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A Real Application of the Theory of Constraints to Supply Chain Management in Brazil

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Abstract

This paper presents how the concepts of Theory of Constraints (TOC), Vendor Managed Inventory (VMI) and Business-to-Business (B2B) tools can be applied to Supply Chain Management (SCM) in order to improve the global supply chain performance. First of all, the TOC concepts and the SCM dilemma, according to TOC thinking, are to be summarized. After that, an alternative TOC approach to SCM will be described, which uses VMI & B2B to minimize the bullwhip effect and inventory levels, therefore as a SC performance improvement. The proposed approach is illustrated by means of a real case study in a Brazilian middle size company, related to the small appliances production.

Keywords: *Theory of Constraints (TOC), Supply Chain Management (SCM), Vendor-Managed Inventory (VMI), Business to Business (B2B), Real Case.*

Introduction

As pointed by Simatupang *et al.* (2004), collaborating firms share responsibilities and benefits with their upstream and downstream partners in order to create competitive advantage. When all the SC's partners are integrated and act as a homogenous entity, profit and performance is enhanced throughout the Supply Chain (SC), as a combination of supply and demand. Flores and Primo (2008) affirm that, with the crescent requirement of the market, the logistic process becomes more and

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more complex and with much higher levels of demands, especially when related to achieving a competitive advantage.

Nowadays, the competition is not among companies but among the SCs, which belong to (Srinivasan *et al.*, 2005). In that scenario, although the main goal of the SCM is to reach a solution with optimized profit for all SC's partners, there is often a great disparity between potential benefits and the practice (Simatupang *et al.*, 2004). This situation occurs because there are several difficulties regarding SC which need to be solved by an efficient SCM. Some of these difficulties are: very long lead times, large number of unfulfilled orders and/or they are executed with much extra effort (overtimes), high level of unnecessary inventories and/or lack of relevant inventories, wrong materials orders, large number of emergency orders and expedition levels, high levels of devolution, lack of key customers engagement, frequent changes and/or absence of control related to priority orders, which implies on schedule conflicts of the resources, among many others. (Goldratt *et al.*, 2000).

Despite the noticeable worldwide performance improvement of the SC, the main problem observed is that the SC's partners have not been achieving better results related to profitability and efficiency, because most of the time, each one of them just considers their local constraints (own problems), when they should be considering all global constraints related to SC as a whole. In fact, the design and analysis of the SC as a whole is critical to develop an efficient SCM (Wang *et al.*, 2004). In this study, it is proposed to use the Theory of Constraints (TOC) to help companies in a make-to-stock SC. By TOC methodology, a SC is analyzed by means of a holistic view, in other words, it is defined as a group of dependent elements and, therefore, the system's global performance (SC) is dependent on the efforts of all elements. Every system must have at least one constraint, and this is explained by the fact that if there were nothing to limit the system's performance, it would be infinite (Cox III and Spencer, 1998). To administer this constraint, the TOC approach includes some issues, such as the drum-buffer-rope scheduling method, the buffer management, and the five-step focusing process, which will be described further ahead.

The main purpose of this paper is to rescue and to discuss TOC application to SCM. The difficulties involving TOC concepts versus real implementation will be described. It will also be analyzed how the adoption of Vendor Managed Inventory (VMI) and Business-to-Business (B2B) tools can support a better SCM solution. Moreover, it is described a real case study associated to Siber do Brasil S.A. – a middle- sized multinational company in Brazil – where it was applied TOC, VMI and B2B to SCM. This paper is organized as follows: It summarizes the main concepts of TOC; discusses the SCM dilemma according to the TOC, exposing a description of the TOC approach to SCM; comments the bullwhip effect and how it can be minimized by using VMI and B2B tools; and lastly an approach for a new manufactures and retailers relationship is proposed and a real case study where TOC, VMI and B2B are applied to SCM is developed, followed by analysis and conclusions.

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Research Methodology

The method and the research techniques were elected with the purpose of joining the theory and the practice needs. In order to attend the scientific requirements, the basic attributes that qualify the research are listed bellow (Silva and Menezes, 2004; Mello, 2007):

- **Applied research:** generation of knowledge for practical application focused on solutions for specific problems;
- **Qualitative approach:** approximation between theory and factors, by means of phenomenological analysis of the subjectiveness and nearness of the researcher with the object in analysis.
- **Explorative research:** bibliographic survey, interviews with people that had practical experiences with the investigated problem; analysis of the examples that instigate the comprehension of the cause and effect relationships;
- **Case study:** direct observation of the reality with the use of inductive logic; deeply analysis of the object (case) and interaction between researcher and the object of research.

Theory of Constraints

In the TOC thinking, the activities planning, execution and control should be done through the Constraint Management paradigm by means of a Continuous Improvement Methodology. The idea is to act on the identified constraint that is avoiding the system to reach its main goal, which is the maximization of profits and system profitability. TOC can help managers to identify and create win-win solutions among the system's entities.

The five steps of the Continuous Improvement Methodology used by the TOC are to identify system's constraints, to exploit them, to subordinate everything to the above decision, to elevate the system's constraints and to get back to step one, but not allowing inertia to become the next system's constraints.

