Optimising performance with distributor managed inventory in a FMCG supply chain

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Abstract: This paper deals with the flow of information and material throughout a four-level Fast Moving Consumer Goods (FMCG) supply-chain. We conclude that under certain circumstances, the coordination of information and material flows along the supply chain should be done by the distributor, in an arrangement called Distributor Managed Inventory (DMI), a significant departure from the more traditional best practice concept of Vendor-Managed Inventory (VMI). We analyse a DMI model from both the strategic and the economic perspectives and also analyse its dynamic behaviour by using a numerical simulation model built for this specific purpose. Our dynamic analyses revealed that the DMI model is stable, and its simulation study showed, in terms of performance measures, that the analysed four-level supply chain could cope with increments of 20% of the normal demand level with 55% less inventory at the retail level and 33% less inventory at the distributor level than a reference VMI model.

Keywords: supply chain management; retail; Distributor Managed Inventory; DMI; systems dynamics; inventory reduction.


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### 1 Introduction

The achievement of excellence in supply chain management is very difficult without appropriate levels of supply chain integration (van der Vaart and van Donk, 2008). The basic objective of supply chain integration is to fully meet demand, with no lack or excess of products. The objective is facilitated by adequate levels of predictability and at the same time, a minimisation of the fluctuations that characterise supply chain dynamic behaviour (Lee *et al.*, 1997). The policies, known as Electronic Data Interchange (EDI), Efficient Consumer Response (ECR) and Vendor-Managed Inventory (VMI) are examples of specific integration initiatives which aim to lessen such fluctuations and are part of the general trend towards the lean-manufacturing and just-in-time movements (Sterman, 2000).

Our study focuses special attention on the VMI policy, which assigns to the manufacturer the task of managing the inventory of the company that is located immediately downstream on the supply chain (often a retailer), establishing when and how many of each product must be sent to its immediate customer. VMI, therefore, is a system in which the manufacturer’s client relinquishes the control of its own inventory, implying that such link of the chain must operate under tight collaboration and trust (Correa and Correa, 2006).

In spite of the appeal that such a form of integration has from the viewpoint of the manufacturer, the literature suggests that the success of VMI has been, in the least, controversial:

> “By understanding and managing the costs, and controlling the risks through careful negotiations, one can make both consignment and VMI work not only for the customer, but for the supplier as well.” (Williams, 2000, p.63)
“[…], unless the retailer provides additional information to the distributor to resolve the uncertainty, higher levels of uncertainty in market demand create significant reductions in the savings realized by VMI.” (Sari, 2007, p.529)

“Almost a year to the day since its inception, one of wholesaling’s most progressive and promising efficient consumer response (ECR) initiatives have been shut down. Spartan Stores announced […] it was closing the door on what some called its continuous replenishment program (CRP), a program Spartan executives always described as their vendor-managed inventory (VMI) effort.” (Ryan, 1995, p.64)

“Officially, the acronym VMI refers to vendor-managed inventory. Today, however, some 15 years after its introduction, the initials could also stand for very mixed impact. Although some businesses are going ahead and implementing the practice of VMI, others are retreating from the concept.” (Cooke, 1998, p.51)

“Various published accounts have described VMI benefits that range from cheaper new product introductions to reduced returns at product end-of-life, but the literature often fails to explain just why these benefits have resulted from VMI. As with many new management theories, it is sometimes difficult to distinguish the achievable results from the hype, just as it is difficult to determine how these results might be replicated elsewhere.” (Waller et al., 1999, p.183)

Apart from the literature, the authors observed first hand the frustrated effort when implementing a VMI type system, in Brazil, by a multinational manufacturer of consumer goods. The stymied effort by the manufacturer motivated the authors to:

- research in greater detail the nature of the interactions of supply chains in general and of the analysed chain in particular
- propose an integration model that would have greater chances of success.

In the initial phase of the investigation (a) – the chain dynamics – was longitudinally followed for three years. A conclusion from the study was that no generic management system should be applied to a specific supply chain without adaptations that accommodated the particular conditions of its material and information flows. In the case of the particular chain analysed, one of the probable reasons identified for the lack of success was the attempt to use an integration system originally developed for a three level chain (manufacturer-retailer-consumer) in a four level chain (manufacturer-distributor-retailer-consumer). This led the manufacturer not to consider the information coming from the point of sale (the retailer), focusing only on the consolidated and delayed demand information available from the immediate customer, the distributor (Saab and Correa, 2005).

