The dynamics of Distributor Managed Inventory (DMI) in a fast moving consumer goods (FMCG) supply chain
[004-0652]

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Abstract
The objective of this paper is to analyze alternatives for the coordination of material flows and corresponding information flows in a particular 4-echelon FMCG supply chain.

A new arrangement is proposed, here called Distributor Managed Inventory (DMI), which is significantly different from the more usual Vendor Manage Inventory (VMI) arrangements. The strength of the proposal described in this paper is evaluated in the strategic, economic, financial and dynamic behaviour dimensions. The economic analysis takes into account some particulars of the intricate Brazilian tax system.

Introduction
The supply chain coordination information systems in real supply chains usually encompass no more than one type of link in the chain. Each “link” represents the connection between two consecutive companies, herein called “nodes”. Frequently, one finds coordination information systems that include the manufacturer, as coordinator, and its immediate clients.

One of such systems which has gained increased popularity over recent years is called VMI (Vendor Managed Inventory), a coordination instrument that is usually associated to the link that connects the manufacturer with large retailers in three level distribution channels (manufacturer – large retailer – consumer).

Nevertheless, in the three echelon channel (chain) environment, the manufacturers have faced increasing pressure from large retailers. In many countries these large retailers have gained relative power without precedent because of recent substantial movements towards retail concentration. In many cases such concentration has resulted in the gradual corrosion of the manufacturers’ profitability. On the other hand, the Brazilian independent so-called “small retail” is the segment that is growing most and obtaining more business results at present, showing an actual growth of 11% in 2002 and 5.8% in 2003 (according to ASSOCIAÇÃO BRASILEIRA DOS ATACADISTAS E DISTRIBUIDORES - ABAD, which is the BRAZILIAN ASSOCIATION OF WHOLESALERS AND DISTRIBUTORS, 2003).

This segment is not directly supplied by the manufacturers, but through distributors, in a 4-echelon chain (manufacturer – distributor – small retailer - consumer).

It is understandable that some consumer goods industries in Brazil have recently begun to redesign their distribution systems (SAAB, 2003), re-electing the 4-echelon chain (or in marketing terms, “channel”) as a priority destination for sales expansion and investment. That has been used as an attempt to rebalance the chain’s power equilibrium, that had been unbalanced favouring the large retail.

With the focus directed towards that new channel, some manufacturers tried to adapt to it the information coordination tool matured in the interface with the large retailers during many years and with significant investments, i.e., VMI.

However, once changed to the 4-echelon chain, traditional VMI presents an information quality deficiency: it becomes restricted to the manufacturer-distributor link and segregates retail, which therefore does not participate in the bilateral (some would call dyadic) information flow.

To segregate retail means to leave out of the system the element where the behaviour of the demand can be detected earliest in the chain. Fluctuations in that behaviour increase in amplitude and become more difficult to neutralize upstream in the supply chain due to the so-called “Forrester effect”, or “bullwhip effect”, explained in a later session of this paper.

In addition to that limitation, SAAB and CORRÊA (2005) showed that the transition of an information coordination system between two different configurations of supply chains, namely, from a 3-echelon one to a 4-echelon one, requires adapting (e.g. identifying new leverage and adjustment points) for its appropriate functioning in the new environment. As the typical large consumer products manufacturers normally use dozens of distributors to
cover the territorial extension of a large country such as Brazil, it is possible to imagine limitations of the VMI type traditional systems for such complex supply configuration. It is therefore, convenient to search for a more conceptually appropriate alternative to coordinate the information flow in the chains that consider 4 echelons instead of only three.

Alternatives
A first alternative to be considered is to allocate the responsibility of providing coordination. However, retailers, in general, have as its business focus rendering services to the consumer and it is normally difficult that they are able to use own resources in the necessary infrastructure to perform that job because of their typical small size in a 4-echelon chain. Lastly, we must bear in mind that even a small retailer can be part of hundreds or in some cases even more than a thousand supply chains (it is common for a small pharmacy or drugstore, for example, to have over 4000 different items in its shelves, supplied by hundreds of suppliers, for sale), not having an immediate reason to dedicate large portions of its energy and resources to only one of them.