Gaither and Frazier (1999) claim that the approach of the TOC is also known as synchronous manufacture, or Drum-Buffer-Rope (DBR). The DBR methodology is the basis of the TOC applied to production and with reflex at the minimization of the inventory; it is explained below:

- **Drum –** with the same analogy of the drums that define the cadence of military marches, in TOC the constrained resource is the drum, which is, the one to set the cadence of the entire productive system, working as a supportive tool for the third step of TOC (Goldratt and Cox III, 1992);
- **Buffer** – in order to support the second step of TOC, where the system's constraint should be highly explored. The buffer is the representation of the safety time for the protection of the constrained resource (CR) to keep the

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flow in constraint in case any problem happens and put at risk the work in CR. A secondary buffer can be created during the process and it can be defined as a passage of sold material through the productive system;

- **Rope** – is responsible to synchronize the arrival of materials at the buffer and the admission of raw materials in the system.

The Main SCM Dilemma According to the TOC

In a typical SC, the middle-sized partners focus only on their own production management strategy, sales and financial planning. This action will devalue the relationship and interdependence in the SC. Figure 1, based on Santos *et al.* (2007), illustrates a traditional behavior for a SC's middle-sized partner, where the Focal Company (FC) uses the sales forecasting for its customers and does the production planning and sends purchase orders to suppliers by means of a MRPII system. Inventory excess or production interruption continuously occurs, resulting to an upstream SC's partners from the FC, the phenomenon of successive mistakes in the information of the demand occurs, well known as bullwhip effect (Lee *et al.*, 1997b). Several researchers have suggested that collaboration initiatives can minimize those problems.

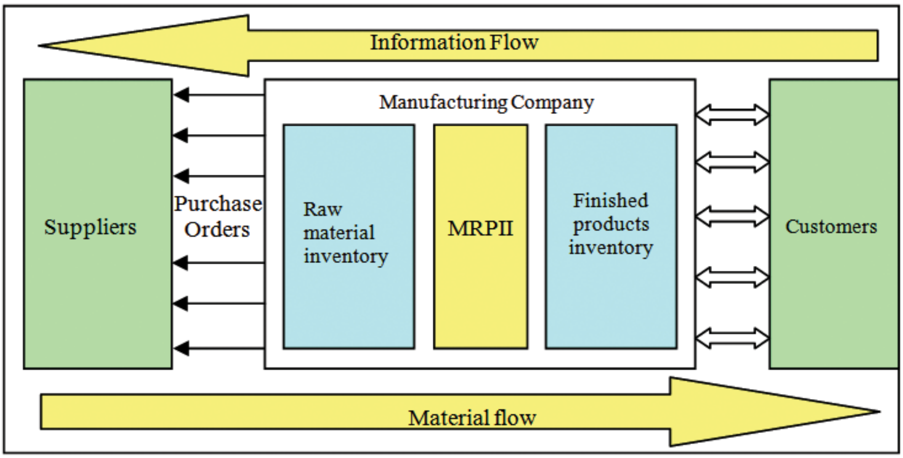

Figure 1 - Traditional Supply Chain

Associated with this scenario, a diagram can be used to capture and describe the main SCM dilemma, and how the SC's partners work trying to solve this problem. Comparing the upper and lower paths of Figure 2, it is possible to verify the divergence between strategies that can be implemented by SC's members to get better collaboration levels (Simatupang *et al.*, 2004). According to Blackstone (2001), in the upper path of the diagram, where each SC's member focuses on the revenues maximization for the whole SC, this goal can be obtained by improving the sales to SC's end-customers. A better SC income will only be achieved through

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a synchronized performance of SC's partners, all of them focused on the global gain and promoting fair gain distribution among them. On the other hand, in the lower path of the diagram, the SC's partners are making erroneous decisions based on a mistaken comprehension in which they are taking great advantage by protecting their own profitability (Blackstone, 2001). This behavior happens because SC's members understand that they "get benefits from collaboration only if their profit margin is enhanced and they are responsible for ensuring high returns to their shareholders" (Simatupang *et al.*, 2004).

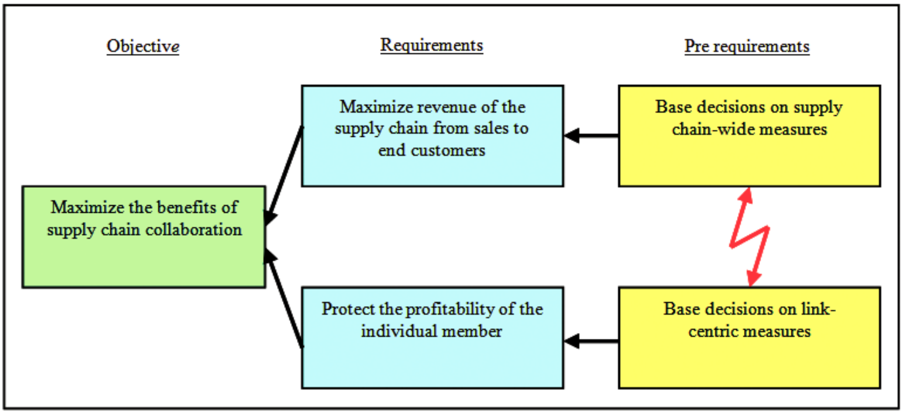

Figure 2 - Supply Chain partners dilemma

A predatory relationship between suppliers and customers can be observed as a consequence from this last behavior. The partner with more bargain power explore the weak one (Simatupang *et al.*, 2004). In fact, this situation confirms that "the traditional approach of the SCM which assumes that each link of a SC can be individually managed fails to maximize the global benefits, that is, to get local optimums does not mean to get a global optimum. Alternatively, the TOC can be adopted by the chain members to help them focus on managing constraints in order to get profitability and subordinating other considerations to this global goal" (Goldratt, 1997). It is not an easy task to convince the SC's partners that the best solution for all SC members is the global and not the individual thinking. This subject is developed in the next section, where the Constraints Management is applied to SCM.