The search for more promising alternatives, which constitutes phase (b) of the investigation, resulted in the proposal presented in this paper. We propose that at least under certain conditions (e.g., in a four-level supply chain) the main coordinating role should be performed not by the manufacturer (as in traditional VMI models) but by the distributor. This is because the more central position occupied by the distributor in a four-level supply chain would provide it with better conditions to integrate the information coming from the retailer into the management system.
2 Theoretical concepts and characteristics of the market considered

In this paper, ‘distributor’ refers to the second entity of the distribution system, located between the manufacturer and the retailer, within a supply chain of non-durable consumer goods, and that operates under the exclusive distribution system (Lambin, 2000).

The distribution channels’ so-called intermediary entities – agents, distributors, wholesalers and retailers – carry out countless activities involved in competitive and free exchange processes, in order that an efficient connection between production and consumption is achieved (Rosenbloom, 2002). Typically, intermediaries associate themselves with manufacturers of diverse products forming the complex grouping of institutions through which a free market system transfers the ownership of products and services (Bowersox et al., 2006).

Supply chains can be direct (manufacturer-consumer) or have several intermediary levels. According to Souza (2002) there are two conceptual streams to help justify the decision of either integrating or outsourcing a marketing channel arrangement: agent theory and transaction cost economics. The potential savings provided by the incorporation of specialised intermediaries in a distribution channel can be illustrated by the example on Table 1.

Table 1 Illustrative example of the reduction in the number of transactions resulting from the addition of one distributor in a hypothetical supply 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>1000</td>
<td>1000</td>
</tr>
<tr>
<td>Number of direct transactions (n × p):</td>
<td>3000</td>
<td>1003</td>
</tr>
</tbody>
</table>

Transaction savings

| Reduction in the number of transactions (n × p) – (n + p): | 1997 |

2.1 Supply chain management

Improving the efficiency of a supply chain is to improve the efficiency of its ‘nodes’ (involved companies’ internal environment) and its ‘links’ (interfaces between two consecutive companies in the chain). After the intense internal reorganisation movements (e.g., just-in-time, total quality management and business process reengineering) that characterised the 1970s, 1980s and 1990s, led to ‘diminishing returns’, corporations re-directed their improvement foci to the external environment: the supply chain.

In supply chains, the physical flow of products, predominantly unidirectional and oriented from manufacturer to retailer, requires simultaneous and coordinated ‘parallel’ (and some times backwards, bi-directional and non-conservative) flows: of orders, of
payments and most of all, of information (Lambin, 2000). The principal objectives of supply chain management are to offer proper value to consumers and maximum return on assets to members of the supply chain. These objectives are accomplished through the effective integration of process activities internally and with other firms in the network (Wisner et al., 2005, p.410). Consider that the Return on Assets (ROA), for any node in the supply chain is given by the product: profit margin ratio (before interest expense and related income tax effects) times Total Assets Turnover Ratio (Stickney and Weil, 2000, p.238).

Consider the case of an exclusive distributor in a four level chain that works with consumer goods in a competitive market. The distributor’s gross margin is exogenously established, as the company’s variable cost is mostly imposed by the manufacturer’s great bargaining power. The distributor’s selling price is determined by the market’s competitive conditions. The distributor, therefore, must effectively execute on fixed costs and inventory turnover, operational variables over which the company has greater control. Inventory turnover is evaluated by the ratio between the flow of products (Cost of goods sold) and the average inventory (also valued at cost), so the distributor is pressured to reduce its average inventory.

However, the causal loop diagram, illustrated in Figure 1, suggests that a possible direct effort to reduce inventory can create excess inventory over time. Reducing inventory may be more effectively accomplished if it occurs as a consequence of managerial action that results in better and more lasting performance (or, in other words, on greater ‘leverage points’). Kirkwood’s (1998) research on leverage points shows that modifying information links in a business process (for example greater levels of information sharing between nodes, changing the delay of information transfer, etc.) can have a profound impact on performance. The solution for greater efficiency of material flow can be found in the way the information flow is carried out and coordinated in the supply chain.

Figure 1 The direct pressure to reduce excess inventory is self-reinforcing

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However, information sharing between nodes of a chain assumes the existence of trust bonds between the entities of the supply chain, something that does not occur in a great number of chains and, in particular, it does not occur in an outstanding way in the chain investigated by the authors. When one entity dominates a network, barriers to trust are created. Trust facilitates the bidirectional flow of information that allows value to be generated through integration, positively influencing the supply chain partners information exchange behaviour (Klein, 2007; Poirier and Reiter, 1997).

“A supply chain must have an element that unites the members; otherwise the chain will have little substance. In a typical situation this element is the position influence. [...] The more powerful members simply exercise their strength over the weaker participants [...], and extract unjustified concessions to guarantee the continuity of supply....” (Poirier and Reiter, 1997, p.95)

2.2 Dynamic systems

When companies form a supply chain, delays in the flow of information and materials (products) result in an outstanding dynamic phenomenon: demand oscillations, which have a direct influence on the chain’s economics. Forrester’s (1973) studies (and many that followed him) have provided an understanding of these oscillations in the flows of capital, orders, information, materials, people and goods, along the links of a supply chain. The behaviour characterised by the increased demand variance in the upstream chain levels when any type of disturbance is introduced in the normal course of retail sales, is known as ‘Forrester’s effect’ (Lee et al., 1997).