A second element of the chain to be evaluated is the distributor, entity that in many situations, participates of the smallest number of chains among the three considered here. If it is exclusive, it often participates of only one significant chain. And, ROSENTHAL (2002) assigned distributors an important place in the globalized distribution chain.

However, contrary to the expectation generated by ROSENTHAL (2002) and other authors, in our research we noted that the consumer products’ distributor frequently does not have a guaranteed strategic position in its chain, regardless of its operational efficiency.

This is possibly a consequence of limited bargaining power and consequently reduced return on assets. This can be noticed, for instance, by analysing ADASP’s (Associação dos atacadistas e distribuidores de São Paulo – Association of wholesalers and distributors of São Paulo) recent reports.

Briefly, we concluded that the analyzed 4-echelon chain lacks a concept wise proper information coordinator. Simultaneously, we saw that the distributor frequently needs to find new ways of generating value to assume a more stable position in the marketing channel of which he is part. Thus, this article proposes to investigate the distributor’s ability to carry out the coordination of the information flow in the 4-echelon distribution chain, considering its central position in the chain.

Brief review of the literature
Marketing Channels
Among the areas least understood in the corporate world is the complex grouping of institutions called distribution channel or marketing channel. The channel is the means by which a free market system performs the transfer of products and services property (BOWERSOX e CLOSS, 2001).

The type of marketing channel chosen by each manufacturer for his products is a critical, not very frequent and difficult to change choice (LAMBIN, 2000).

The significant transaction cost reduction provided by specialized intermediaries, such as distributors and wholesalers, is the factor that determines the forming of a distribution channel with the participation of several echelons, besides the manufacturer.
Table 1 – Example of reduction in the number of transactions – illustrative numerical evaluation, using representative number of components in each level of consumer product chain.

<table>
<thead>
<tr>
<th></th>
<th>Direct Chain</th>
<th>Indirect Chain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Manufacturers (n):</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Number of Retail outlets (p):</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Number of direct transactions (n x p):</td>
<td>3,000</td>
<td>1,003</td>
</tr>
</tbody>
</table>

**Transaction Savings**

Reduction in the number of transactions (n x p) - (n + p):

1,997

The indirect marketing systems (LAMBIN, 2000) are those that involve other levels as well as those of manufacturing and consumption and can be long or short. The intermediaries in those channels (agents, distributors, wholesalers and retailers) perform dozens of activities involved in the competitive and free exchange processes, in which an efficient bond between the production and consumption ends is looked for.

The distributor can add a significant set of services to the manufacturer’s products and the resulting value package is supposed to be capable of producing competitive differences in the fiercely competed for and “commoditized” Brazilian consumer product market, eventually creating economic value.

From the distributor’s point of view, an exclusive distribution contract should have a strategic nature: to represent the products of a specific manufacturer, it must trade off negotiating the different competitor’s brands that exist in the market. The theoretic benefit is

**Figure 1 - Marketing channel systems: typical structures of consumer goods chain. That of two levels is called “direct” and the others are called “indirect”. Adapted from ROSENBLOOM, 2002**
that the exclusivity provided in the contract constitutes a comparative differential. In practice, as a result of the difficulties that the manufacturers find to coordinate their business policy through the other marketing channels (key accounts, delivery wholesales, cash and carry wholesales, direct sales, and the like), they cannot keep the exclusivity promised, making the contract a relatively risky instrument for the distributor. The above mentioned interchannel coordination difficulties have various origins: they can be internal to the manufacturer (complacency, need, moral hazard, etc.), or exogenous, such as the complex Brazilian tax regime and in rare situations, less honourable market practices.

Supply chain management (SCM)
According to POIRIER and REITER (1997), the supply chain is a network of interlinked organizations or components, whose objective is the best possible means to influence the delivery of products and services produced by that system to their clients.

To improve the efficiency of a chain is to improve the efficiency of its nodes (companies’ internal environment) and of its links (interfaces between two consecutive companies in the chain).

After the internal reorganization movements, the corporations turned towards the outside environment: The 90 first years of development of operations management techniques of the XXth Century were almost exclusively directed towards the performance improvement within the supply chain nodes and the result was that the marginal costs of incremental improvements in performance within the nodes (companies) reached fairly high levels, due to the effect of diminishing returns (CORRÊA, 2003). In the chain, the main flow of products, predominantly unidirectional, requires information coordination flows working in parallel. Flows include goods, orders, payments and, mainly, information (LAMBIN, 2000).