Constraint Management and SCM

"Although the main thrust in supply chain collaboration is to achieve a win-win solution for all participating members, there is often a large disparity between potentials and practice, where collaboration means a power game among the chain members" (Simatupang *et al.*, 2004), as discussed in section 3. The most harmful consequence of this scenario is the excess of inventories in the SC. Why does inventory rise? TOC sustains that, even with the use of conventional tools of the SCM,

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there is still a considerable waste with inventory in the SC as a whole. This problem will be explained in the following paragraph.

With the implementation of SCM tools, instantaneously the plants can get information from their suppliers on inventory levels. Besides, with the adoption of integrated ERP's systems and continuous improvement programs, they are improving quality and productivity with the reduction of supply lead-time. The problem observed by Goldratt *et al.* (2000) is that the supply lead times are being reduced but the same is not occurring with the inventories, once the plants are maintaining inventories levels based on the prediction of consumption. In reality, it is impossible to forecast with precision the consumption of a specific product at a specific region with weeks of advance.

In fact, while the sales forecasting is usually done based on demand time series, the inventory stipulated levels at warehouses are set up based on non-updated data of production capacity and on the average lead time to replace the inventory sold. Simultaneously, a plant starts product manufacturing every time those products are lacking in a warehouse, which attends specific customers. Eventually, there are enough inventories of those products in other warehouses to attend the demand. Therefore, in the plant, for scale reasons and communication failures, the production lots can be larger than the necessary ones, because the plant believes they are needed at all warehouses. This situation becomes worse because, from the logistics point of view, it is better to use a truckload than a less-than-truckload transportation, so that the production lot can be even larger. At the same time, even if the plant is manufacturing larger production lots than necessary, it cannot fall in the trap that the solution is just to reduce the production lots, once the required number of set ups can absorb the plant capability and, at the same time, the inventory levels at any warehouses can be lower and result in lost sales. Unfortunately, these problems are very frequently found in many SCs, and the usual adopted solutions are not so good.

The above discussion explains why the SC's scenario of product inventory excess at some places, whilst lacking product inventory at others, usually occurs. If the inventory reduction is not the solution, then what is the solution? It can be answered based on steps 1, 2 and 3 of TOC 5-step focusing process. Therefore, it can be said that an important factor that avoids a SC from maximizing its profits is the occurrence of unbalanced inventories across the SC. Moreover, it can be said that it is caused mainly by that SC's partner who acts individually and follows the lower path in Figure 2 (SCM dilemma), while the best-recommended behavior would be to contribute to the global optimization. In order to get global optimization, it is relevant to identify who is the SC's partner that would allow to control the product flow and the SC's performance and, at the same time, to determine the best production rhythm on the SC.

It is well known that the accuracy of a forecasting procedure depends, among other factors, on if the goal is to get information (prediction) about aggregated (for a product family, a market region, or a group of customers) or individual sales to end-customers; and the relative position (upstream or downstream, far or near the end-

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customer) of that SC's member who will do the forecasting. So, it is very important to identify who is the SC's partner better qualified to get more accurate forecast to end-customer sales, and therefore the SC as a whole, must adopt its forecast results for production and distribution planning, to calculate inventories levels, to order replenishment, and so on (Goldratt *et al.*, 2000).

Plants are those places which produce for all customers. So, they have to assure the necessary inventories for them so they do not interrupt or do not have problems in manufacturing adequate production lots in order to attend the end-customer's demand forecast. However, this proposal collides with the usual enterprises logistics planning which recommends delivering and keeping inventories near end-customers, in order to avoid sales loss due to long delivery lead times, and often because customers wish to receive the product immediately.

But, by TOC approach, the right thing to do is to assure that when a plant produces to replenishment inventory of a particular warehouse, the excess of product manufactured should be stored at the factory itself, instead of sending products to all warehouses where, in many times, the replenishment is not necessary, as explained before. Since the consumption of the factory inventory is an overall function of end-customer's demand, it is subject to less variability and, at the same time, the factory inventory turnover is significantly faster. As a consequence of that approach, the plants will never have to manufacture small product lots, and besides, they can offer a better service to the warehouses in the SC's downstream, because they can maintain even a daily (or by an other adjusted cycle time) replenishment, if necessary, to each warehouse, using a truck-load distribution scheme (step 2). In other words, the idea is to keep enough inventories (TOC buffer) in the plants and to replenish the warehouse inventories just to attend real sales to the end-customers. Therefore, as TOC step 3 indicates, the SC's product flow control should be subordinated to the factory buffers management. In this way, the total inventory level in the SC as a whole will be significantly reduced.

At last, a new paradigm to be followed by SC's partners could be established in order to assure an efficient implementation of this described TOC's approach: the benefits ($) of the SC's members will be guaranteed only if the products were sold to the end-customers. This paradigm contrasts with the traditional rule usually adopted where each SC's member produces benefits ($) by selling to others partners. In this way, all SC's members should align its goals to a global profitability SC, and the waste in the SC will be lower. Furthermore, it should be elaborated in a common agreement with all SC's members a hierarchical local and global indicators structure (Figure 3) to assure complete visibility of SC's performance for all stakeholders, so that partners can individually assess as well, as seeing their real contribution to the global SC's performance. This indicators structure has to include financial metrics, for instance, inventory-money-day and the gain-money-day. The Figure 3 presents the indicators structure that contains individual and global metrics and proposes a hierarchy between them (Simatupang *et al.*, 2004).

