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Supply chain management, bullwhip effect, and CPFR from an Internet perspective: basic considerations

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Abstract

The Internet has contributed for making organizations change the way their business is done. Electronic-business, or simply, e-business, is the term in vogue. Basic problems persist though, like true integration of the supply chain members and the bullwhip effect. Often, data are inconsistent, outdated, information available just inadequate. To work with collaboration, meaning easy, confident and safe information exchange among partners, the Internet can offer access to multi-stage information in real time, easily and efficiently through a business network. The Internet allows supply chain members to see analytical information from other parts of the chain; this information can then be used to reduce purchase and sales prices, decrease inventory, aid management, optimize resource utilization, and avoid frequent changes to plans and schedules. Internet accessibility and standardization allow a corporation to transmit and integrate data among the several different stages of the supply chain. All of this ends up decreasing the bullwhip (or Forrester) effect.

Keywords: Supply chain management, bullwhip effect, CPFR, internet.

1 Introduction

In the past, when managers faced production-related problems, they would normally look at their own production facilities. Nowadays, with companies getting more focused on their core business, entrepreneurial relationships are common and managers need to consider a net or chain of companies to solve production problems more efficiently.

One can define a supply chain (SC) as a business network of suppliers, industries, distributors and consumers. In the chain, three types of flows exist: material, information and capital. Managing these three flows is what supply chain management (SCM) is all about.

Innumerous types of problems occur in SCM, a common and quite important one is the bullwhip (or Forester) effect. This, according to Lee *et al.* (1997), takes place when there is a distortion among the elements of the supply chain, specifically on the way they perceive demand. In other words, the final consumer demand is amplified as it moves upwards the chain. Each one's reaction tends to be amplified, either positively or negatively. This leads to increasing or decreasing orders, building or avoid as much inventory as possible, trying to protect each one's own businesses' interest. As a consequence, companies work with too much inventory in certain periods, lack material in others, have unfeasible due-dates to meet, and put extreme pressures and stress on their employees to meet unrealistic schedules. Consequences for the production planning and scheduling are therefore, tremendous. For those staying further from the actual point-of-sale information, it gets even worse to manage production.

Collaborative planning, forecasting and replenishment (CPFR) is a SCM strategy that promotes increase in efficiency through the collaboration of the main companies in the chain. The involved peers establish common plans and accords and share information, mainly those regarding demand and special events. Following the agreed plans can minimize the negative consequences of the bullwhip effect in a supply chain.

This work briefly and simultaneously reviews three subjects intimately related: Supply chain management, bullwhip effect, and CPFR – under the perspective that the Internet can and should be present to aid companies in the chain improve their business. This paper is organized as follows: Next section reviews the Internet and the supply chain. Section three shows some of aspects on how the Internet can decrease the bullwhip effect. Section four describes main characteristics of the CPFR and how it is related to the Internet. Last section sums up the ideas presented.

2 Internet and the supply chain

The Internet is pushing organizations to redefine their business models. Focus is shifting to the improvement of the supply chain and not just one's own organization. Companies can now easily exchange information, place orders and show order status for their customers, and virtually everyone can buy or sell over the net. Terms like B2B (business to business), B2C (business to consumer), C2B (consumer to business), C2C (consumer to consumer), E-commerce, E-business, and E-procurement are in vogue.

The Internet helps and will help even more businesses around the world. According to Liautaud & Hammond (2002), there are some tendencies that support these ideas:

- Customers always expect quicker and more integrated services;
- Sales, services and customization are not separated phases anymore;
- More and more famous brands manage marketing, sales and distribution without any production process - they rely on suppliers to do the manufacturing;
- Production facilities are spread across the world and distribution should consider the five continents. Supply chain is global and should be managed as such.

The basic problem in the traditional SC management is the lack of process integration among the SC partners, usually considering outdated information and doing isolated planning. The Internet can facilitate collaboration among the SC members by providing consistent and fast information for the companies involved and therefore allowing material to flow more smoothly and efficiently, from suppliers to the final customers. (Liautaud & Hammond, 2002)

According to Bowersox (2001), main challenge for the organizations is to identify the correct structure for his/her supply chain and the appropriate level of collaboration among the SC echelons (stages or links). These strategies will greatly affect the success of the supply chain management.