Among the basic objectives sought for related with integration in supply chains are: meeting demand without stock shortage, demand predictability and minimizing stocks along the chain.

Governance structure in the supply chain
The diversity and complexity of the relations in the channel make it difficult to describe and generalize the challenges faced by executives when developing widespread strategies for the channel (BOWERSOX and CLOSS, 2001).

According to POIRIER and REITER (1997), a supply chain should have an element that integrates the members, if not the chain will have little substance - frequently and unfortunately, that element is the degree of influence of the position. The more powerful members simply impose their force on the weaker participants and extract unjustified concessions to guarantee the continuity of the supply [...]. Such circumstances only weaken the chain, according to both authors.

SOUZA (2002) proposed a model in which the cash flow appropriation capacity by the channel members is a result of the way in which the transactional governance structure is built in relation to the individual sources of value generation, power and degree of dependence among them. The author states that there are two lines of thought to justify the decision of integrating or outsourcing a marketing channel arrangement: the agent theory and the transaction costs theory.

Collaboration in the supply chain
The bidirectional information flow that allows the generation of value along the chain depends on a relationship of trust to be previously established between the links of the chain. Trust is crucial to the process, since strategic and business information is shared.

According to POIRIER and REITER (1997), partnership is an association of parties acting
in mutual benefit; a process by which the parties involved establish and maintain a competitive advantage over similar entities, by joining resources and in an atmosphere directed to mutual and continuous improvement.

The long term interactive perspective affects the probability of cooperation (OYE, 1985), therefore strategies that lengthen the interaction horizon should be preferred.

**Forrester or “bullwhip” effect**

With FORRESTER (1973) studies, a deeper understanding of the dynamics involved in the flows of capital, orders, information, materials, people and goods, which are established between the links of a supply chain, was possible.

In his honour, the dynamic behaviour inherent of the chain characterized by the demand variance increase at the levels upstream from the consumption outlet, when any disruption is introduced in the normal sales rate, is sometimes called ‘Forrester effect’.

FORRESTER (1973) uses a production-distribution structure of durable goods (home appliances) to show how the format and policy of an organization can give origin to characteristic and undesirable behaviour attitudes:

- Small changes in retail sales can result in large fluctuations in the plant’s production.
- Reduction of administrative delays can be insufficient to significantly improve management decisions.
- A plant manager can be unable of fulfilling orders even when capable of producing more goods than what is being sold to the consumers.
- An advertisement campaign can widen the production variances.

Among his various conclusions and proposals, a threat to the distributor and other intermediaries derived from his studies: FORRESTER (1973) proposed and simulated, as a way to mitigate fluctuations, the elimination of the node represented by the distributor, showing that the instability can be reduced by eliminating intermediary levels (or echelons) from the chain. Thus, from the dynamic point of view, a smaller number of echelons (or levels) in the supply channel would be desirable.

**The market “disintermediation” risk**

In spite of FORRESTER’s (1973) simulations, the distributors continue more active than ever in the globalized world market, even after over 30 years of the publication and intense discussion of his work. It can be argued that his analysis is of a pure dynamic nature and, in spite of its great importance, omits economical aspects such as the transaction cost, which seems the be one of the most important determining factor of the corporate and chain structures (MILGROM and ROBERTS, 1992).

A more serious threat of disintermediation appeared with the advance of hardware, software and telecommunications infrastructure, which have substantially reduced the transaction costs and made it possible to increase the direct interaction (via e.g. the Internet) between distant elements in the chain (e.g. manufacturer and consumer). In spite of the intense changes, “[...] the belief that the web would eliminate the intermediaries of the various business processes finished up being considered one of the Internet myths, which has not gotten confirmed as a reality [...] the disintermediation which already occurred and still will occur is related with the chain’s links that do not add value and simply join two ends” (ALBERTIN, 2001).

The same author also foresees the disappearance of some types of intermediaries as a result of the globalization and the appearance of new types of intermediaries, transaction facilitators in the new reality: “The simple intermediation competence, even if electronic, is destroyed, and the value adding competence in intermediation must be built”.