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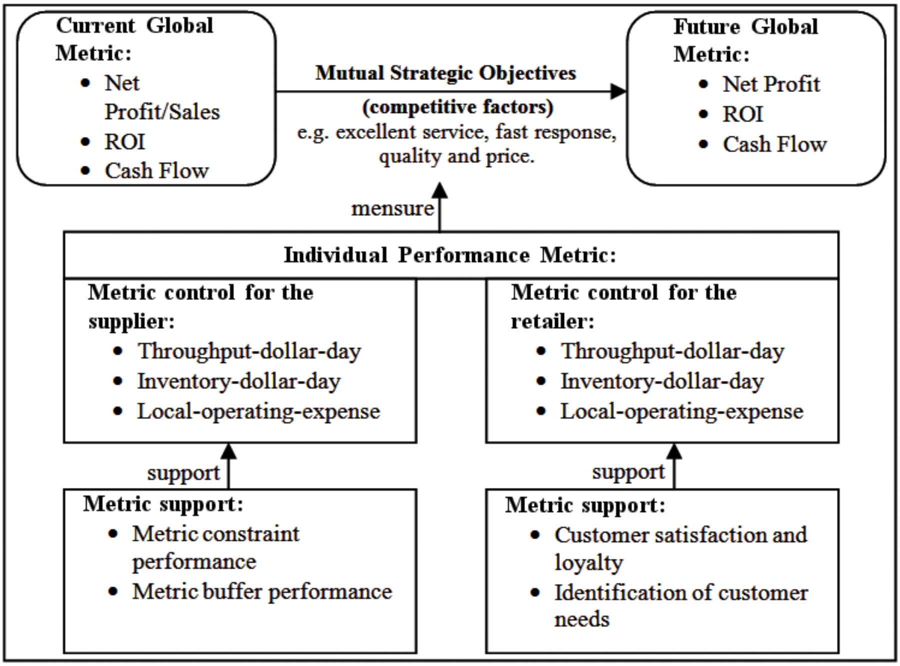

Figure 3 - The hierarchy of collaborative performance metrics

In addition to this, there are other issues and initiatives that can be incorporated to the TOC approach described above, as an alternative (Simatupang *et al.*, 2004). The Supply Chain Council (SCC), a non-profitable organization established in 1996, has developed the SC's operations reference (SCOR) model, intended to be an industrial standard that contains a standard description of management processes, a framework of relationships among the standard processes, standard metrics to measure process performance, management practices that produce best-in-class performance, and a standard alignment to software features and functionality (Huang *et al.*, 2005). The SCOR performance metrics are structured in two levels, where, Level I is based on SC's business strategy; and Level II focuses on: Delivery reliability - delivery performance, fill rates, perfect order fulfillment; Responsiveness - order fulfillment lead times; Flexibility - supply chain response time, production flexibility; Cost - cost of goods sold, total supply chain management cost, value-added employee productivity, warranty/return processing costs; and Assets - cash-to-cash cycle time, inventory days of supply, asset turns. It is very important to remember that the approach proposed here is focused on a make-to-stock SC. In a make-to-stock SC, there is a demand forecasting and the market share can be admitted as constant. In order to avoid the problem associated with the traditional TOC application to SCM, an alternative approach will be presented below.

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Vendor-Managed Inventory and Business-to-Business

Taylor (2004) suggests that managerial systems have parameters or attributes that present a natural variability, even when well administrated. In fact, managers make decisions based on average information about those parameters, such as average daily sales, average delivery time and average productivity. As the variability of these values increases, more complicated the SCM becomes, and, for example, a short delay of an intermediate SC's delivery time could initiate a series of subsequent downstream delays in the SC, and could jeopardize the deadline dealt with the end-customer in an irreversible way.

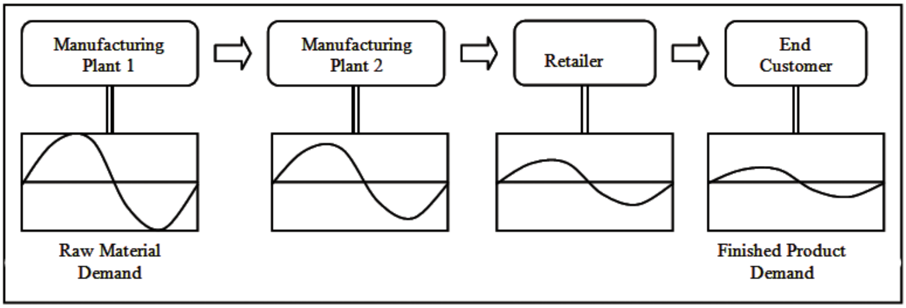

Figure 4 - Amplification of Demand or Bullwhip Effect

The Bullwhip Effect

Usually, the impact of the decisions made on the above scenario is the demand amplification to upstream SC's partners, as presented in Figure 4 (Taylor, 2004). This effect is known as bullwhip effect that causes a negative impact by increasing the level of safety in the inventory and/or damage in the service level, increasing the lack of products. Lee *et al.* (1997a) suggest that four there are main causes of bullwhip effect, reinforcing the need to fight against these causes:

1) Processing of the variations in the demand – a distortion of the demand appears due to the lack of visibility that the suppliers and manufactures have of the real consumption of their products. A way to reduce this aspect is to share the information of consumption with the companies that act in the distribution chain. Even so, the different methodologies of prediction among the companies will maintain the bullwhip effect;

2) Rationing (purchase to prevent shortages) – in situations where there is shortage of products, the tendency is the companies to order larger quantities instead of their real needs. In this case, in order to avoid distorted orders, the manufacturer should share information about inventory and production;

3) Formation of purchase and production lots – the causes for the utilization of lots are the fixed costs of the order, production and transportation, and the

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utilization of "periods of inventory review" without the awareness of the manufacturer about the consumption of its product. In this case, the fight against the bullwhip effect happens through the reduction of the fixed costs of the order;

4) Price variations - the distortions in the flow of materials, caused by the strategies of variations in the price, should be avoided by using other commercial policies, such as the policy of everyday low price. Another alternative is by breaking the contractual link between the purchase and the delivery of the products, so that a great order for obtaining discounts can be divided in several deliveries in future periods.