For Kalakota & Robinson (2002), new technologies for supply chain management have improved the capacity of organizations to integrate processes through sharing and planning of collaborative information. These innovations include the proliferation of

web sites, introduction of devices to get information from point-of-sales, appearance of data handling tools for optimization of large-scale information and the ability to disseminate data. Information is replacing inventory.

The Internet allows the SC members to see analytical information from the different parts of the chain. Such information can be applied to (Liautaud & Hammond, 2002; McLaren *et al.,* 2002; Giovannini, 2001; and Chang & Makatsoris, 2001):

- Reduce purchase and sales price;
- Reduce administration and inventory costs;
- Improve SCM;
- Improve inventory management and decisions regarding replenishment and purchasing;
- Identify opportunities for new markets;
- Increase the productivity of the distribution channel;
- Answer quality related questions quickly;
- Help in the search for logistics efficiency;
- Reduce the economically viable size of the corporations;
- Increase the value offered to the client and the communication with it;
- Improve coordination between the material flow and production capacity;
- Reduce production cycle times;
- Optimize transportation through the optimization of logistics and vehicle loading using more reliable and up-to-date information;

3 Internet to aid decrease the bullwhip effect

One of the bullwhip effect causes is the myopia in the various links of the chain: each stage of the chain only sees the demand from its immediate customers. However, this demand is distorted by the inventory policies adopted by downstream corporation, defined independently and not necessarily adequate for a better performance of the whole SC. Furthermore, there is an effect that adds even more oscillation to each stage's demand that is the inertia in the material and information flows, from one stage to another. Therefore, one can say this effect is caused by the inadequate management of the overall supply chain. So, in the traditional structure, each link looks at its own demand and tries to maximize its own financial performance, even if the chosen actions damage the performance of other links. When this happens, the only link that really brings the money into the chain gets negatively affected: the final customer.

The bullwhip or Forrester effect is not caused only by errors and distortions. In fact, according to Slack *et al.* (1999), its main cause is the rational and perfectly comprehensible desire of each SC link to manage production rates and inventory levels independently. For Lee *et al.* (1997), there are four main causes for this effect:

- Demand forecasts inconsistency and frequent changes;
- Frequent changes to order lots;
- Price fluctuations, caused by, for instance, promotions;
- Expectative of product or material shortage.

The negative consequences of the bullwhip effect include (Keskinocak & Tayur, 2001; Khator & Deshmukh, 2001):

- Increase in inventory levels throughout the supply chain;
- Poor customer service;
- Profitability decrease;
- High transportation costs;
- Poor product quality;
- Frequent changes to production plans and schedules.

Among these, inventory related costs are probably the most negatively affected.

Any study aiming at "solving" this problem should initially focus on measuring it. According to Fransoo & Wouters (2000), data-related issues are the main causes for not being able to sense this effect. Some of these issues are, for instance, excessive accumulation of superfluous information, and incomplete, outdated or isolated data. Here the Internet can play an important role, by providing an integration media for information systems across different platforms and corporations. This will result in a decrease in the quantity of repeated data stored at multiple places. Internet can also supply more current data and on "real-time". Besides all this, it is inexpensive. It has, however, some issues that need to be considered, such as data security and confidentiality, in multi-tasking and multi-access environments. According to Simchi-Levi & Simchi-Levi (2000) and Chen *et al.* (2000), one can reduce the bullwhip effect through better integration and visibility, which means to provide each stage of the SC

with complete and accurate information regarding consumer demand and inventory levels. And again, the Internet can provide this visibility and integration platform.

According to Joe Andraski, the creator of the CPFR concept – described in the next section – one of the main causes for excessive inventory in the companies is the bullwhip effect. From his experience from practical situations, CPFR is one of the main ways to reduce this effect (Andraski, 2002). CPFR can also be intimately related to the Internet.

4 CPFR: an Internet-based SCM strategy

Collaborative planning, forecasting, and replenishment (CPFR) is a set of rules and procedures which objective is to increase the efficiency of supply chains through the establishment of standards that facilitate the physical and information flows among corporations (Arozo, 2001). Voluntary Interindustry Commerce Standards (VICS) Association published for the first time the VICS CPFR Guide in 1998. During this period, CPFR became one of the best B2B practice in the world.

