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On the benefits of CPFR and VMI: A comparative simulation study

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Abstract

This paper aims to help managers of a supply chain to determine an appropriate level of collaboration according to their specific business conditions. For this purpose, a comprehensive simulation model representing two popular supply chain initiatives, that are collaborative planning, forecasting and replenishment (CPFR) and vendor-managed inventory (VMI), is constructed. In addition, a traditionally managed supply chain (TSS) is also included in the model as a benchmark. The results indicate that benefits of CPFR are always higher than VMI. However, we also realize that under certain conditions, the gap between the performances of CPFR and VMI does not rationalize the additional resources required for CPFR. Especially, when the lead time is short and/or when available manufacturing capacity is tight, a careful consideration has to be given on the selection of an appropriate collaboration mode.

Keywords: Supply chain collaboration; CPFR; VMI; Simulation

1. Introduction

A supply chain, consisting of several organizations with different and sometimes conflicting objectives, is a complex network of facilities designed to produce and distribute products according to customers' demands. By coordinating different enterprises along the logistics network or establishing business partnerships, supply chain management (SCM) is concerned with finding the best strategy for the whole supply chain (Simchi-Levi et al., 2003, p. 2). Nevertheless, finding the best strategy in this complex network of facilities is not an easy task. It requires intensive communication and coordination among trading partners so that material flow along the supply chain is optimized as well as information flow. Fortunately, with the emergence of new management paradigms at the beginning of 1980s, e.g. Lean Thinking, Total Quality Management and Partnership Sourcing Programme, much progress has been made in the coordination of material flow (Mason-Jones and Towill, 2000; Simchi-Levi et al., 2003, p. 5). However, an equal attention has not been paid to the optimization of information flow. This ignorance of the information flow has contributed to one important problem in supply chain literature, which is called "bullwhip effect" (Lee et al., 1997a, b). The bullwhip effect represents the phenomenon where orders to supplier tend to have

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a larger variance than sales to the buyer (Lee et al., 1997a, b). In return, high inventory levels and poor customer service rates are typical symptoms of the bullwhip effect (Metters, 1997; Chopra and Meindl, 2001, p. 1363). Today, SCM researchers indicate that elimination the bullwhip effect plays a vital role for supply chain enterprises to gain competitive advantage.

Most of the researchers focusing on remedies for coping with the bullwhip effect dictate that sharing retail-level information (i.e. point of sales (pos) data) between supply chain members is a prerequisite for elimination of the bullwhip effect, see e.g. Lee et al. (1997a), Chen et al. (2000a, b), McCullen and Towill (2002), Dejonckheere et al. (2004), Ouyang (2006) and Li et al. (2006). Nevertheless, retailers, most of the time, do not desire to engage in information sharing because it provides ignorable levels of benefits for them, see e.g. Lee et al. (2000), Yu et al. (2001, 2002), Zhao et al. (2002a, b). Therefore, this requires upstream members (e.g. suppliers or manufacturers) to offer incentives for retailers in return for information sharing. Vendor-managed inventory (VMI) and collaborative planning, forecasting and replenishment (CPFR) are the partnership programs primarily developed to encourage retailers to share information, see e.g. Lee et al. (1997b) and Disney and Towill (2003a, b).

VMI, also known as continuous replenishment or supplier-managed inventory, is one of the most widely discussed partnering initiatives for encouraging collaboration and information sharing among trading partners (Angulo et al., 2004). Popularized in the late 1980s by Wal-Mart and Procter & Gamble (Waller et al., 1999), it was subsequently implemented by many other leading companies from different industries, such as Glaxosmithkline (Danese, 2004), Electrolux Italia (De Toni and Zamolo, 2005), Nestle and Tesco (Watson, 2005), Boeing and Alcoa (Micheau, 2005), etc. It is a supply chain initiative where the vendor decides on the appropriate inventory levels of each of the products and the appropriate inventory policies to maintain those levels. The retailer provides the vendor with access to its real-time inventory level. In this partnership program, the retailer may set certain service level and/or self-space requirements, which are then taken into consideration by the vendor. That is, in a VMI system, the retailer's role shifts from managing inventory to simply renting retailing space (Simchi-Levi et al., 2003, p. 154; Mishra and Raghunathan, 2004).

VMI offers a competitive advantage for retailers because it results in higher product availability and service level as well as lower inventory monitoring and ordering cost (Waller et al., 1999; Achabal et al., 2000). For vendors, on the other hand, it results in reduced bullwhip effect (Lee et al., 1997b; Disney and Towill, 2003a, b) and better utilization of manufacturing capacity (Waller et al., 1999), as well as better synchronization of replenishment planning (Waller et al., 1999; Çetinkaya and Lee, 2000).

While many benefits have been identified in the literature, there are also a number of challenges that may exist in practice and that can potentially reduce the benefits obtained from VMI or lead to failures in VMI programs. For instance, Spartan Stores, a grocery chain, shut down its VMI effort about 1 year after due in part VMI vendors' inability to deal with product promotions (Simchi-Levi et al., 2003, p. 161). Similarly, Kmart cut a substantial amount of VMI contracts because Kmart is not satisfied with the forecasting ability of VMI vendors (Fiddis, 1997). Consequently, many studies have been carried out to investigate the effectiveness of VMI programs under different conditions. For instance, Kuk (2004) empirically tested the acclaimed benefits of VMI programs in electronics industry. Similarly, Sari (2007) used a simulation model to evaluate the benefits of VMI under different market conditions. Dong and Xu (2002), on the other hand, evaluated the value of VMI programs both for suppliers and buyers. Most of these studies show that ineffective usage of retail-level information is one major limitation of VMI programs (see e.g. Aviv, 2002; Ovalle and Marquez, 2003; Angulo et al., 2004; Yao et al., 2007). That is, since retailers are closer to the marketplace, they may have better knowledge about customer behaviors, products and marketplace. However, in most, if not all, VMI programs, this unique knowledge of the retailers cannot be joined into inventory decisions. This is because in a typical VMI program, retailers are excluded from demand forecasting process. Indeed, in a VMI system, the responsibilities of the retailers are noting more than sharing sales and inventory data.

CPFR, on the other hand, can solve majority of the problems that are encountered in adaptation of VMI because it requires all members of a supply chain to jointly develop demand forecasts, production and purchasing plans, and inventory replenishments (Aviv, 2002). It is a business practice that combines the intelligence of multiple trading partners in the planning and fulfilment of customer