., 2005; Rosen, 2001; Tibben-Lembke & Rogers, 2002). Owing to uncertain and inconsistent demand, flexible capacity requirements for storage, processing, and transportation activities are necessary (Amini et al., 2005; Blumberg, 1999). Therefore, many manufacturing firms with limited resources and capabilities outsource their reverse logistics operation requirements to 3PLs (Krumwiede & Sheu, 2002).

Reverse logistics has received increasing attention (Blumberg, 1999; Carter & Ellram, 1998; Dowlatshahi, 2000; Daugherty, Autry, & Ellinger, 2001; Efendigil, Semih, & Elif, 2008; Fleischmann et al., 1997; Fleischmann, Beullens, Bloemhof-Ruwaard, & Van Wassenhove, 2001; Goldsby & Closs, 2000; Hu, Sheu, & Huang, 2002; Johnson, 1998; Knemeyer, Ponzurick, & Logar, 2002; Lee & Dong, 2008; Poist, 2000; Rogers and Tibben-Lembke, 2001; Ravi & Shankar, 2005; Tibben-Lembke, 1998; Srivastava, 2008). However, most reverse logistics studies focus mainly on evaluating reverse logistics from the tactical and operational perspectives such as production planning, inventory management, transportation management, reverse logistics system design, network design, and reverse logistics program design. Moreover, how to cope with uncertainty and the complexity of reverse logistics in strategic level decision making has seldom been addressed in literature. Developing reverse logistics services should be viewed as an effective means of nurturing a competitive advantage (Stock, Speh, & Shear, 2002). Dowlatshahi (2000) also developed a reverse logistics theory that requires both a strategic component and an operational component. However, reverse logistics in industrial marketing has rarely been examined from a strategy planning perspective.

Based on the reverse logistics problem in the supply chain, previous literature could be classified broadly as reverse logistics program design, reverse logistics operations, and the significance) of reverse logistics (Srivastava, 2007). The significance of reverse logistics programs and the processes of their development and implementation have been described elsewhere (Autry, 2005; Daugherty, Richey, Hudgens, & Autry, 2003; Poist, 2000; Richey et al., 2005; Richey, Daugherty, Genchev, & Autry, 2004; Stock et al., 2002).

Empirical studies on reverse logistics include case studies (Goldsby & Closs, 2000; Flapper et al., 2005; Khoo, Bainbridge, Spedding, & Taplin, 2001; Scherpereel, van Koppen, & Heering, 2001), field surveys and interviews (Blumberg, 1999; Daugherty, Richey, Genchev, & Chen, 2005; Guide, 2000; Lund, 1984; Zhu & Sarkis, 2004). Apart from an empirical study on reverse logistics, Fleischmann et al. (1997) indicated that quantitative models for reverse logistics have received growing attention. That study classified three main areas of this field as distribution planning, inventory control, and production planning. Additionally, reverse logistics and network design have attracted increasing interest (Blumberg, 1999; Fleischmann et al., 2000; Hess