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Assessing the impact of e-business on supply chain dynamics

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Abstract

The Internet and related information and communication technologies (ICT) have recently enabled the cost-effective dissemination of information between disparate parties in the supply chain. New supply chain strategies, such as vendor managed inventory (VMI), collaborative planning, forecasting and replenishment (CPFR) and efficient consumer response (ECR), have begun to exploit these new communication channels, principally at the retail end of the supply chain. The impact of the e-business enabled supply chain on manufacturers and materials/component suppliers is, however, less well understood and exploited. This paper is aimed at establishing e-business enabled supply chain models for quantifying the impact of ICT, in particular its effect on dynamic behaviour. The paper concludes that simple, yet robust, models enable considerable quantitative insights into the impact of e-business on supply chain dynamic behaviour prior to their implementation.

Keywords: Supply chain dynamics; e-Commerce; Bullwhip; EPOS; Vendor managed inventory; e-Shopping

1. Introduction

While information and communication technologies (ICT) in the form of e-business is advocated as an enabler to the 1–2–1 enterprise (Peppers and Rogers, 1997) by allowing market place information to be shared by all businesses in the supply chain, there is little analytical or quantifiable evidence that it will actually improve the overall performance of the enterprise in delivering customer wants. It is usually proposed that passing information to all businesses in the supply chain via ICT will improve performance. In fact, recent research (Hong-Minh et al., 2000) has shown, via the supply chain "Beer Game" (Sterman, 1989), that simply passing information on to businesses can have a detrimental effect. This is due to the fact that, as well as having more information available, schedulers need to know what to do with it.

There are many ways in which innovative information flows could be used within supply chains. Kiely (1998) provides a good starting point, specifically focusing on using demand data for forecasting purposes. In this paper we analyse the impact of four ICT enabled scenarios by investigating the bullwhip effect (Lee et al., 1997a, b) using two different approaches and

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comparing them to a traditional supply chain. The first approach is based on an analysis of the results of a management flight simulator, the Beer Game. The second approach is based on a quantitative z-transform analysis using the tools highlighted by Disney and Towill (2002). The aim is to compare and contrast the two approaches qualitatively to assess the implications of their evaluations of e-business scenarios on supply chain dynamics.

Bullwhip is an important measure, being symptomatic of a poorly performing supply chain (Jones and Simons, 2000). It is a surrogate measure of production adaptation costs (Stalk and Hout, 1990) and implies the inclusion of "just-in-case" stock holding to buffer against uncertainties. There is considerable empirical evidence of bullwhip including recent examples in the:

- food sector where the supplier orders two tiers further upstream varied 10 times more than the electronic point of sales (EPOS) data (Jones and Simons, 2000).
- automotive sector where the ratio of the variance between incoming orders and order to suppliers at just a single echelon in the supply chain was 1:2 (Naim et al., 2002).

The five supply chain strategies considered are:

- Traditional—in which there are four "serially linked" echelons in the supply chain.
- e-Shopping—where the distribution network is by-passed and information and materials flow directly between the end consumer and the product suppliers.
- Reduced—where an echelon in the supply chain had been removed.
- Vendor managed inventory (VMI)—that is simulated by developing a protocol positioned between two businesses in the supply chain that gives the necessary inventory and sales information, authority and responsibility to the supplier in order to manage the customer's inventory.
- EPOS—where information from the market place is transmitted to all enterprises in the supply chain.

Although various e-business scenarios are available the above were chosen by four groups of four Masters Programme students based on their review of commonly quoted and/or implemented strategies in both the academic and practitioner literature. It was these Masters students who implemented the scenarios in the Beer Game.

2. Methodology

Research on improving the dynamic behaviour of individual manufacturing businesses and supply chains is well known. Most recent research methodologies may be categorised as:

- *Management games*: Tools such as the Beer Game that was developed at MIT at the end of the 1950s (Sterman, 1989), are useful to illustrate the benefits of different supply chain strategies. Games are limited in the sense that generally nothing can be rigorously proved from the game in itself, but they do provide a valuable source of anecdotal evidence and are a good learning device. Other authors have extended or computerised the Beer Game including van Ackere et al. (1993), Kaminsky and Simchi-Levi (1998), and Lambrecht and Dejonckheere (1999a, b).
- *Empirical studies*: A number of authors have investigated the impact of ICT on the supply chain including Holmström (1998), Fransoo and Wouters (2000), and Kaipia et al. (2000). However, this type of contribution looks at quantifying the improvement performance of a known strategy after its implementation; that is, there is no predictive element and the focus of the research is to identify best practices. Unfortunately, it is not always possible to compare ICT implementation strategies directly due to the varying nature of the environments they have been implemented in.
- *Statistical*: This type of contribution typically provides statistical insights about the impact of demand properties such as standard deviation and correlation, and supply chain properties such as lead-times and information paths on inventory costs and the bullwhip effect or