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A profit maximization for a reverse logistics dual-channel supply chain with a return policy

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ABSTRACT

In the last few decades, the rapid development of e-commerce technologies has encouraged many manufacturers to adopt an online channel in addition to their existing traditional retail channel, which resulted in redesigning their supply chain channel structure. Additionally, an increasing number of manufacturers nowadays offer a return policy to attract more customers and to stay competitive. This paper studies a supply chain system, which is comprised of production, refurbishing, collection, and waste disposal processes. A return policy in which customers can return the purchased item for a refund is also considered. Two selling strategies, a single-channel strategy (i.e., a retail channel) and a dual-channel (i.e., a retail channel and an online channel) strategy are discussed from which mathematical models are developed. The purpose is to examine the effect of different return policies on the behavior of SC systems before and after adopting the dual-channel. In both strategies, the paper analyzes the change in the profit, the pricing and inventory decisions. Numerical examples and sensitivity analyses are provided with their results discussed. The findings of this paper demonstrate that in both strategies, the more generous the return policy is, the higher the demand, the selling prices and the overall profit. The findings also indicate that adopting a dual-channel strategy is more profitable to the supply chain.

1. Introduction

The last few decades witnessed remarkable changes in the business world. One of these changes is the emergence of the internet and e-commerce technologies. It was forecast that the direct online sales in the United States and Canada, will reach US$500 billion by 2018 (Retail Sales Worldwide Will Top $22 Trillion This Year - eMarketer, 2014). This growing size of the e-marketplace is promising; therefore, many manufacturers have been motivated to redesign their supply chain (SC) channel distribution through the adoption of an online channel in addition to their existing traditional retail channel (Yao, Yue, Wang, & Liu, 2005). For example, companies such as Apple, Dell, hp and IBM have adopted an online channel in addition to their traditional retail channels (Tsay & Agrawal, 2004). This has also allowed many manufacturers to be more interactive with customers, understand their needs and deliver products that meet the specification of each customer's requirements (i.e., mass-customized items) (Liu, Choi, Yuen, & Ng, 2012; Mukhopadhyay & Setoputro, 2004).

Mass customization (MC) is an industrial system practice, triggered by advances in e-commerce, information technologies (IT), flexible manufacturing system (FMS) and computer-aided design/-manufacturing (CAD/CAM) to produce a wide range of customized products or services at a cost that is close (but higher) to that of a mass produced item (Batarfi, Jaber, & Zanoni, 2016; Liu et al., 2012). In practice, successful MC builds products from combining preassembled components, which the literature refers to as built-to-order (BTO). Most manufacturers that offer customized items do not consider offering it as an isolated business strategy, but alongside an existing standardized production strategy (e.g. Dell, Apple and Nike). The motivation behind this is to enrich the capability portfolio of the manufacturer, which will increase their market share and improve their profit. However, implementing MC as a new method would require the adoption of a dual-channel strategy. However, with the adoption of a dual-channel strategy, the problem of managing the inventory of the SC becomes more complex in which the online channel may cause difficulties that could cannibalize the retailer's market share and impact the inventory decisions (Takahashi, Aoi, Hirotani, & Morikawa, 2011). Firms that adopt a dual-channel strategy may be required to redesign their SC structure and, accordingly, determine their pricing strategy and their inventory policy decisions.

Another challenge to firms is product returns. Offering a return policy, in which customers can return the purchased items for a refund, has been used as an important marketing tool and a com-

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petitive strategy to substantially increase customer satisfaction and improve product sales (Mukhopadhyay & Setoputro, 2004). A return policy can take many forms such as full or partial refund of the selling price, exchanging the item, store credit or no refund whatsoever (Mukhopadhyay & Setoputro, 2004). In practice, the type of return policy may vary from business to business or from one industry to another. It also depends on the type of an item. For example, in the computer industry, Dell Computers offers a full return policy that allows its customers to return purchased items, even customized ones. Apple Computers, on the other hand, for most of its products, offers a full return policy on non-customized items, and no return for special custom orders (e.g. engraving on iPad) (Mukhopadhyay & Setoputro, 2005). Companies that realize a return policy as a competitive tool need to recognize its impact on the selling prices and the SC inventory decisions.

The importance of managing the inventory of the SC has received tremendous attention from researchers and businesses. However, this attention, in most cases, is concentrated on managing the inventory of the forward logistics (FL) of an item from the point-of-origin (i.e., vendor) to the point-of-consumption (i.e., consumers) (Agrawal, Singh, & Murtaza, 2015). Recently, however, the scope of SC has been extended to include managing the inventory of items from consumers to the point-of-origin, known as reverse logistics (RL) (Agrawal et al., 2015). RL involves products that fall into two categories. The first deal with products that are returned by customers to the point-of-origin either because the products failed to function as designed or because the customers, for whatever other reasons, are not satisfied with them. In most cases, these returned items are sold to a secondary market as repaired or refurbished items (Cheng & Lee, 2010). The second category, deals with products that are collected from customers for the purpose of recovery (remanufacturing, recycling, disposal, etc.) once they have reached the end of their useful lives (Agrawal et al., 2015; Prahinski & Kocabasoglu, 2006).