CPFR`s basic premise is to promote increase in efficiency through the co-participation in the overall SC management. Key participants in the chain should contribute to the process improvement, by sharing information and plans that will help them to make more accurate forecasts. Main information come from the point-of-sale and are considered for demand forecasting, production planning and for planning deliveries.

Seifert (2002) gives a simple but good definition for CPFR, stating that it is a business strategy between supply chain partners for collaboration through exchanging information about consumer demand forecasts from the point-of-sale level (where the actual demand is).

Operating under the CPFR philosophy, the Internet can supply information regarding price and delivery time estimates, unpredicted events occurrence, promotions, new stores/markets, and other planning parameters. However, when used as a media for getting customers orders, the Internet can also gather and supply point-of-sales information. Since information among the SC peers is exchanged in real-time, efficiency in the use of working capital is also improved.

According to Domingues (2001), CPFR was born to cover gaps left by other practices like vendor-managed inventory (VMI) and efficient consumer response (ECR). With CPFR, several problems have been solved from the beginning, such as (Barratt & Oliveira, 2001):

- Influence of promotions on sales price calculation (and on inventory management policies);
- Influence of changes in demand pattern on sales forecast calculations (and on inventory management policies);
- The common practice of keeping high levels of inventory to guarantee product on shelves;

- Lack of coordination among stores, purchasing processes, and retailers logistics planning;
- Lack of synchronism among the manufacturing/production planning, sales, and distribution;
- Existence of multiple forecasts within the same company (sales, finances, purchasing and logistics).

In fact, supply chain collaboration is a bigger challenge to the business aspect than to the technology itself. Today, the Internet provides accessibility and standardization that allow easy data transmission and integration among SC partners. Implementing cultural and organizational changes is in fact what demands the biggest efforts (Simchi-Levi & Simchi-Levi , 2000).

In numerical terms, companies doing collaborative planning, forecasting and replenishment report a 67% reduction on lead times, 60% reduction of forecasting errors, 40% reduction on inventory levels, 22% increase on service levels and a 47% increase on sales (Vieira, 2002; and Pio, 2003).

The Internet can provide several different types of information, as seen so far. Currently, a change in demand in a certain product is felt by the product's distribution center, which transmits the information to the industry that passes it to the suppliers. The whole process depends on the emission of production and purchasing orders, which pushes the whole process. The CPFR idea is to make these information readily available

for all in the chain so that they can anticipate changes and collaborate to find solutions for the overall process improvement.

CPFR is today the most advanced business strategy for the industry focused on true collaboration. Several industries, suppliers, and retailers, from different consumer markets, are implementing CPFR-based concepts and systems (Vieira & César, 2003).

Main benefits presented by companies that implemented CPFR are presented below (Arozo, 2001; Seifert, 2002; and Fliedner, 2003). Some of them are directly related to the use of the Internet as an integration media:

- Drastic increase in reaction time to customer demands. The systematic fault (deficiencies) reduction and the optimization of turn-around times make the supply chain more flexible and safe. This, in the end, increases product availability and customer satisfaction.
- High precision in sales forecast. Through collaboration, forecasts get more dependable. Regardless of their positions in the supply chain, partners can and should contribute with their different perspectives, consumption data, previous experiences and forecasts studies. The combination of these factors is the basis for the high dependability of sales forecast.
- Direct and permanent communication. The establishment of direct lines of communication increases the exchange rate among the value chain phases. Rare demand changes can be promptly considered.
- Sales increase. CPFR dramatically reduce out-of-stock situations. Potential losses on sales are previously recovered. All the partners win.

- Inventory reduction. Imprecision in sales forecast is the main reason for excessive inventory in the supply chain. Stocks are kept for safety reasons; usually do deal with possible mistakes in sales forecast. Such inventories are now minimized and, at the same time, availability is increased, by using CPFR.
- Cost reduction. The integration of the production planning with material supplier and the industry through the optimizations of sales forecasts open new ways for cost reduction. Setup times, overtimes, variations are reduced.

The collaborative commerce allows better management of partnerships since it defines each corporation role in the business network, sets the business rules, keeps updated information, standardizes and defines attributes between the companies (Pio, 2003). The Internet provides the way for this to happen.