Vendor Managed Inventory (VMI) and its results

To soothe the problems of the supply chain’s typical demand volatility caused by the Forrester effect, many companies set out efforts toward increasing the integration of the chain [...] via information system integration. Those initiatives are various and known as for e.g. Electronic Data Interchange (EDI), Efficient Consumer Response (ECR), and Vendor Managed Inventory (VMI) (STERMAN, 2000).

According to STERMAN (op. cit.), all those policies are part of a general trend towards the lean-manufacturing and just-in-time movements and the objective of each one is to solve a different problem of the supply chain. The VMI philosophy is that the manufacturer manages all the supply chain and determines the quantity of product to be sent at each step, eliminating the need of clients to order material. Therefore, it is a planning and management system that is not directly linked to the ownership of the inventory, implying that the nodes of the chain must work under strict collaboration and with high levels of reliability. In practice, the working of VMI is controversial. Below are but some examples of the controversy that the theme causes:

“Nearly a year after its implementation, one of the most promising and daring ECR initiatives was finalized. The Spartan chain announced it was leaving the project that its executives described as Vendor Managed Inventory (VMI)” (MATHEWS, RYAN; 1995).

“Those initiatives of the industry – ECR, VMI, CRP and QR – failed in completely solving the requirements of the companies that produce and distribute products as the initiatives were not specifically developed for particular industries. Those techniques do not coordinate the demand and supply processes, which are the main issues where manufacturers and distributors need to coordinate requirements and restocking. As well, the processes do not include different business partners that use other conventional practices or systems” (SIMBARI, 1996).

“Officially, the acronym VMI refers to Vendor Managed Inventory. However, about 15 years after its introduction, the initials could also mean ‘Very Mixed Impact’. In spite of some businesses having implemented the practice of VMI, others are abandoning the concept.” (COOKE, 1998).

“Many reports published have described VMI’s benefits, which include from more economical launches of products up to less replacements because the validity is overdue, but the literature frequently does not explain why those benefits result from the VMI. As occurs with other management theories, it is difficult to distinguish actual results from the exaggeration, as well as it is difficult to determine how those results could be reproduced in other situations.” (WALTER et al, 1999).

“Through the understanding and management of costs and risk control by means of careful negotiations, it is possible to make both VMI and consignment work not only for the client, but also for the supplier” (WILLIAMS, 2000)

Savings in the supply chain

The objective of the supply chain management is primarily to offer adequate value to the consumer and the maximum return on assets for its participants, by managing effectively the flow of materials, information and financial resources (REIS, 2003).

The return on assets (ROA) results from multiplying the Net Profit Margin by the Asset
Turnover, for any node in the chain.

In the specific case of the exclusive distributor of the four-echelon chain, the margin is fixed exogenously (the cost is fixed by the manufacturer and the sale price by the competition’s conditions), so what is left for the distributor is to work on its own fixed costs and on its assets turnover.

As turnover is defined as the ratio between the flow and the average inventory, a great pressure exists to reduce levels of inventory. However, the cause and effect diagram below shows that, with time, the direct effort to reduce inventory may in fact aggravate the problem. Therefore, the reduction of stocks cannot be seen as the main action point, but as a consequence of actions on the chain’s larger leverage points.

According to KIRKWOOD (1998), practical experience has shown that to modify the information links in a business process can have deep impacts on their performance. That suggests that the real key to providing more efficiency to the system can be in the way supply chain’s information flow is carried out and coordinated.

![Figure 2 - The direct pressure to reduce the stock excess is self-reinforcing. Reproduced by permission of Sterman, J. D. (2000). Business Dynamics: Systems Thinking and Modelling for a Complex World, Irwin/McGraw-Hill. ISBN 0-07-238915-X, p. 753. All rights reserved.]

Modifying the Vendor Managed Inventory (VMI) system.

Based on the arguments built in the introduction and on reviewing the literature, we propose to analyse the feasibility and appropriateness of a system in which the distributor plays the role of information flow coordinator, in the “downstream” portion of the supply chain, i.e., at both links that involve the manufacturer, the distributor and retail.