The Vendor-Managed Inventory (VMI) is pointed as one of the main tools that act to reduce the bullwhip effect, and it has been successfully applied to this goal (Lee *et al.*, 1997a). In manufacturing companies, the VMI implementation is complex and requires some adjustments in the original VMI idea.

Vendor-Managed Inventory - VMI

VMI is a sharing system of information of demand and inventory in the SC. This system favors the reduction of inventory and logistics costs, due to the minimization of bullwhip effect. Disney and Towill (2003) affirm that the bullwhip effect could be reduced or even eliminated by using VMI. The VMI is compared by Taylor (2004) in Figure 5 with two other models: conventional and consignments, both very applied in the 80s and 90s.

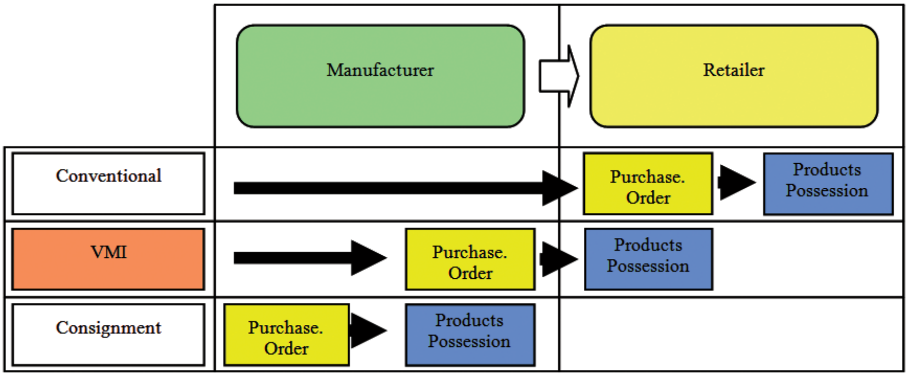

Figure 5 - Illustration of the systems: Conventional, VMI and Consignment

VMI acts in the communication improvement between customer and supplier, minimizing the bullwhip effect; however, it considers only the Outbound Logistics in the relationship of the companies, despising the problems found in the Inbound Logistics. Another constraint for the efficiency of the model is the need of a very efficient communication system, which can be solved with the use of the Internet. Here, it is proposed the adoption of B2B tools and Internet, along with VMI, to solve communication problems.

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Business to Business

The communication among companies has been suffering deep alterations since the upcoming of Internet popularization. This fact has been propitiating the inclusion of companies that did not have access to this technology in the popular electronic trades (Novaes, 2004). With the high-speed Internet, a real time data communication among the companies is available. With the use of gateways, information exchanging systems referring to the business in process among the involved parts became possible. The cost reduction and consequent popularization of the high-speed Internet are making the diffusion of electronic systems in business communication through WEB possible, for the small and middle sized companies. However, the security systems have not developed in the same speed what has been causing great concern to managers that come across the possibility of frauds and loss of privacy, with the risk of immeasurable damages.

The Proposed Approach

Figure 6 shows a proposal approach for this new manufacturers and retailers relationship, denoting where to apply buffer management of TOC to finished goods inventory, in order to control the SCM flow: in the factory, the forecast (including all end-customers) is more accurate, and there is a faster inventory turnover daily replenishment (adopting full truckload) to adjust the cycle time and avoid the bullwhip effect. To keep only strategic (reduced) buffers for daily replenishment forecast (for individual end-customer) is less accurate.

Finally, this article proposed a hybrid SCM system using as base TOC, VMI and B2B tools, generating inventory reduction and consequently a better and easier SCM. This hybrid SCM system was implemented to a medium-size manufacturing enterprise in Brazil, with great structural and financial results for all the SC's partners. It is worth emphasizing that, although the positive results with the implementation of the proposed model have been obtained in a specific segment company, the model should be tested in other categories of companies. Figure 7 illustrates how TOC and VMI integrate all parts in SC from primary suppliers to end customers.

Case Study: Siber do Brasil S.A.

The purpose of this section is to describe the application of a proposed hybrid SCM model based on TOC, VMI and B2B at Siber do Brasil S.A., a middle-size multinational Italian company, related to home appliances line. In Brazil, there are two sites located in the cities of São José dos Campos and Guararema, both in the state of São Paulo. It operates in the electric-mechanic and electronic components market, and it is specialized in the manufacturing segment for high volume of products. These products are: switches plugged into electric cables and electronic components, quartz resistances for grilling process in microwaves and conventional stoves, among others. Its production line is composed by 300 kinds of different final products, using a total amount of 800 components (stock keeping units - SKUs). Notwithstanding Siber do

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Brasil S.A. detaining technological knowledge and strong experience on its trade segment, it needed to improve strategies to promote a customer service Excellency. The main reason for this is the current global and competitive environment which claims the need of the companies not to be limited just at technical and product knowledge.