Forrester (1973) used in an original manner a production-distribution system for durable consumer goods (home appliances) to numerically demonstrate how organisational structure and policies can result in undesirable behaviours. Examples include: small changes in retail sales can cause great fluctuations in the plant’s production levels; compressing the time of administrative delays may not be enough to improve the conditions under which management decisions are made; a plant may become unable to fulfil orders even when it is capable of producing more goods than are being sold to the consumers; or an advertisement campaign can amplify the demand variances at the production node in a totally unpredictable way.

Since Forrester’s (1973) seminal work a systematic way has been developed to test the dynamic result of alternate supply chain coordination proposals. We suggest that such systematic approaches should be the (or at least one) discriminating criterion when any supply chain integration proposal is assessed.

Forrester (1973) showed that typical oscillations in the supply chain can be reduced by reducing the number of intermediary levels (distributors, retailers). However, after over 30 years from the original publication of his work, other authors (Rosenbloom, 2002) continue to assign important functionality to distributors in globalised distribution chains, partly due to transaction cost savings (for example, due to the possibility of consolidation and economies of scale in transport, storage and deliveries) (see Table 1).

A second and more recent wave of supply chain ‘disintermediation’ proposals arose with the advance of the internet, which made possible the increase of direct interaction between ‘distant’ supply chain elements (e.g., between manufacturer and consumer). However, despite profound changes in the distribution of some products and services, the belief that the World Wide Web would eliminate intermediaries from various business processes ended up being deemed one of the myths of internet. According to Albertin
Forrester’s (1973) main legacy is the application of System Dynamics Analysis to the business world. This methodology is sometimes called ‘systems thinking’.

During the phases of problem definition and boundaries establishment of systems thinking, it is possible to represent any business process by means of an “inventory and flow diagram” (Kirkwood, 1998). In this type of diagram the relationships between inventory and information flows are parts of a system. Detailed information is not relevant, such as the equipment used, but the characteristics shared by the business processes and their components are. All these processes can be characterised in terms of variables of only two types: inventory (levels and accumulations) and flows (rates). According to Kirkwood (1998), decades of practical application confirm that this approach can result in a competitive advantage.

2.3 The evolution of the fast moving consumer product supply chains in Brazil

After the adoption of the so-called Plano Real economic plan, in 1994, Brazilian inflation was reduced and stabilised. As a consequence, a change in consumption habits of the inhabitants of large cities gradually took place. As a response to the change in purchasing and consumption behaviour of the consumer, the small Brazilian independent retailer supply chain gradually became the most important distribution channel for consumer goods in the country. The small retailer became responsible for the flow of over half of the local production and reached double digit growth in recent years, according to the Brazilian Association of Wholesalers and Distributors (ABAD, 2003). Domestic manufacturers reach directly only 5% of the outlets in Brazil. Therefore, they depend on the ‘tiered’ chain to reach the remaining 95%, which illustrates the importance of intermediaries to ‘vascularise’ Brazilian distribution and consumption (Baumgarten, 2006).

The small retailer traditionally attended to in an intermittent manner by long and uncoordinated supply chains, became a new strategic target for manufacturers. By developing effective relationships with small retailers, manufacturers would be able to reduce the influence and bargaining power of the large retail chains that began to merge and consolidate in the 1990s (Parente, 2000). To take advantage of the change in the market, some consumer goods manufacturers established in Brazil started to redesign their distribution systems (Saab, 2003), selecting the four level distribution channel as a priority for investment and sales expansion.

With the growth in strategic importance of the ‘longer’ four-level distribution channels, the manufacturers tried to adapt into this new segment the existing coordination tools (e.g., VMI), which they had developed, at great organisational and financial cost, to manage their interface with the large retail chains (in ‘shorter’ three-level distribution channels). The specific initiative which is the object of this research work, attempted to apply VMI to longer four-level channels. The results were disappointing in that the application of VMI did not reduce demand oscillations in the various levels of the supply chain and actually reduced the inventory turn rate at the distributors. Interestingly enough, the problems the VMI was supposed to eliminate were essentially unabated three years after the large manufacturer implemented the initiative, regardless of the significant amount of resources spent in the effort.
3 DMI: an alternate system to VMI