Briefly, the proposal, which we will call Distributor-Managed Inventory (DMI), includes the following aspects:

? The distributor would have access to data related to sales to the consumer, emanating from the outlets it serves, very frequently (possibly on line);
? The distributor would calculate the replacement quantities needed at the outlets in order to maintain the high service level and turnover, as well as to guarantee the inventory safety level agreed with each retailer;
? The determined quantities and mix would take into account macro-regional trends, such as seasonality, and micro-regional trends, identified by the data on sales of the other clients of that micro-region;
? For there to be a really efficient bond between the sales to the consumer and the stock replacement, the DMI process should be necessarily supported by an IT system and executed by a highly efficient distributor;
? In the distributor–retailer link, the system should be able to accommodate various trade transaction modalities, from the traditional sale to the inventory’s complete
consignment;

? The strong bond between retailer and distributor would have the purpose of reducing stock shortage, reducing stocks, increasing the Turnover and reducing the Forrester effect, as the link would become only one “virtual” node.

? The “push” chain would become a “pull” chain since the quantities of products sent to the distributor would be determined by the latter, based on sales made to the consumer with a dynamic continuous replenishment logic; and,

? The distributor-retailer link would work in a collaborative manner, as only one node, regarding information, therefore, not contributing to widen further the demand variances detected in retail. This would also allow a more economical planning of the production resources by the manufacturer.

The proposal of a decision model (DMI) appropriate for the 4-echelon SCM environment
The traditional models to evaluate investments take into account the capital value varying along the time and the necessary returns under various aspects. Some more modern proposals try to quantify the intangible portions of value to include them in the analysis\(^a\). However, a problem that involves the supply chain must also be evaluated regarding the impact that the dynamic responses will bring to the economical and financial dimensions. Additionally, the new arrangement proposed must be stable, i.e., must not lead the chain to show an ever increasing amplitude or frequency of the typical oscillations it presents.

Thus, a complete evaluation model for decisions in the supply chain must necessarily contemplate all the following aspects:

? Initially, check that the proposed transformation is aligned with the company’s and the channel’s strategy;

? Secondly, the transformation must be tested and “approved” in a dynamic simulation of the chain’s behaviour, which must show the maintenance or reduction of the amplitude and frequency shown before the modification; and,

? Finally, the proposal must be analysed regarding the economical and financial aspects, using the most appropriate parameters for each case. In the present case, the measurements chosen are: Contribution Margin and Turnover.

Analysis of a particular case
The particular supply chain to be analysed is part of a network that involves a multinational consumer goods manufacture established for many decades in Brazil, one of its 7 exclusive distributors in the State of São Paulo and the retailers served by this particular distributor. A detailed description of the strategy and structure development of the specific Manufacturer of this particular chain can be found in SAAB (2003).

In the channel restructuring, carried out by the Manufacturer in 2001, the distributors were given the status of “strategic partners” in the consecution of the long term objectives and with that the “connectivity” project begun, having in view the implementation of Vendor Managed Inventory (VMI). Four years later, only two of the over forty domestic distributors have the VMI system in operation, and precarious ly, without attaining the desired chain coordination objectives, up to the date this paper was written.
A strategic value analysis of the proposed model (DMI)

We will use PORTER’s (1999) competitive pressure diagram (adapted), to guide us in the analysis of the main competitive pressures existing in the interfaces between the market and the Distributor under analysis.

Regarding the Suppliers (Manufacturer) issue, the aspects that exercise pressure on the latter, reflecting on the Distributor, are:

- Pressure from the Corporation for high profitability in the consumer goods line of the Subsidiary (Manufacturer), to finance other divisions of products that are undergoing fast growth;
- Difficulty of the Manufacturer in generating productivity gains, as a result of the Corporation focusing more on other divisions’ portfolios; and,
- Exchange rate disadvantage.

In this link of the chain (Manufacturer – Distributor) there can be an aggravation, at least in the short term, of the relationship with a possible implementation of the DMI system, since in the VMI the Manufacturer is who determines the quantities and time of the logistics operations. However, in the medium and long term, an increase in sales, mitigation of back orders and stock-outs and lower production costs of the Manufacturer (this will be shown in the dynamic analysis discussed later in this paper) would be verified. The new role of the Distributor would allow the Manufacturer to focus on reducing costs and continuous differentiation of products that is usually required from the participants of the consumer goods market. The conclusion is that the Manufacturer would also benefit from the process, in the medium term, easing the initial possible interface tensions.