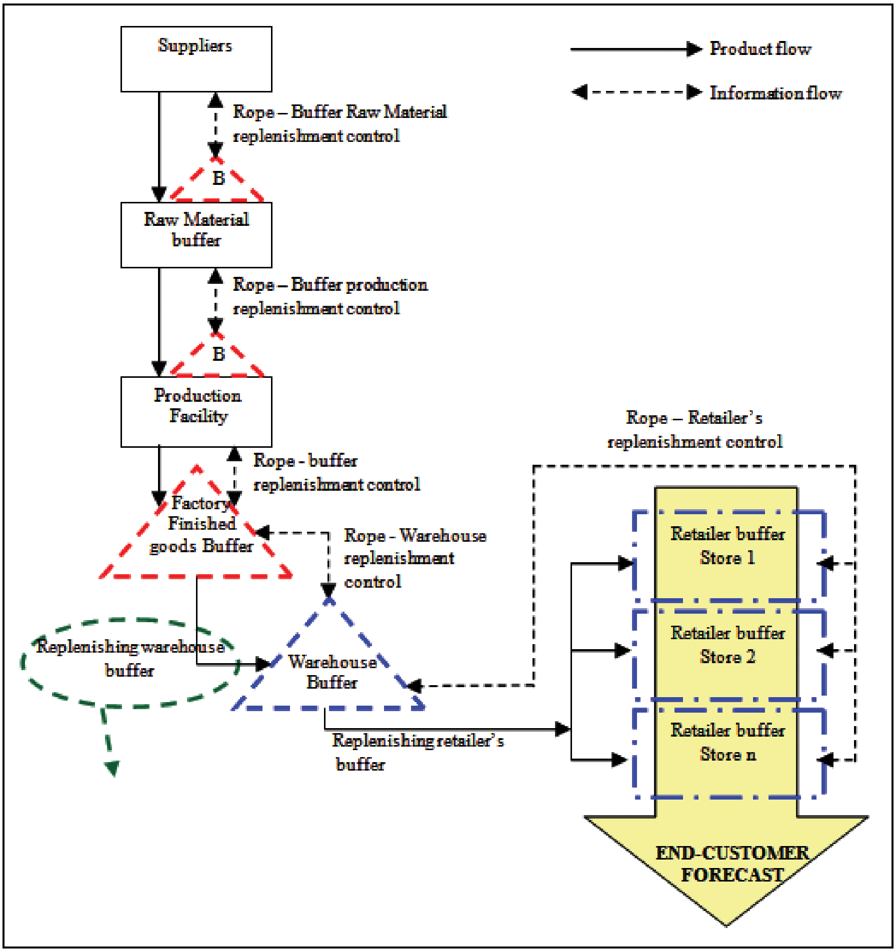

Figure 6 - Proposal for new manufacturers and retailers relationships

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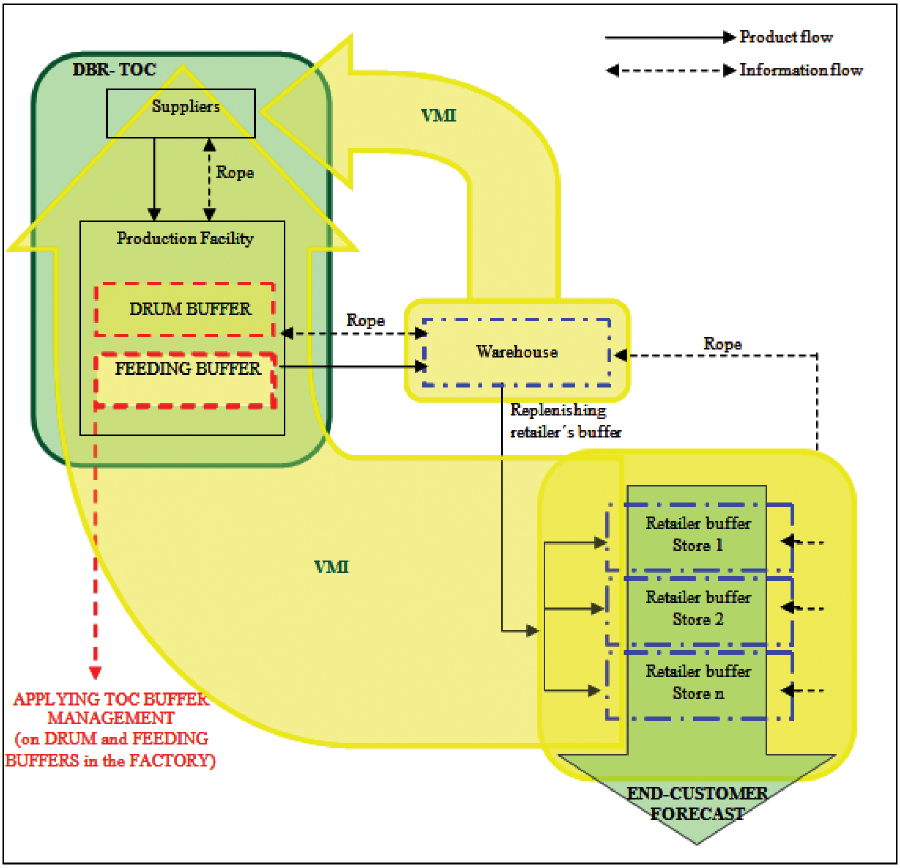

Figure 7 - TOC and VMI in the relationships among new manufacturers and retailers

In the last decade, the scenario was the following: Siber do Brasil was facing result difficulties; it did not have production flexibility with reflex in the long lead delivery times, resulting in constant customers complaints. On the other hand, at Siber, high inventory levels were maintained, but they were not sufficient to guarantee customer's supply. In fact, the ERP (Enterprise Resource Planning) system used in Siber was not satisfying the manager's expectation in facing the new requirements of the market. Besides, the Siber shareholders demanded an immediate hard course change to keep the company investments. One of the first adopted change was to replace the current ERP system with a new one, named Customer Integrated System (CIS). So, while the complete CIS implementation was not finished, the management was partially based on TOC (with DBR concepts), but this new approach was not good enough to solve all management problems. Finally, the complete CIS implementation was finished, including an innovative logistics module with VMI and B2B tools, and the financial results had a significant improvement.