From the viewpoint of dynamic systems analysis, omitting the retailer is a critical oversight. Without the retailer, the early identification and measurement of supply chain demand fluctuations is not possible. The Forrester effect suggest that undetected demand fluctuations at the ‘source’ – at the retail level – get amplified upstream and become much more difficult to neutralise or manage (Lee et al., 1997). In addition to this evident limitation, Saab and Correa (2005) demonstrate that the transplantation of a coordination/integration information system from one supply chain to another requires the identification and adjustment of new leverage points for an appropriate operation in the new supply chain environment. Their conclusion explains and reinforces Simbari’s (1996, p.94) comment:

“These industry initiatives – ECR, VMI, CRP, and QR – failed to fully address the needs of companies producing and distributing goods because the initiatives were not developed specifically for particular industries. These approaches do not coordinate the demand supply chain processes, which is the exact point where manufacturers and distributors must coordinate requirements and replenishment. Additionally, they do not provide for disparate trading partners that adopt other approaches or use conventional practices.”

The successful integration of a four-level supply chain depends on the adoption of more complex solutions in some aspects (integrating, for instance all the involved nodes) and more customised in others, so that the specifics of a given supply chain can be addressed.

The extension of the information flow management system to include all nodes of a supply chain could in principle be led and managed by any of the nodes except for the end consumer. However, a preliminary analysis of the four-level supply chain nodes suggest that the distributor might well be the best candidate to assume the coordination role.

The first and stronger argument for superior coordinating role of the distributor is that both the typical manufacturer and the typical retailer belong to dozens and in some instances hundreds of different supply chains. In a country the size of Brazil, thousands of different products categories from thousands of manufacturers to thousands of retailers are distributed in complex supply networks. By contrast the distributor is a node in a chain that participates in fewer different networks and, if (as in the case analysed in this paper) the distributor is exclusive, just one, upstream from it.

To customise the information flow system to the specific chain (due sometimes to specificities in the business models involved and sometimes due to incompatibilities between the different legacy information systems involved), manufacturers and retailers would in practice have much more difficulty to establish a coordination model. The distributor, dealing with a smaller number of different chains would be in a privileged position to do so.

Besides these practical limitations, the manufacturer has competencies and responsibilities predominantly related to research, development, manufacturing and marketing of their products. The retailer in general, has the increasingly important task and responsibility of rendering services to and managing the relationship with the consumer. On the other hand, the main activity of the distributor is to provide the distribution service to the chain. The distributor node has a natural vocation to coordinate flows of information and material, since this activity is to a certain extent its core business as our study suggests.
Based on the preliminary results of the studied case, the objective of the research reported here was defined as to explore and analyse an alternate management model for the four level supply chain. In the proposed model the distributor (and not the manufacturer, as in more traditional models such as VMI) assumes the role of coordinating the flows of information and material throughout the supply chain. Summarising, according to the Distributor Managed Inventory (DMI) the distributor:

- gains frequent access to the final consumer demand information (collected from the retailers), regarding the products they distribute
- frequently transfers the retail demand information to the manufacturer to allow for a better manufacturing capacity dimensioning and planning
- calculates the replenishment frequency and quantities of products to be delivered to the retailers so that agreed service levels, inventory turns and safety stock levels are maintained
- considers macro-regional (such as seasonality) and micro-regional tendencies (considering products sold to consumers in nearby retailers of the same kind) so that appropriate mixes of products are maintained in each retail store
- manages the regional consolidation of freight so that economies of scale are obtained and more frequent deliveries to the retailers are made possible.

This coordinated information system requires an appropriate information technology infrastructure. New internet based solutions have made the requisite infrastructure more readily available and affordable.

4 Research methodology

The methodological approach was to analyse, from different perspectives, the proposed DMI for a four-level supply chain. The first challenge was to determine a model to be used to test the proposal.

Traditional capital investment and project evaluation models involve estimates of the investment dollars, the generated future cash flow along the project life, and the opportunity cost rate to be applied in discounting the future cash flows. These models deal with essential financial values. Other contemporary approaches seek to quantify more intangible values involved in a decision or, to make sure that the proposal is aligned with the overall business strategy even before the financial analysis is done (Kaplan, 1986; Bronwich and Bhimani, 1991). However, no appropriate evaluation model for supply chain related projects was found in the literature since they do not consider the impact of dynamic response to economic and financial dimensions. Dynamic response is important per se as an autonomous dimension, because any new arrangement should be conducive to stability or, in other words, to reductions in the amplitude and frequency of the oscillations of demands at all levels of the supply chain.

We propose a new model for the assessment of decisions in the supply chain management realm. Initially, we assess whether the proposed change is generically aligned with the companies and the distribution channel strategies, because incentive alignment is an important facet of supply chain management (Narayanan and Raman, 2004).
Second, the proposed DMI is tested in a dynamic simulation of supply chain behaviour. Finally, the proposed DMI is analysed from the financial perspective. We decided to utilise two metrics, Contribution Margin (CM) and Inventory Turns (IT). CM and IT directly influence the operational result of all nodes in the chain. The metrics also allow for generalisation of the conclusions, since they do not depend on the particular company’s fixed cost structure. These parameters were not estimated based on usual linear projections, instead they were obtained directly from the dynamic simulations performed.