The New Entrants issue also is important in the context. As the Manufacturer is in the “harvest” period of its product line, re-investment in the same line is very limited. That implies progressive ceding of room for new incomers. The main risk comes from the competitors who place themselves in the lower price strategy, since the Manufacturer competes in the premium segment and the expansion in the Brazilian consumer goods market occurs mainly at the base of the social pyramid, either because of the increase of income of the less privileged classes or because of the middle class contraction phenomenon, which replaces the higher cost products adopting lower price similar ones.
It is plausible that the dissemination of the DMI system throughout the outlets could enhance “loyalty” of the outlets to the products sold by the Distributor, as a result of the services that come with the value package, specially the inventory management guaranteeing the turnover increase and security against shortages, which will make the entry difficult of substitute products via another distribution chain that uses the same retail outlet.

Additionally, the peculiar organization of the Chain’s activities that allows generating value remits to PORTER’s (1999) fit concept. According to the author, a business strategy must reflect first the choice of a set of activities allowing for a differentiated position for the company, providing it with quite a long lasting competitive advantage.

Regarding the Clients issue, the Distributor currently faces a consolidation wave that increases the retail bargaining power in the interface. The results (at least so far) of this wave do not seem to have matched the capability of the independent retailer establishments to generate value.

The small retail that became professional (but remained independent) and adopted more modern management rules, layout and services to the consumer is not only surviving but growing more than the networks resulting from the consolidation wave.

The pharmacy market of the United Kingdom shows the same long term ownership concentration trend (ORTENZI, 2000) as the Brazilian market. In that market, research work by ORTENZI (2000) tried to identify supply opportunities of retailers in the health segment.

Among the general conclusions of the research, ORTENZI (2000) reports the ranking of the preferred services, according to the importance given by the pharmacies:

Table 3 – Ranking of the importance of services rendered by the Distributor, as seen by the pharmacies of the UK. Source: ORTENZI (2000).

<table>
<thead>
<tr>
<th>Service</th>
<th>Importance (1 - less to 5 - more)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information on stock availability</td>
<td>4.71</td>
</tr>
<tr>
<td>Punctual delivery</td>
<td>4.67</td>
</tr>
<tr>
<td>Delivery frequency</td>
<td>4.63</td>
</tr>
<tr>
<td>Help desk response time</td>
<td>4.57</td>
</tr>
<tr>
<td>Competitive discounts</td>
<td>4.47</td>
</tr>
<tr>
<td>Transparency in trading terms</td>
<td>4.06</td>
</tr>
<tr>
<td>IT System support</td>
<td>3.83</td>
</tr>
</tbody>
</table>

ORTENZI (2000) also reports the main deficiencies identified in the Distributors’ operation, according to the same research:

Table 4 – Opportunities to improve distributors’ service. (ORTENZI, 2000)

<table>
<thead>
<tr>
<th>Distributor deficiency</th>
<th>% of the researched Pharmacies where the problem was detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of information on stock/ shortage.</td>
<td>22.0%</td>
</tr>
<tr>
<td>Low discounts for generic drugs.</td>
<td>8.4%</td>
</tr>
<tr>
<td>Does not know the discounts.</td>
<td>2.0%</td>
</tr>
<tr>
<td>Bad service to the client</td>
<td>2.0%</td>
</tr>
<tr>
<td>Minimum order value</td>
<td>1.3%</td>
</tr>
<tr>
<td>Supply frequency</td>
<td>1.3%</td>
</tr>
<tr>
<td>Pays more attention to his own retail chains</td>
<td>1.3%</td>
</tr>
<tr>
<td>Overdue deliveries</td>
<td>1.3%</td>
</tr>
<tr>
<td>Oriented towards profit and not the patients’ problems</td>
<td>1.3%</td>
</tr>
<tr>
<td>Not established on the WEB</td>
<td>1.3%</td>
</tr>
</tbody>
</table>
Note that the three services highlighted as the most important, *information on stock availability, punctual delivery and delivery frequency*, are directly affected by DMI. Additionally, the largest opportunity indicated by Ortenzi’s (2000) research is the reduction of shortages, one of the main DMI objectives.