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Method Used to Measure the Results

In this study case, the obtained data of the patrimonial balance sheet and official demonstrations of Siber do Brasil S.A. are used as a final measurement and evaluation of the company´s performance in the face of implementation of the proposed model. As requested by the company´s administration, all presented financial values are proportionally real and not absolute, in order to preserve the company´s privacy, however, at the same time, keeping the fidelity of the analyses.

The New ERP Structure and Implementation Results

The new ERP system is based on the TOC concepts, using several management tools, integrating all company areas and always managing with customer focus. Its operation is a responsibility of the commercial department, to keep the focus on the customer. Figure 8 presents, in an illustrative way, the operation of the model and its interfaces. It should be observed that the supply chain module of CIS is based on the Theory of Constraints (TOC), using specifically the Drum-Buffer-Rope (DBR) model to control the relationship among customers and suppliers. Other important issues are: VMI tools are available for all the SC's partners in an Internet gateway managed by B2B tools, to get complete integration between suppliers, company and customers, coordinating the production processes and inventory levels on the SC.

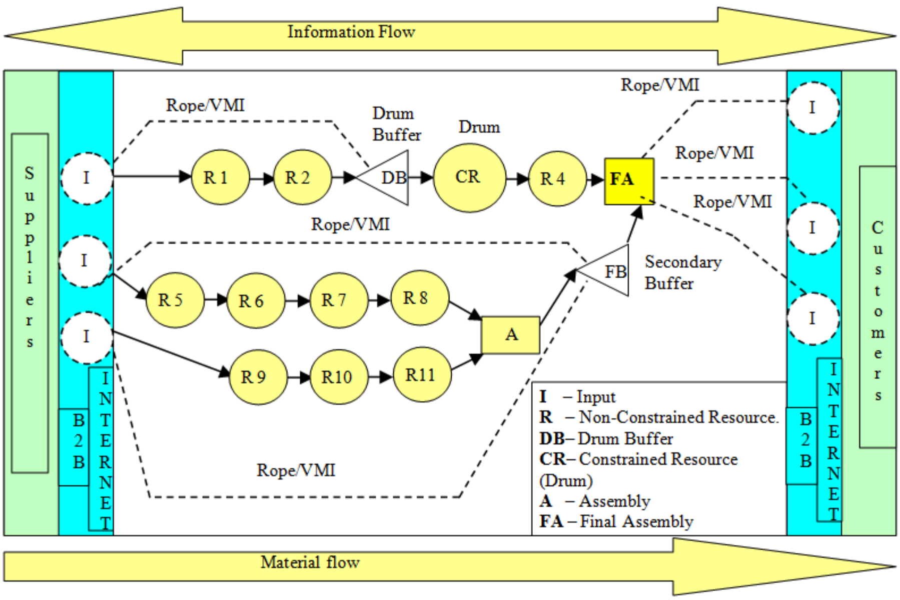

Figure 8 - CIS using TOC, VMI and B2B applied to SCM

It was possible to get integration and visibility of the information among customer, supplier and company through VMI, and as a consequence, there was a

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significant reduction of the bullwhip effect. This model brought a reduction in all inventory level with consequent reduction of the logistics costs, and provoked an impact directly on the final sale costs. To overcome the difficulties found by VMI to manage Siber production planning, the DBR model implementation was very useful. After the identification of manufacturing system's constraints, the model DBR defines a buffer of time to protect the production at bottleneck (CR – constrained resource), and auxiliary buffers in the convergences points of the manufacturing system, in order to guarantee the correct information of the system's synchronism. In the conventional DBR model proposed by TOC, the rope - information that controls the production system and subordinates all manufacturing activities to constraint performance - starts the production process.

In the system, the rope is the VMI tool that synchronizes the Siber's production with the supplier's production, based on end-customer's sales. The interface among Siber, customers and suppliers is done by an Internet gateway, as said before. A possible re-planning of any customer production in the SC starts automatically the DBR system, and informs all the changes to all upstream partners, including Siber and its suppliers. So, all the SC partners immediately receive an e-mail reporting the production planning change, and inviting all upstream suppliers to access the gateway to know more about the alterations. If any supplier does not access the gateway in 2 hours, the system sends e-mails to it in every two hours; including an e-mail to the logistics department of Siber do Brasil S.A. to inform about a possible communication problem with this supplier. This implemented system is demonstrating to be very efficient to the SCM involving Siber, with great inventory and cost reductions; however, in order to work well, the system needs an environment of complete trust among all customers and suppliers on the SC.

In a nutshell, the new performance of Siber SC can be separated in two distinct phases: the first one with the partial use of the CIS system, without implementation of its supply chain logistics model (VMI and B2B tools); and finally, the second one and current phase with the application of the hybrid model TOC, VMI and B2B as described in this paper.