Recently, RL has received a growing importance by many researchers and firms for its economic benefits, competitive advantage and corporate social image (Agrawal et al., 2015). However, managing the RL of the SC is significantly more complex than managing a traditional FL-SC (Krumwiede & Sheu, 2002). This complexity is due to the lack of resources and/or the capabilities to manage returned items from customers. It can substantially increase the cost of the SC. Due to this complexity, many firms (such as, K-mart, Best Buy and Philips) have outsourced their RL part of the SC to third-party logistics (3PL) providers (such as GENCO, Ryder and UPS, OZARK) to reduce cost and ensure an effective RL process (Cheng & Lee, 2010; Krumwiede & Sheu, 2002; Olorunniwo & Li, 2011). Firms have relied on 3PL providers for logistic operations (e.g., transportation) for many years. However, the reliance on 3PL providers for RL is fairly new (Bloomberg, LeMay, & Hanna, 2001; Prahinski & Kocabasoglu, 2006). For example, in the computer and electronic industry, Thomson Consumer Electronics outsourced its RL part of the SC to a 3PL provider, GENCO, to facilitate returns and for the refurbishment of repairable items in Mexico; whereas, unrepairable items are disposed of in the US before they are shipped to Mexico (Dhanda & Hill, 2005). As well, Cerplex Group built a RL and repair system business to provide services for the computer and electronic industry that range from the handling of returned items to the refurbishments and repairs of these items (Dhanda & Hill, 2005). Similarly, Philips outsourced the collection, repairing, repackaging, refurbishing and disposition of returned items to a 3PL provider, Ryder Supply Chain Solutions (Sharma, Revankar, & Sathvik, 2012). It was proven that firms that outsourced their RL to 3PL providers reduced their annual logistics cost up to 10% (Krumwiede & Sheu, 2002), and were able to reduce inventories and improve field engineering productivity by up to 40% (Cheng & Lee, 2010). Martin, Guide, and Craighead (2010) reported that remanufacturing was traditionally performed by independent small and privately owned 3PL remanufacturers; however, some original equipment manufacturer (OEM) prefer to remanufacture in-house for several reasons. For example, they noted that Caterpillar established a remanufacturing decision for its products to gain a competitive edge in a growing lower-price market segment. They mentioned that when the products contain high levels of proprietary technology and to avoid exposure during disassembly, firms remanufacture in-house. Xerox is one of these companies. This paper assumes that the remanufacturing 3PL facility is a division of the parent company and legal concerns are not an issue in this paper.

This paper studies a SC system that comprises of production, refurbishing, collection, and waste disposal processes. An OEM manages the FL part of the SC; whereas, the RL part of the SC is outsourced to a 3PL provider for the refurbishment of returned repairable items. The objective of this paper is to examine the effect of adopting different return policies when a dual-channel strategy is adopted on the SC system behavior while considering inventory, refurbishing, outsourcing, and disposal costs. The paper analyzes first the behavior of the system when the SC is composed of a single-channel strategy in which the retail channel offers both standard and refurbished standard items. Then, the paper analyzes the behavior of the system when a dual-channel strategy is adopted, where the retail channel offers standard items whereas the online channel offers customized and refurbished items (refurbished standard and refurbished customized). In both strategies, we find the optimal prices and the optimal inventory decisions under different return policies (i.e., full, partial, or no refund) that maximize the total profit of the system.

The remainder of the paper is organized as follows. Section 2 is the literature review. Section 3 introduces the assumption and notations used in developing the proposed models, which is presented in Section 4. Sections 5 and 6 present the numerical results and the sensitivity analyses, respectively. Finally, Section 7 presents the conclusion remarks and outlines some future extensions.

2. Literature review

This paper relates to the literature that considered RL-SC in either single or dual-channel structure and examined the pricing of products, return policy, and/or inventory decisions. Readers can refer to Prahinski and Kocabasoglu (2006) and Agrawal et al. (2015) for a complete literature review on RL-SC. The first research category in this area investigated the use of an online channel to sell returned items. In this area, Choi, Li, and Yan (2004) investigated the optimal return policy of a two-level SC where returned items from the retailer to the manufacturer could be sold on an e-marketplace. They showed this practice to be very profitable. Using an online direct channel strategy, Li, Xu, and Li (2013) examined the relationship between return policy, product quality and pricing strategies and its impact on customer's purchase and return decisions. Their main findings indicated that when product quality improves, the direct online channel should provide a lenient return policy and can increase the selling prices. Mukhopadhyay and Setoputro (2004) developed a profit maximization model for a RL-SC in an e-business context. They studied optimal pricing decisions and return policy regarding certain market reaction parameters. One year later, Mukhopadhyay and Setoputro (2005) developed another RL-SC model. However, they considered a BTO product built from modules and sold to customers through an online channel. They analyzed the effect of two decision variables, namely return policy and modularity level, on the demand, the refund amount returned to customers and the overall profit of the SC. Liu et al. (2012) extended the work of