1 CHAPTER 7: CONCLUSION AND IMPLICATIONS

1.1 Conclusion

The focus of this study is on managing new and reconditioned versions of same product. The central issue is to configure the whole supply chain in such a manner that total net profit is maximized over the entire life-cycles of both new and reconditioned products. This issue becomes particularly relevant as more and more firms are trying to work towards sustainable development. The existing literature of supply chain configuration deals only with new product (Amini and Li, 2011; Li and Amini, 2012); whereas reverse supply chain literature does not consider configuration. This study fills this gap and configures forward and reverse supply chains simultaneously. In other words, it is CLSC configuration. CLSC operation is much more complex than FSC operation as a firm has to deal with lot of uncertainties associated with reverse channel (Debo et al., 2006). For example, quality and quantity of used products, speed (responsiveness) of reverse channel are some of the most important factors. Other questions of interest are whether FSC is better than CLSC or not, at what price a used product should be acquired, what is the impact of return rate, what should be sales-price ratio of new and reconditioned products, and how much backlogging should be allowed. Our analyses provide answers to these questions, and are summarized below.

**FSC is better or CLSC is better.** In most of developed countries governments have formed regulations that force firms to take responsibility of products after their useful life. Firms in developing countries like India, where government do not have well-formulated strict rules and regulations, are facing one of the most crucial questions whether they should introduce CLSC operations or not. Our results indicate that CLSC model is beneficial for all realistic values of
sales-price ratio of new product. Our results might be helpful for all those firms which are considering starting CLSC operation but hesitating to do so. A firm can use some of its existing facilities for reverse operations in order to reduce investment cost. For example, retail showrooms or retailers can be used as collection centers (Savaskan et al., 2004). It is a strategic decision that a firm has to make whether it wants to share the capacities of forward operation with reverse operation. Specificity of operational assets and intellectual property concerns are primary drivers of in-house reconditioning or refurbishing (Martin et al., 2010).

**Price level at which used products should be acquired.** Acquiring of used products is one of the most important functions of CLSC operation as all other activities of reverse supply chain depend upon arrival of used products. Our results indicate that firms should try to acquire used products of better quality at a lowest possible price so as to make maximum profit. Firms should be able to define acceptance quality criteria for used products at which it will purchase them at an appropriate price. As shown in Guide and Van Wassenhove (2001), setting an appropriate price corresponding to a specific quality grade would not only generate profits but also reduces inventory. ReCellular, Inc., introduces a six level quality system for used mobile phone for acquisition. With each quality level, a specific price is associated. This strategy resulted in better quality and quantity of used products.

**Significance of return rate.** Quantity of used products is as important as quality is. Our results indicate that higher return rate would fetch more profits than lower or moderate return rates. However, more returns with lower quality may not be good for firms as they have to incur significant cost either in reconditioning or disposing (Debo et al., 2006). Firms need to offer some lucrative financial incentives to attract better quality used products. Caterpillar Inc., receives on an average 93%-95% used products every year due to its attractive financial
incentive program (Caterpillar Sustainability Report, 2011). Higher better quality product returns coupled with responsive reverse channel would reduce the work-in-progress inventory and hence inventory turnover rate. Responsive reverse channel is a prime requirement for time sensitive products as their value erodes rapidly (Guide et al., 2005).

Return rate of a product depends on product type and its life-cycle. For example, products like heavy machinery may have a life-cycle of 20 years for which product returns would start coming back only after 6-7 years (Atasu et al., 2010). That means a firm involved in producing heavy machinery type products should focus on forward supply chain issues for early stage of product life-cycle (Sahyouni et al., 2007). For the shorter life-cycle products, firms need to map out reverse channel before the launch of new product as their returns would start coming back quickly.

**Sales-price ratio of reconditioned product plays an important role.** Total profit of supply chain is a function of profits related to both new and reconditioned products. Literature suggests that sales-price ratio of new product can be as high as 1.3 (Kumar and Swaminathan, 2003; Amini and Li, 2011). On the other hand, sales-price ratio of reconditioned or refurbished product could be as high as 5 for certain type of products (Srivastava, 2008a). At the same time consumers are not willing-to-purchase a reconditioned or refurbished product if its price is close to new product’s price (Guide and Li, 2010). But the cost of reconditioning or refurbishing is generally 20%-30% of new product’s cost (Dowlatshahi, 2000). Therefore, a firm can have sales-price ratio of reconditioned product as high as 5 in some cases, which means reconditioned product plays a vital role in supply chain’s profit. A firm needs to reduce cost of reconditioning as much as possible in order to reap more and more benefits.
1.2 Implications

From academic perspective, this is the first study that configures supply chain considering both new and reconditioned products. We also consider diffusion of new product which is ignored in most of the CLSC related studies. The major contribution is our study integrated three streams of literature: Operations management (supply chain configuration), Marketing management (Bass model), and Sustainability (Reconditioning).

From a managerial perspective, the classification of product on the basis of its diffusion pattern becomes first and foremost thing. The diffusion pattern would provide an insight to the managers about the most likely time to receive product returns. It will allow them to establish efficient reverse channel in stipulated time and introduce the reconditioned version of the product on time. Our study also provide a decision making tool to managers by which they can choose the best available option at each stage of whole supply chain. This selection not only reduces the total cost but also improves the service level which in turn increases customer satisfaction. Also, supply chain managers can specify inbound and outbound service times taking into consideration uncertainties. For instance, specification of maximum inbound and outbound service times facilitates a well formulated mathematical model. The managers should take utmost care in specifying the maximum service times. This may be based on experience and there is a small chance that maximum limits will be violated. Our study also provides insights about several critical factors that affect total net profit of whole supply through our modeling framework. As discussed above, managers can set the value of each parameter depending on market conditions that will maximize the total net profit. Each of these factors is discussed in detail in results section. Furthermore, supply chain managers can use GAMS to solve specific
problems related to supply chain optimization. Variety of solvers is associated with GAMS which can solve approximately all types of linear and non-linear problems.

For policy makers, as shown in Mitra and Webster (2008), we also believe that government can play an effective role to encourage reverse logistics activities. Government can provide subsidy and tax relief to those firms who are involved in reverse logistics activities. Also, firms can be asked to dedicate a portion of their Corporate Social Responsibility (CSR) activities towards value recovering activities. It should be ensured that firms are strictly adhering to rules. Furthermore, some awareness programs about sustainability should be conducted for executives of firms. These executives can play a crucial role in setting up reverse logistics activities. According to Drumwright (1994), these people are known as Policy Entrepreneur and are influencing factor for successful socially responsible buying.