First Phase of Siber do Brasil S.A. – between 1999 and 2002

The new system implementation certainly was the breakthrough point to transform the company culture. This new system, with management philosophy focused on the customer, allowed to expose relevant information of the SC real behavior to the managers. The balance sheet presented the reflex of this condition and Table 1 summarizes the results obtained in this period. They were significant when compared with the previous ones, but very unsatisfactory when taken into consideration the necessary investment to CIS implementation and the barriers originated due to management system interchange. In fact, the new system implementation focused on the customers' needs brought great improvements in the productive processes, resulting in better results indicators. However, inventories were still high, and the shareholders were still unsatisfied.

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Table 1 – Financial Results of SIBER DO BRASIL S.A. (phase I)

Description	Original Results	PHASE I	Market Benchmarking
	1995 ... 1998	1999 ... 2002	
Sales	1915	2800	
Contribution Margin (CM)	1879	2503	
Cost of Goods Sold	36	297	
Net Profit (NP)	-944	-203	
Cash and Banks	-92	-127	
Inventory	775	957	
% CM / Sales	**2%**	**11%**	**25%**
% NP / Sales	**-50%**	**-7%**	**6%**
Inventory Turnover	**2,4**	**2,6**	**4**

Second Phase of Siber do Brasil S.A. – between 2003 and 2007

In 2003 an additional study indicated that with lower investment the CIS could incorporate a new logistics module with TOC, VMI and B2B tools, and the expectation was great with respect to the SC's performance improvements, and the module was implemented. Besides, there was the implantation of other systems, such as: administration of the production through "Lean Manufacturing", cellular production of the type "one piece flow", lesion control system for repetitive efforts in the cells and intensive training, guaranteeing the collaborators' multifunctionality.

The main objective is to avoid the performance indicators of get worse, and assure that the end-customer's needs are being fulfilled. In summary, the results achieved in that last period were expressively better when compared to the previous ones, and they were better than the market average, presented in Table 2. The new management system, with CIS support, demonstrated to be robust and flexible for future evolutions.

Analysis

The best advantages to perform SCM under TOC's rules are: the management is easier, there is more information visibility, and decisions are focused on the causes that consume the buffers that protect the factories and dealers warehouses against delays. In fact, if the SC is subordinated to the drum (factory) and any other resource is more inefficient than it, if the drum's efficiency falls, it will be impossible to recover it. So, protecting the drum means that indirectly all the system is protected. With the described approach, there is a change in the manager's task, that is, instead of being worried about all system variables related to the SC's performance, now they will be just concerned with the constraint management; in this way, they are controlling all

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others variables indirectly by system subordination to the main element that restricts it from increasing its gains.

Table 2 – Financial Results of SIBER DO BRASIL S.A. (phase II)

Description	**Original Results**	**PHASE I**	**PHASE II**	**Market Benchmarking**
	1995 ... 1998	**1999 ... 2002**	**2003 ... 2007**	
Sales	1915	2800	8515	
Cost of Goods Sold	1879	2503	5790	
Contribution Margin (CM)	36	297	2725	
Net Profit (NP)	-944	-203	766	
Cash and Banks	-92	-127	455	
Inventory	775	957	712	
% CM / Sales	**2%**	**11%**	**32%**	**25%**
% NP / Sales	**-50%**	**-7%**	**9%**	**6%**
Inventory Turnover	**2,4**	**2,6**	**8,1**	**4**

In the downstream SC, the situation is as follows: the inventory levels in the regional dealers (located near the end-customers) are determined by the lead-time replenishment, ordered by manufacturing capacity, expedition and transportation from factories. In fact, now the inventories replenishment policy based on sales forecasting of the dealers was replaced by adopting the replenishment just when a good is sold, and the warehouses will make the orders just when their inventories fall down to a minimum level. The replenishment time is more accurate, because all necessary products are available in the factory and equals the delivery time. So it is possible to work with real inventories levels needed, and while they are practically eliminated (Goldratt *et al.*, 2000): all inventories exchanges among the warehouses; the lack of products at warehouses; and the long lead time reply.

Before full CIS implementation, when the factories delivered goods to the warehouses, the SC's performance measurement system rewarded the factories, it did not consider the warehouses needed, nor the goods, so, factories were always rewarded. However, this practice reflected a shortsighted vision, because when anyone on the SC registers a sale at the moment that it sends products to next downstream SC's partner, the entire SC cannot consider that as a sale yet; in fact, a real SC's sale is made just when the last SC link sells to the end-customer. Summarizing the concept, as long as the end-customer does not buy, nobody in the SC sells anything. The SC's performance measurement system must credit an internal sale when the delivery is made to a warehouse that really needs the product. In this perspective, both parts (customers and suppliers) are encouraged to focus on the SC's global gains, once

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their individual profitability depends on their collaborative efforts to increase these same gains (Simatupang *et al.*, 2004). For this purpose, they must also disseminate TOC's concepts to their customers, to their suppliers, and so on, convincing all the SC's partners to improve their operations and collaboration among them, creating a competitive advantage (Goldratt *et al.*, 2000).

Conclusion

In a more and more competitive and globalized environment, it becomes indispensable for industries to have a Logistics Management aligned with the strategy of the company. Siber do Brasil S.A., like many other companies in its industrial segment, needed to redirect their management process breaking the existent paradigm, and implemented new management philosophies that made it possible to redirect the company goals toward the profit and their strategic objectives. In that context, three contemporary models appear: TOC - affirms that global improvements should predominate over the locals ones by the focus on the system constraint, and maintain total attention to the throughput of the company in detriment of the activity costs; VMI - that proposes to transfer the customer's inventory control to the supplier without a loss of customer's control over the ownership of the goods; and B2B - that provides fast and effective communication among organizations and people.

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