For the strategic evaluation, we used the traditional analysis of competitive forces by Porter (1999). We adapted Porter’s model to analyse the competitive forces present in the interface between the distributor and the market. Additionally, we also considered the so called resource based view, with the use of the concept of ‘core competencies’ (Hamel and Prahalad, 1994).

For both the strategic and the economic analysis, we studied a real case as reference. The case supply chain is part of a large distribution system involving a large US multinational manufacturer of Fast Moving Consumer Goods (FMCG) that have established operations in Brazil for more than five decades, one of its exclusive distributors in the state of São Paulo and the retailers served by this distributor. The manufacturer in 2001, in an initiative to restructure its distribution channels, granted distributors the status of strategic partners. Consequently, the manufacturer began a programme to connect its information systems with those of the distributors. The final objective of this initiative was to implement a VMI management model. The authors had the opportunity to follow closely the integration effort and also had full access to detailed operational and financial data related to the implementation. For the dynamic analysis, we built a mathematical model of a four level supply chain that was calibrated and subjected to a number of simulation studies. The simulation model building exercise followed a typical methodology in dynamic systems analysis, with the initial development of a causal relationship diagram and of a stock and flow diagram, reproduced in Figure 2.

**Figure 2** Stock and flow diagram of the DMI model for the particular four level supply chain analysis
For the numerical simulation, all interactions between entities represented in the stock and flow diagram (Figure 2), whether conservative (stock) or non-conservative (information) deemed, were turned into equations, then numerically integrated along a pre-established time period. Based on the initial value of each variable, and on the numerical iterations, it was possible to find all intermediate and final values of all variables of interest to the model evaluation. To perform this operation we used the VenSim© software, that not only supported the organisation of the necessary diagrams but also, by utilising the Euler (Kopchenova and Maron, 1975) method, performed the numerical integration of the equations that resulted from the model. We took the usual care to guarantee the method stability during the integration process, for instance, the careful choice of the time pace, consistently with the time constants present in the model. The final model utilised was the 17th in the sequence of studies and presented complete mathematical closure, in other words, equality between the number of equations and number of variables. It also presented consistency in the units of stocks and flows.

One of the main characteristics of the developed model is its flexibility. This allowed for the testing and comparing of the different supply chain management policies represented by the traditional VMI and by the proposed DMI. To test the VMI in comparison to the DMI we changed the frequency with which information was exchanged between nodes in the chain. For example, in the case of VMI, the information flow of sales at the retailer got to the manufacturer only indirectly (through sales at the distributor) and with low frequency, referenced as ‘loose coupling’ of the chain. To simulate DMI, the information flow from sales at the retailer got not only directly to the distributor, but also with high frequency, referred to as ‘rigid coupling’.

The time interval selected for the simulation was 50 weeks, along which we studied the dynamic responses of the chain to the situations of loose and rigid coupling. As we performed a large number of preliminary simulation studies, the criterion chosen for the initial stock levels was the minimum stock level that would not allow for stock-outs during the simulation period. The stimulus was an instantaneous 20% increase of end consumer demand (which is called a ‘step function’). Although the step function does not represent typical market behaviour; an instantaneous demand shock triggers all the natural frequencies of response possible to a certain dynamic model (Kirkwood, 1998), thus testing the robust nature of the model. The ten initial simulation weeks allowed the system to converge to total equilibrium before the shock. Consequently all the dynamic responses after the tenth week could be unmistakably attributed to the shock of demand alone.

5 Analysis and results

5.1 Strategic analysis

Four out of the five Porter’s (1999) ‘competitive forces’ are particularly relevant for this strategic analysis: the bargaining power of suppliers, competitive rivalry within the industry, the threat of new entrants and the bargaining power of customers.
5.1.1 Considerations about the bargaining power of suppliers

The strategic consideration to the manufacturer and its interface with the distributor is the corporate pressure for higher profitability in the subsidiary’s FMCG business. The FMCG business line was used as a cash cow to fund other divisions in rapid growth phases. A second strategic consideration was the difficulty the Brazilian manufacturer had in obtaining corporate funds to invest in productivity improvements. Strategically, the FMCG division in Brazil was considered a lower priority compared to other corporate divisions (e.g., the pharmaceutical division). A further complicating factor was at the time of the study, the Brazilian currency, the ‘real’ was highly devalued in relation to the dollar, putting the FMCG division at an exchange rate disadvantage.