Performance indicators are used to measure the performance between consecutive stages, for instance, between supplier and industry and industry and retailers. To assure the success of CPFR implementation, the involved companies should define common goals, as well as the performance indicators to be used for controlling purposes, that is, to monitor if goals are being met according to the pre-defined values (GCI, 2002). The Internet can again be used to collect and transmit these information, accurately, fast and continuously.

Several companies are now developing CPFR solutions or are making their current systems “CPFR-enabled”, most of them through the Internet. Table 1 summarizes some of these companies and their respective systems (Vieira & César, 2003).

Table 1 – Companies offering CPFR solutions.

Company	CPFR / CPFR-enabled System	Web site
AVAYA	DEFINITY Prologix Solutions	http://www.avaya.com.br
BAAN	IBAAN for Supply Chain Management	http://www.baan.com
DYNASYS	n-SKEP	http://www.dys.com
I2	i2 TradeMatrix CPFR	http://www.i2.com
JDA Software Groups	Portfolio Collaboration Solutions	http://www.jda.com
J.D. Edwards	OneWorld / APAS	http://www.jdedwards.com.br
LOGILITY	Logility Voyager Solutions	http://www.logility.com
MANUGISTICS	Collaborative VMI	http://www.manugistics.com
NeoGrid	Planejamento Colaborativo (Note: This seems to be the only Brazilian CPFR solution available at this date.)	http://www.neogrid.com.br
PeopleSoft	(Note: PeopleSoft has done a partnership with Syncra)	http://www.peoplesoft.com
SAP Brazil	MySAP PLM	http://www.sap.com/brazil
SYNCRA	CPFR (Note: Syncra_Xt Collaboration Platform has four collaboration solutions: Promotion Synchronization; Continuous Replenishment; CPFR; Demand Planning)	http://www.syncra.com

Some of the features companies claim their systems have are, for instance:

- Sharing of forecasts and proposed replenishment plans with key customers. One can collaborate on planned promotions and other events for better visibility into consumer demand, as well as share forecasts in a consensus-driven process to help strengthen trading relationships.
- Built in integration into planning and replenishment solutions and system performance.

- The CPFR system compares the data it collects from the supplier's enterprise systems with the data it receives from retail partners. It generates any exceptions it finds and communicates results with the retailer's CPFR solution.
- Companies only need access to the Internet. Data is up-loaded to the hosting service through a secure connection. Then planners access their company's view through a web browser. Participants who use a single, public ex-change achieve exchange-to-exchange interoperability and end-to-end visibility across the supply chain.
- Participants do not need to manage the technology platform and can spend their time fortifying supplier and retailer relationships, making work process more efficient, and developing key competitive strategies with the data generated.
- Link business processes across the extended supply chain by sharing detailed, real-time information.
- Provide critical business intelligence at all levels in an organization, including strategic, tactical and operational and visibility to see within the organization and throughout the value chain.

5 Summing up

This paper briefly described how supply chain management, the bullwhip effect and collaborative planning, forecasting and replenishment are related to Internet. Basically, the Internet is a media that provides easy, fast and reliable integration of corporations or corporations´ systems.

The basic problem in the traditional SC management is the lack of process integration among the SC partners, usually considering outdated information and doing isolated planning. The Internet can facilitate collaboration among the SC members by providing consistent and fast information for the companies involved and therefore allowing material to flow more smoothly and efficiently, from suppliers to the final customers.

Any study aiming at "solving" this problem should initially focus on measuring it. Data-related issues are the main causes for not being able to sense this effect. Some of these issues are, for instance, excessive accumulation of superfluous information, and incomplete, outdated or isolated data. Here the Internet can play an important role, by providing an integration media for information systems across different platforms and corporations. This will result in a decrease in the quantity of repeated data stored at multiple places. Internet can also supply more current data and on "real-time". Besides all that, it is inexpensive. It has, however, some issues that need to be considered, such as data security and confidentiality, in multi-tasking and multi-access environments.

But performance indicators should not only be used for controlling internal performance or performance between adjacent corporations, but for looking at the overall supply chain. New key performance indicators might need to be created, but companies should focus on the whole chain's performance and not local performance.

The Internet provides the innovation to companies change business by using advanced technologies and strategies to open new channels, increase revenue and be competitive like never before.

Currently, the authors are developing a methodology to evaluate the effects of CPFR implementation through computer simulation. Future studies should present a more detailed overview on CPFR systems, their main characteristics and common features.

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