The DMI proposal also has additional advantages. Attributing the information flow coordination responsibility to the distributor, the process releases the manufacturer to focus on its core activities. Of the three nodes analysed, retail has consumer service and the manufacturer has production as natural core activities. Control and automatic stock replenishment of the small retail would, then, appear as the distributor’s core activity. In addition, the information coordination with hundreds of outlets would certainly require the use of IT and telecommunication infrastructure, converting old threats of disintermediation into instruments to generate value and solidify the Distributor’s position in the chain.

In short, DMI is a strategic value proposal, which purpose is not only to deliver the necessary and sufficient products at the right time, but make the distributor fully responsible for the *retail* inventory management, releasing the retailer’s resources to take care of its core activity, which is customer service.

**A dynamic analysis of the proposed model (DMI)**
With the help of VenSim® software, a dynamical model representative of the 4-echelon supply chain discussed herein was created. A model representation is shown in figure 4. A loose coupling situation (greater delay) regarding the information flow between the Distributor-Retailer (VMI) and a rigid coupling situation (shorter delay) between them (DMI) were simulated. Then, during 50 weeks, the chain’s dynamic response for both situations was simulated, with initial stocks regulated at the minimum value necessary for there not be shortages. The stimulus that allows the system’s behaviour analysis during that length of time occurs on the tenth week of simulation, in the form of a 20% sudden increase (step function) in consumer demand.

**Main Results of the dynamic analysis**
The behaviour during the time period regarding the Retailer’s and Distributor’s stocks, as well as the Manufacturer’s production, is shown in figures 5, 6 and 7.

**A rough economic analysis of the proposed model (DMI)**
To analyse the operation finances of a typical distributor of the State of São Paulo, Stock Turnover and Contribution Margin metrics were chosen. Contribution Margin has the propriety of allowing comparisons among different companies regardless the fixed costs structure of each one, making it easier to reach generable conclusions.

The premises and details of the economical and financial analysis can be found in SAAB (2003). Considering the typical 20% Gross Margin in this type of chain and subtracting from it the Variable Expenses (taxes, freight and commissions on sales) the Contribution Margin is equal to 3.57% on every sales operation. With that gross result, the considered distributor must pay for the fixed expenses of his organization, depreciate the investments made on infrastructure and generate a return on the investment above the opportunity rate. During the period of one month, the multiplication Contribution Margin x Turnover must pay for the fixed expenses and generate the expected return on assets.
Figure 4 – Diagram of the DMI stock and flow model proposed for the particular Supply Chain analysed. The equations that represent this dynamical model and all its parameters can be obtained in SAAB (2003) to allow the reproduction of this simulation.
Considering that the Distributor is part of the Supply Chain and that the relationships should be balanced and long term, it would be plausible to suppose that the Return on the Assets invested

Figure 5 – In the VMI case (indicated as “model 17” in the graph), when subjected to a 20% demand increase in the 10th week, the minimum initial retail stock to avoid shortages is 89 units. As the DMI model operation is more stable, 56 units of stock are enough to face the same demand shock. When the system becomes stable, around the fiftieth week, the stocks are 29 items in the VMI system and only 13 in the DMI system.

Figure 6 – For the Distributor, the VMI (model 17) requires a minimum initial stock of 108 for there not to be shortages with the sudden 20% increase in demand. On the other hand, with the DMI model, 89 units are enough. When the system becomes stable, around the fiftieth week, the stocks are 54 items in the VMI system and only 36 in the DMI system.

Figure 7 – Note that with DMI, the situation also improves for the manufacturer. The production at the plant responds earlier to the demand’s fluctuation and reaches lower peaks. The production curve becomes more flat, in general.

Considering that the Distributor is part of the Supply Chain and that the relationships should be balanced and long term, it would be plausible to suppose that the Return on the Assets invested
would be similar for every node of the chain. If the average ROA is used as reference in the 2000-2002 triennium Manufacturer’s consumer products line, we will have an annual value of 22.13\%^{viii}, or 1.29\% per month.

In spite of the particulars of that analysis, it is possible to say that only two parameters show a significant variance for the 7 distributors that operate for the same Manufacturer in the State of São Paulo, Brazil: Fixed Expenses and Assets. Therefore, to make it easier to extend the analysis conclusion to this small group, an estimate of the Turnover and Assets value range that would meet the requirements of every one of them was pursued.