The pressure that the manufacturer faced for short term profitability together with the relative short term price-demand inelasticity of its products, prevented the distributor from increasing inventory turnover to desirable levels. The result was cyclical crises to the supply chain because members were not capable of selling excess production caused by corporate targets for high plant utilisation. This is one of the causes of the bullwhip effect in ‘pushed’ supply chains (Lee et al., 1997). The bullwhip effect was aggravated by a poor incentive alignment system, where the supply chain has a distribution of risks and rewards that is not perceived as fair by all their members (Narayanan and Raman, 2004).

Given the past practice legacy there is potential for manufacturers to resist the adoption and implementation of a system such as DMI, which would reduce their control level regarding the quantities and timing of the logistic operations, control manufacturers have in traditional VMI systems. However, the migration of the coordination of information flows to the distributor enables the supply chain to be more ‘pulled by demand’ rather than ‘pushed by supply’. Also the new system would allow for the manufacturer to concentrate and focus on its core competencies (Hamel and Prahalad, 1994). In the long run, if (at least) part of the cost reductions attained by the new DMI system is passed on to the final consumer, there should be the potential for sales increases. Therefore, the benefits of DMI for the manufacturer in the short term are related to cost reductions and in the long term, to sales increases.

5.1.2 Considerations about the competitive rivalry within the industry and the threat of new entrants

The substitute ‘new entrants’ aspect is of particular relevance to the analysed supply chain. Most of the products of the Brazilian manufacturer were in the maturity life cycle phase and new investments in products was limited. Low investments led to low differentiation levels and in a market with relatively low barriers to entry (as the FMCG market has been characterised), the result was increasingly lost market share to ‘new entrants’. The main threat typically came from small local new producers and some current competitors who positioned themselves in the ‘low price’ market segment. The market segment with the highest growth rate in Brazil was the so called ‘bottom of the social pyramid’, a segment that is very sensitive to price. In this scenario, the more cost effective DMI system can add value to the distributor and the manufacturer, making the supply chain members better able to face competition from low cost producers.
5.1.3 Considerations about the bargaining power of customers

In the interface with the retailers, DMI can represent the role of an integrating catalyst rather than a source of tension. Not much has been found in the literature or in practice about the distributor-retailer interface. In one of the few identified contributions, Ortenzi (2000) in research performed in the UK health related products market reports the ranking she found of the most important services provided by distributors to retailers, perceived from the standpoint of the retailers (drugstores) (see Table 2).

Table 2  Ranking of the importance of different services provided by distributors to drugstores in the UK, as perceived by the drugstores

<table>
<thead>
<tr>
<th>Service</th>
<th>Importance 1 (less) to 5 (more)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information about inventory item availability</td>
<td>4.71</td>
</tr>
<tr>
<td>On time deliveries</td>
<td>4.67</td>
</tr>
<tr>
<td>Delivery frequency</td>
<td>4.63</td>
</tr>
<tr>
<td>Speed of customer service response</td>
<td>4.57</td>
</tr>
<tr>
<td>Competitive discounts</td>
<td>4.47</td>
</tr>
<tr>
<td>Transparency in commercial terms</td>
<td>4.06</td>
</tr>
<tr>
<td>TI system support</td>
<td>3.83</td>
</tr>
</tbody>
</table>

Ortenzi (2000) also reports the main deficiencies found in the distributors’ operations according to their customers (drugstores) (see Table 3). According to Ortenzi (2000), the health and beauty care market structure and current practices of the UK and Brazil are to some extent similar and allow for comparisons between the two countries.

Table 3  Opportunities for improvement in services provided by distributors to drugstores in the UK, as perceived by the drugstores

<table>
<thead>
<tr>
<th>Distributor’s deficiencies</th>
<th>Percentage of researched drugstores where the problem was detected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of information about inventory/stock outs</td>
<td>22.0</td>
</tr>
<tr>
<td>Low discounts for generic medicines</td>
<td>8.4</td>
</tr>
<tr>
<td>Does not know enough about discounts</td>
<td>2.0</td>
</tr>
<tr>
<td>Poor customer service</td>
<td>2.0</td>
</tr>
<tr>
<td>Minimum order quantities</td>
<td>1.3</td>
</tr>
<tr>
<td>Supply frequency</td>
<td>1.3</td>
</tr>
<tr>
<td>More attention to owned retailer chains</td>
<td>1.3</td>
</tr>
<tr>
<td>Late deliveries</td>
<td>1.3</td>
</tr>
<tr>
<td>Profit orientation rather than to orientation to patient problems</td>
<td>1.3</td>
</tr>
<tr>
<td>No established on the web</td>
<td>1.3</td>
</tr>
</tbody>
</table>

If we accept Ortenzi’s conclusions regarding the two markets similarity, we can use the improvement opportunities listed by her research as an initial framework to further analyse the attractiveness of the DMI proposal. Out of the dimensions listed by Ortenzi, at least four are directly affected by DMI: information about inventory items availability;
frequency of deliveries, transparency in commercial conditions and, IT business support. The worst deficiency identified by Ortenzi was related to product and product availability information availability which is one of the main objectives of DMI.

5.1.4 Considerations about the involved competencies

In terms of competencies, out of the three nodes analysed, the retailers’ main competency should be customer relations management and sales. The manufacturers’ should be product development, manufacturing and marketing. Capillary data capture, information provision to the manufacturer, consumer demand forecasting (helped by the ‘risk pooling’ effect since the distributor sells to hundreds of retailers), product replenishment control and the management of consolidated warehousing and transportation should be the competencies of a distributor.

The dissemination of the DMI system amongst the retailers can favour the development of trust relations and therefore loyalty to the exclusive distributor and consequently to the manufacturer. This is because of the accessory services that would form the value package offered to the retailers by the distributors. These services include inventory management with protection against stock-outs and excess stocks. With DMI the decisions about inventory replenishment are made by the distributor and not by the retailers, so it is important that the risks of a bad decision are assumed by the decision-maker. The use of policies such as ‘buy back’ and ‘consignment’ protect the retailer against overstocks and ‘free emergency shipments’ protect them from possible stock-outs. These polices fall into the realm of incentive alignment that must be a part of a DMI supply chain. The enhanced value package offered would raise the barriers to entry for potential new entrants and would increase pressure on the competitors.

Summarising, DMI could be a strategically valuable alternative in relation to several interfaces between the market and the distributors, bringing potential advantages to all the partners in the supply chain: the manufacturers, the retailers and the distributors.

5.2 Dynamic analysis

The results of the dynamic analysis – second step of the assessment method – were obtained by the time integration of the system of equations and contour conditions developed in the mathematical model of the four-level supply-chain during 50 simulated weeks. The dynamic behaviour for the retailer’s inventory, distributor’s inventory and the manufacturer’s production levels (considered to be the three most important variables to demonstrate the economic and dynamic value of the model) are shown in the graphs in Figures 3, 4 and 5.

In the case of VMI, as can be seen in Figure 3, when the system was subjected to a consumer demand increase of 20% (using a step function) on week ten, the minimum retailer’s stock level necessary to avoid stock-outs was 89 units. The DMI operation is more stable, 59 units are sufficient to ensure no stock-outs occur when the system is submitted to the same demand ‘shock’. When the system stabilises, around week 50, the inventory levels are 29 units for VMI and only 13 for DMI.

For the distributor, Figure 4 indicates that VMI requires a minimum initial inventory level of 108 units to avoid stock-outs with a sudden consumer demand increase of 20%. With DMI, 89 units would suffice. When the system stabilises, also around week 50, stock levels are 54 units for VMI and 36 for DMI.
Figure 3  Dynamic behaviour of the retailer’s inventory for VMI and DMI

Figure 4  Dynamic behaviour of the distributor’s inventory for VMI and DMI

Figure 5  Dynamic behaviour of the manufacturer’s production for VMI and DMI
Figure 5 demonstrates that the manufacturer also enjoys improved performance with DMI: production in the manufacturer’s plant reacts earlier to the consumer demand fluctuation and the production level peaks are lower. The production curve becomes more flat, which can represent lower production costs.

5.3 Economic analysis

In this type of Brazilian chain the typical gross margin is 20% (Saab, 2003) and subtracting the variable expenses (taxes, freight and commissions), the contribution margin for the distributor, for the line of products in this case was 3.75% of gross sales revenues. From this a distributor has to pay the fixed costs of its organisation, amortise the investments realised in infrastructure and generate a ROA above the market opportunity costs. Therefore, along a month’s operation, the product CM multiplied by IT should be sufficient to cover the distributor’s Fixed Expenses (FE) plus the expected ROA.

Considering that the distributor is part of a specific supply chain and under the premises that the relationship between the chain partners should be long term and even, we assumed that the ROA should be in principle similar for all supply chain members. Thus, we utilised the same expected ROA for the distributor as the average manufacturer’s ROA, calculated based on the publicly available balance sheets (since the manufacturer in our case is a publicly traded company). We used the latest three year period to calculate the average ROA of 22.13%. We also investigated a number of other distributors in Brazil and concluded that a good estimate of their typical FE would be in the range of 7 to 11% of their revenues. We also estimated their total assets and these ranged from 50 to 200% of their monthly revenues (according to their different cost structures and management policies). Based on these data, we conducted a sensitivity study (Saab, 2003), which demonstrated that the (monthly) inventory turnover ratio for distributors in this market should be between 2.14 and 3.8. In our case’s supply chain, the inventory policies practiced (and at a certain extent imposed) by the manufacturer resulted in a (monthly) inventory turnover of 0.75 for the distributors – or around one fourth of what would be necessary for the risks and rewards to be aligned in the supply chain.