The Fixed Cost of the distributors’ group was estimated in the range between 7\% and 11\% of the billing\textsuperscript{ix}, and the Assets were estimated between 50\% and 200\% of the monthly billing, in 2003.

With those variables, a sensibility study (SAAB, 2003) was carried out, which showed the need of the Turnover to be between 2.14 and 3.80 per month, or 0.54 and 0.95 per week.

The Manufacturer’s present inventory policy for the distributors is in the range of 40 selling days, i.e., the present turnover is 0.75 per month or 0.19 per week (from 3 to 5 times less than necessary). The turnover and inventory situation calculated for the VMI and DMI systems, by the dynamical simulation carried out, is as follows.

Table 3 – Turnover and stock variation in a VMI model (model 17) that represents the specific chain studied, and in the DMI model proposed. All the comparisons are made on the 50\textsuperscript{th} week of the simulation, therefore, with the system stabilized.

<table>
<thead>
<tr>
<th></th>
<th>Present system</th>
<th>VMI (Model 17)</th>
<th>DMI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distributor</td>
<td>Retail</td>
<td>Distributor</td>
</tr>
<tr>
<td>Sales (unit/week)</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Stocks (unit)</td>
<td>632</td>
<td>29</td>
<td>54</td>
</tr>
<tr>
<td>Turnover (1/week)</td>
<td>0.19</td>
<td>4.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Turnover (1/month)</td>
<td>0.75</td>
<td>16.6</td>
<td>8.9</td>
</tr>
</tbody>
</table>

Conclusion on the particular case

If the premises of the model are representative and both the VMI and DMI systems could be implemented, in practice, in 4-echelon supply chains, both have the potential to increase the distributor’s Turnover to monthly values greater than (8.9 and 13.3, for VMI and DMI, respectively) the estimated necessary period [2.14-3.80] for a ROA of 1.29\% p.m.

However, in addition to the violated conceptual aspects with the implementation of VMI in the 4-echelon environment, DMI will allow the assessed chain to face demand peaks of 120\% with stocks 55\% smaller at retail and 33\% smaller at the distributor.

As well, as the physical and logistical barriers can be surpassed by using technology, DMI will allow attaining a Turnover 100\% greater at retail and 50\% greater at the distributor, when compared to VMI.

As shown by the dynamical analysis, DMI would also have advantages for the manufacturer. Its faster identification of demand fluctuations would allow a faster production planning and supply of the other levels.

The DMI system integrates the distributor to the retailer in such a manner that everything happens as if the chain shrunk lengthwise, meeting, for practical effects, FORRESTER’s (1973) recommendation to reduce fluctuations in the chain.
Discussion on generalization

The specific characteristics of the chain analyzed are: 4 echelons, consumer products, exclusive distribution, taxes of the State of São Paulo, 20% Gross Margin, 2.5% freight cost, 6% commissions and charges on the income of every sales transaction.

In spite of the large number of specificities, apparently many of the consumer products distributors of the State of São Paulo are in a similar situation to that discussed. That can be confirmed in association meetings periodically promoted by the ADASP. That association discusses the particular limitations of Sao Paulo’s distributor and frequently proposes projects to reverse or lighten common difficulties, be it of taxation, merchandising or even power asymmetry.

The result of the analysis presented in this paper could be extended to the Manufacturer’s 7 distributors that operate in the State of São Paulo, with little or no adaptation, especially because the Fixed Expenses and Assets ranges that include the reality of every one of them were considered.

More serious limitations to generalization of the conclusions come from the information relationship models used to assess the VMI and DMI performance among the entities of the Supply chain. As shown by SAAB and CORRÊA (2005), each chain is a particular combination of many activities, difficult to be reproduced and many times with different dynamical leverage points. Therefore, it is not the intention of this paper to propose that the results presented herein are easily generalized to any other Supply chain with information details different from the model proposed.

The conclusion allows us to state, however, that whenever a 4 echelon chain is a candidate to work under VMI, it will probably be able to work under DMI with advantages, since the differences between the models are not only numerical but, mainly, conceptual. In DMI, the dynamics occur as if the 4-echelon chain were again reduced to a 3-echelon chain, but the greater value generation of the 4-echelon chain and the quality of information obtained at the retail outlet are preserved, to minimize the system’s fluctuations.

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