The mismatch between the requirement (for higher inventory turnover levels) and the reality (low inventory turnover levels) of the distributors in the studied supply chain allowed us to conclude that there was not an appropriate level of incentives and objectives alignment in the manufacturer’s supply chain. The distributors were then forced to participate in at least one more supply chain (with products of other categories not found in the manufacturer portfolio due to their ‘exclusive’ distributor condition). The second supply chain involvement allowed for additional and higher percentage contribution margins. Concurrently with this situation, the manufacturer was trying to impose a VMI system.

The economic analysis before and after the DMI model implementation, the third and last step of our evaluation, was performed by calculating IT levels for the distributor and for the retailer, with data drawn from the dynamic analysis. The data are presented in Table 4. The results show the superiority of the DMI system over the current system and the VMI, for both the distributor and the retailer.
Table 4  Variation of inventory turnover levels in a VMI applied in a simulated four-level supply chain and in a DMI model applied to the same supply chain. All comparisons were done based on data from the 50th week of simulation and therefore with the system already stabilised

<table>
<thead>
<tr>
<th>Performance</th>
<th>Current system</th>
<th>VMI</th>
<th>DMI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Distributor</td>
<td>Retail</td>
<td>Distributor</td>
</tr>
<tr>
<td>Sales (units/week)</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>Inventory (units)</td>
<td>632</td>
<td>29</td>
<td>54</td>
</tr>
<tr>
<td>Turns (one/week)</td>
<td>0.19</td>
<td>4.1</td>
<td>2.2</td>
</tr>
<tr>
<td>Turns (one/month)</td>
<td>0.75</td>
<td>16.6</td>
<td>8.9</td>
</tr>
</tbody>
</table>

6 Conclusions and limitations

After following an actual unsuccessful three year attempt to implement a VMI system in the FMCG sector of Brazil, the indication was that the potential benefits of VMI may not be realised in particular distribution systems. A review of the literature found the existence of various other unsuccessful cases, adding confirmation to our conclusion. Our analysis to the four level chain showed that VMI in the manufacturer-distributor link under-utilises information and does not address sufficiently important conceptual and dynamic aspects, when adapted to the four level chain.

The alternate management approach proposed, here called DMI, added the integration of the sales outlet (retail) to the management system. Our strategic analysis shows that the distributor in our case could reach a better strategic situation compared to the VMI. Assuming the responsibility over the information and finished products flow in the supply chain, the distributor would also allow its partners to focus on their core competencies.

The dynamic analysis of the proposed DMI showed that the system was:

- stable (convergent)
- dampened the typical fluctuations of the chain faster to a smaller amplitude and steady state due to the greater frequency of the information traffic
- allowed significant inventory reductions
- was robust enough to cope with a 20% instantaneous increase in demand, with inventory 55% smaller in retail and 33% smaller at the distributor, when compared to the reference situation VMI.

The economical analysis, based on the numerical simulation and the specific requirements of the chain studied, showed that the system has the potential to increase the distributor’s monthly turnover to up to 13.3. That number is much higher than the minimum interval necessary of between 2.14 and 3.80 for the distributors of the network found to attain a minimally acceptable ROA.

As shown by the result of the dynamic analysis (Figures 3 to 5), followed by the economical analysis, DMI presented advantages for retailers. Their turnover reached the theoretical limit of 36.9 inventory turns per month. Manufacturers benefited as well, as the greater speed in identifying demand fluctuations allowed a faster response in
production planning and supplies purchase. In our simulation the DMI system integrated the distributor to the retailer in such a way that it was similar to ‘shortening’ the chain, complying with, for practical effects, Forrester’s (1973) original recommendation.

Limitations to the generalisation of the conclusions are related to:

- the relationship models of the flow of information and materials used to assess the VMI and DMI performance between the entities of the analysed supply chain
- the lack of research on the problems and opportunities in the distributor-retailer interface in the Brazilian market.

These issues are indicated as suggestions for further research.

As shown in the literature, each chain is a particular and difficult to reproduce combination of many activities, many times with different dynamic leverage points (Saab and Correa, 2005). Therefore, the automatic generalisation of the results herein is not proposed for any other supply chain with particularities of flow of information and materials different to the proposed model.

The results allow stating, however, that whenever a four level chain is a candidate to operate under VMI, DMI may also work with potential advantages. The differences between the models are not only in the dynamic and economic performance, but, mainly, in the supply chain integration concept itself. In DMI, the dynamics make the four level chain act as though it was reduced to a three level chain, preserving, however, the advantages of the four level chain. In addition, information use is improved by including data obtained at the retail level, thus helping minimise demand fluctuations at all levels.

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Optimising performance with DMI in a FMCG supply chain


Bibliography


